Anniversary Issue — Looking Back Over 50 Years

Radio-Electronics

APRIL 1958
K

TELEVISION · SERVICING · HIGH FIDELITY

HUGO GERNSBACK, Editor

Electronic Switch For Your Scope

■

Stereophonic Tape Preamp

■

Taming the Horizontal Oscillator

■

Oscillations in Transistor Radios

■

Assembling an Airborne Digital Computer

(See page 4)

35c
U.S. and Canada

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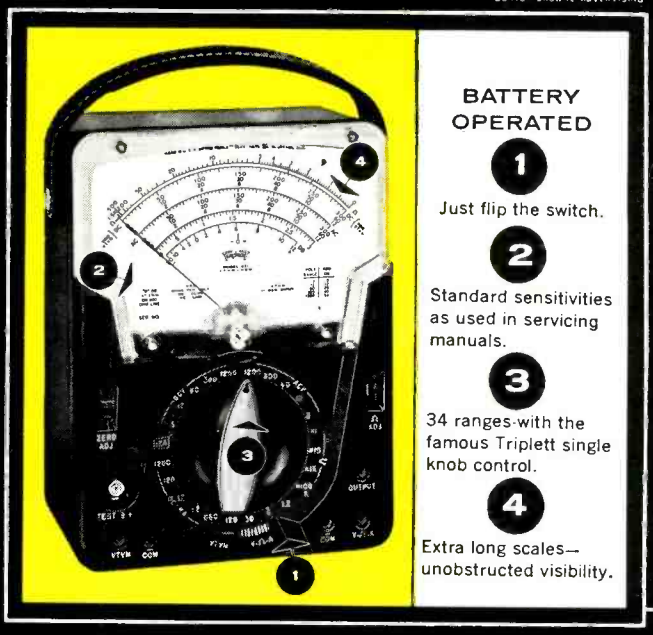

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Triplett Model 631 the standard Combination VOM and VTVM $64.50. Here's the *one* instrument which will do practically *all* the measuring in your electronic projects.

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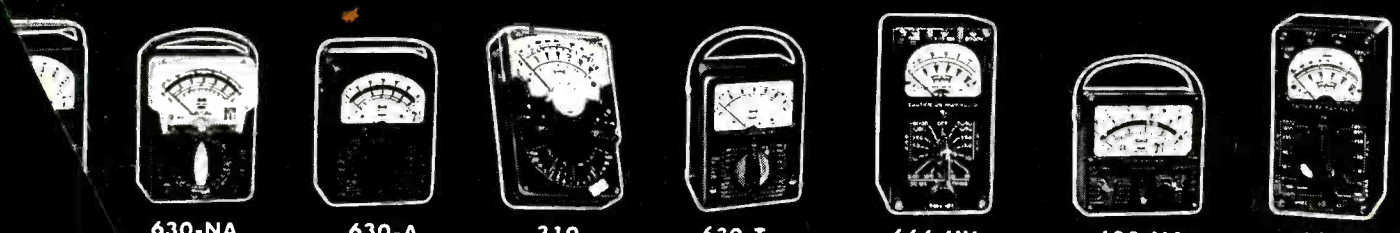

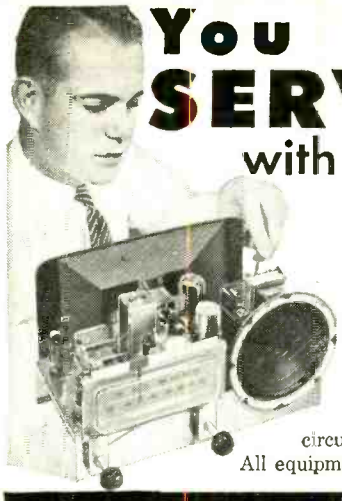

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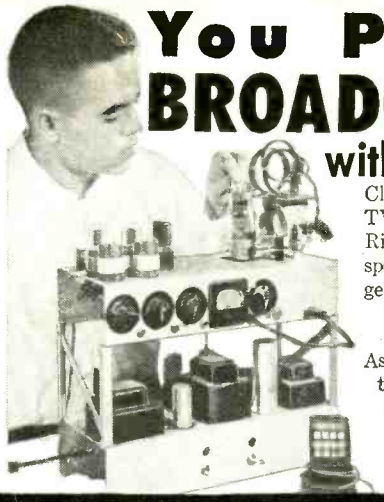
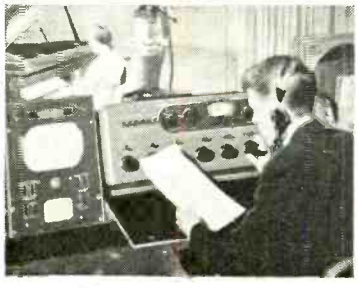
Right now, a solid, proven field of opportunity for good pay is servicing the millions of Television and Radio sets now in use. With NRI's Servicing Course, *without extra charge*, you get NRI kits developed especially to give actual practice with Television-Radio equipment. You build, test, experiment with actual Television-Radio receiver circuits; build, use testing equipment. All equipment is yours to keep.



You Practice BROADCASTING with Kits NRI Sends

Clearly written NRI lessons teach TV-Radio-Electronics principles. Right in your own home, during spare time, you gain knowledge, get confidence building experience, develop skills needed to get and hold jobs in this vast industry. As part of NRI communications training you build low-power Broadcasting Transmitter, other equipment; train for your FCC Commercial Operator's license. You learn by doing.

I Will Train You at Home in Spare Time to be a TELEVISION-RADIO Technician



TELEVISION Making Jobs, Prosperity

A steady stream of new electronic products is increasing opportunities for TV-Radio Technicians. The millions of Television and Radio sets now in use need servicing. Hundreds of TV and Radio stations on the air offer interesting jobs for Operators and Technicians.

J. E. SMITH,
Founder, National Radio Institute
Over 40 Years' Experience Training Ambitious Men

America's Fast Growing Industry Offers You Good Pay, Success

People look up to and depend on the Technician, more than ever before. His opportunities are great, and are increasing. Become a TV-Radio Technician. At home and in your spare time, you can learn to do this interesting, satisfying work—qualify for important pay. NRI is America's oldest and largest home study TV-Radio school with over 40 years' experience and thousands of successful graduates. NRI methods are tested, proved. Successful graduates are everywhere.

Technical Know-How Brings Better Pay, Advancement

NRI TRAINED THESE MEN

"My income has steadily increased in Radio. I have advanced to Chief Engineer of TV Station KTIV."—A. H. SMITH, Sioux City, Iowa

"Fix sets part time in my shop. Made about $500 first three months of the year. Could have more but this is about all I can handle."—FRANK BORER, Lorain, O.

"I've come a long way in Radio and Television since graduating. Have my own business on Main Street."—JOE TRAVERS, Asbury Park, New Jersey.

"Before finishing the NRI course I was employed as Studio Engineer at KMMJ. I am now announcing."—BILL DELZELL, Grand Island, Nebraska.

New electronic products are boosting the need for more and more trained TV-Radio Technicians. Offices, plants, homes everywhere—are obliged to buy their knowledge and services. For instance, transistor Radios, Color TV, Hi-Fi, were unknown a few years ago. Guided missiles, computing machines, automation would not be possible without this miracle science—Electronics. Police, Aviation, Mobile Two-Way Radio are expanding. The military services reward qualified Technicians with higher rank and pay. To ambitious men everywhere, here is rich promise of fascinating jobs, satisfaction and prestige, increasing personal prosperity.

Mail Today-Tested Way to Better Pay

Start Soon to Make $10, $15 a Week Extra Fixing Sets

NRI students find it easy and profitable to start fixing sets for neighbors and friends a few months after enrolling. Use the Tester built with parts NRI furnishes to locate and correct TV-Radio receiver troubles. Picking up $10, $15 and more a week gives substantial extra spending money. Many who start in spare time, soon build full time TV-Radio businesses.

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APRIL, 1958

Radio-Electronics

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SPECIAL FEATURE

EDITORIAL

AUDIO—HIGH FIDELITY

TEST INSTRUMENTS

RADIO

WHAT'S NEW

TELEVISION

ELECTRONICS

ON THE COVER

(story on page 68)

Some final soldered connections on the plug-in assembly of the Digitair—an airborne digital computer—are made by Catherine Bochat at the Hughes Aircraft El Segundo, Calif. plant.

Color original by Hughes Aircraft Co.

RADIO-ELECTRONICS is Indexed in *Applied Science & Technology Index* (Formerly *Industrial Arts Index*)

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News Briefs

THREE-CHANNEL MULTIPLEXING has been proved feasible by two stations in a series of tests over the past 9 months. FM station WGHF, Brookfield, Conn., reported to the FCC that it had successfully broadcast three programs simultaneously on a single FM channel. WGHF used two methods of transmission during the trials. For one, the station's main channel was used for one program and two subchannels carried a stereo program. In the second method one of the subchannels was used for a commercial background music service, which was supplied to restaurants and other companies, while the main channel and other subcarrier were used for stereo broadcasts.

The second station successfully to use the three-channel system is KBMS-FM Los Angeles, Calif. The station plans to broadcast stereo for 3–5 hours a day.

WGHF uses transmitting equipment supplied by the Multiplex Services Corp., N.Y., and receivers developed by the same firm. KBMS-FM uses multiplex equipment built by Markins Co., Phoenix, Ariz.

LEARN RUSSIAN BY TELEVISION? People around Schenectady, N.Y., can! WRGB-TV, General-Electric's station in Schenectady, is broadcasting a dawn course (6:30–7:00 A.M.) in basic Russian twice a week, which is to run for 12 weeks.

The course is designed to help solve a problem currently plaguing U.S. scientists—rapid dissemination of Russian technical literature to American scientists and engineers.

Preceding the course was a special series of 6 television programs on Russia's historical and cultural background. The series has featured recent visitors to Russia.

1958 IRE NATIONAL CONVENTION in New York, March 24–27, presents a 55-session program, involving 280 papers covering 27 fields of radio-electronics, according to preconvention releases, including 33 sessions at the Waldorf-Astoria Hotel and 22 at the New York Coliseum.

The Coliseum also houses the Radio Engineering Show, displaying approximately 20,000 items of the latest electronic equipment.

The Institute of Radio Engineers (IRE) scheduled two *special sessions* for the evening of March 25 to discuss the subjects, "Electronics in Space" and "Electronics Systems in Industry". Among the panel members listed are Wernher von Braun, space satellite expert, and Ernest Stuhlinger, both of the US Army Ballistic Missile Agency.

4-CHANNEL STEREO TAPE MAGAZINE, says a report in *Home Furnishings Daily*, has been demonstrated to some industry members by RCA. The magazine contains a ¼ inch-wide tape and playing at 3¾ inches per second provides about an hour's playing time. The stereo cartridge will have four sound channels, two on the top and two on the bottom of the tape. Only two of the channels are used at one time. RCA is said to claim a frequency response of 30–15,000 cycles for the new system (see also page 43).

EXPANDING CANADIAN TV has been boosted by the opening of a 350-mile microwave link between Quebec City and Saint John, N. B., by the Canadian Broadcasting Corp. The link joins TV stations in the Maritime Provinces with the central network stretching west to Alberta. The network, when completed (about the end of the year), will extend some 4,000 miles from Victoria, B. C., to St. John's Nfld.

On the home side, the 3-millionth TV receiver has been uncrated by some Canadian TV dealer. Along with this announcement, made by the Radio-Electronics-Television Manufacturer's Association, was the comment that this has been accomplished in 9 years and that Canadian TV stations have been on the air for only 5 years. Completion of the cross-Canada microwave system is expected to make a national network possible, increasing the market for TV receivers.

LOUISIANA RADIO AMATEUR who provided the only communications from a hurricane-devastated town for three days won General Electric's annual Edison Radio Amateur Award for 1957. James E. Harrington, 45, of Lake

Charles, La., who operates amateur radio station K5BQT, received the trophy and $500 at a banquet in Washington, D.C. The presentation was made by L. Berkley Davis, G-E division general manager.

On June 26, 1957, hurricane Audrey hit the coastal town of Cameron. Harrington—then alternate Civil Defense radio officer in Lake Charles—gathered equipment and a crew of two amateur radio assistants and traveled by boat 40 miles southward through the swollen Calcasieu River. At Cameron, he, Capt. Neal H. Mabrey, W5VTU, and Sgt. Michael J. McDermott, K5CTQ, of the Lake Charles Air Force Base set up a radio station in the Cameron courthouse and in three days and two nights handled 1,500 messages. The communiqués told rescue agencies of the need of drinking water, food and medical supplies. They reported the arrival of rescue boats and scheduled return trips so the hundreds of refugees would be met with ambulances, clothing, medicine and food.

PAY TV via the airwaves has been effectively delayed for an indefinite period. The House Commerce Committee after studying the problem and considering letters from the general public (which averaged 1,000–1 against pay TV) came up with a resolution requesting the FCC to call off its pay-TV trials until further action by Congress. The text of the resolution read ". . . it is the sense of this committee that the FCC should not grant authorizations for subscription TV operations as contemplated . . . unless and until the Communications Act of 1934 is amended so as to specifically empower the commission to grant such authorizations."

SPLIT-CHANNEL CHANGES for land transportation services have been finalized effective April 1, 1958. Among those affected is the railroad radio service whose bandwidth has been changed from 2.37 to 1.365 mc. The ruling includes provisions for the use of secondary and tertiary frequencies and specifies frequencies to be used by other land transportation services. Two channels for developmental and experimental use are provided. They are 157.450–157.4625 mc and also 159.480–159.4875 mc.

Regulations for establishing eligibility in the motor-carrier radio service were eased. Starting March 3, 1958, an applicant only has to identify the authorization under which he operates and no longer has to submit a copy of the authorization.

RADIO FADING is caused by a layer of electrically charged gas which, at times, extends to 12 miles below the ionosphere. According to a report by Hugh Odishaw, executive secretary of the US National Committee for the International Geophysical Year, conclusive evidence to this effect has been obtained from rocket experiments con-

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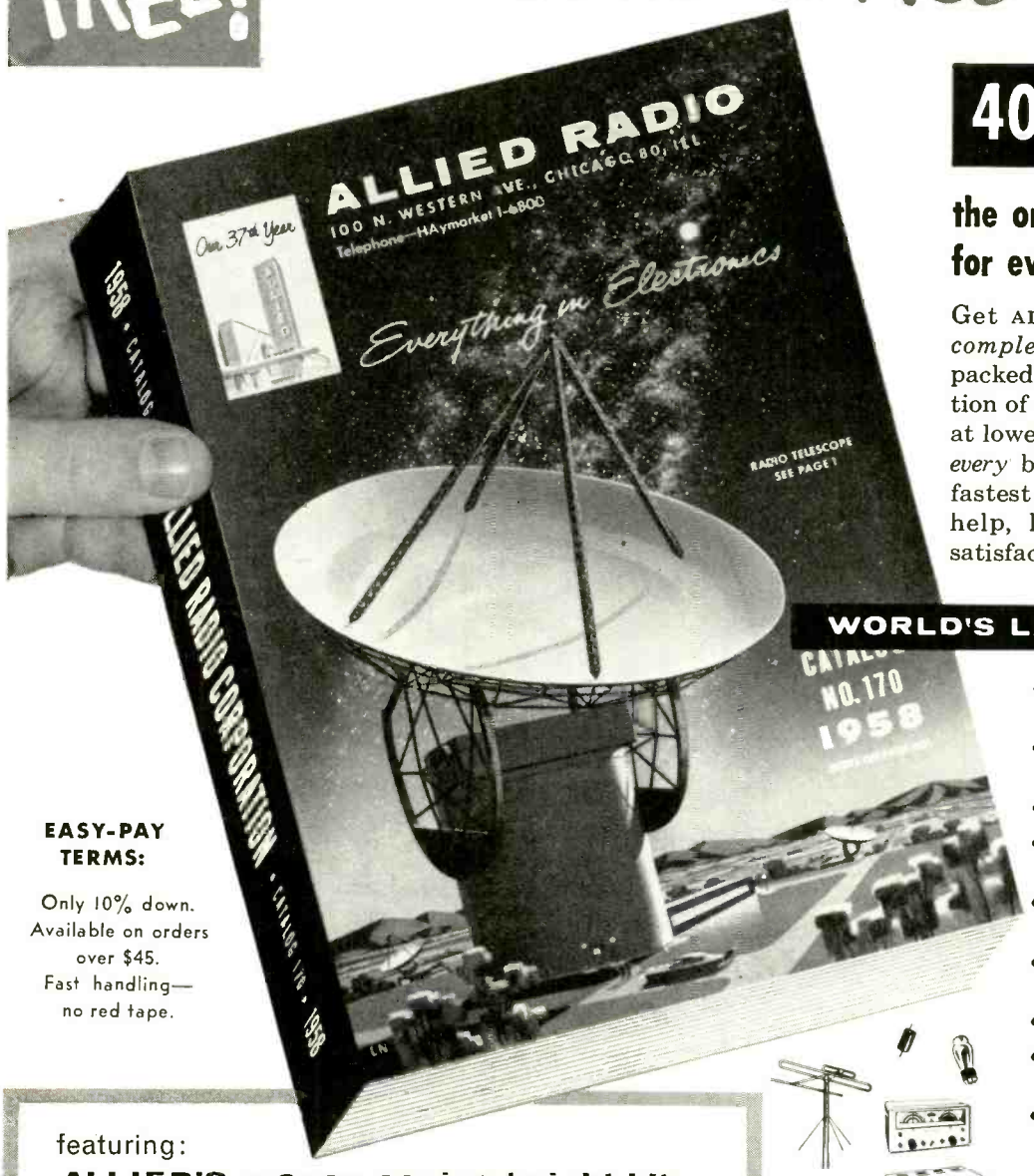

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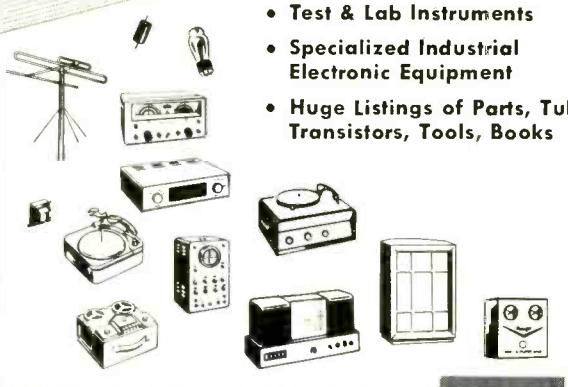

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ducted as part of the IGY. See "Electronics and the IGY" by Jordan McQuay in The March, 1958, issue of RADIO-ELECTRONICS. Mr. Odishaw's report was prepared for presentation to the American Association for the Advancement of Science.

Calendar of Events

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.
Spring Technical Conference on Telesion & Transistors, April 18–19, Engineering Society of Cincinnati Bldg., Cincinnati, Ohio.
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.
Western Joint Computer Conference, May 6–8, Ambassador Hotel, Los Angeles, Calif.
National Aeronautical & Naval Electronics Conference, May 12–14, Dayton Biltmore Hotel, Dayton, Ohio.
Spring Assembly Meeting of Radio Technical Commission for Marine Services, May 13–15, Benjamin Franklin Hotel, Philadelphia, Pa.
1958 Electronic Parts Distributors Show, May 19-21, Conrad Hilton Hotel, Chicago, Ill. RADIO-ELECTRONICS and the GERNSBACK LIBRARY will exhibit in Room 601. (This is a closed show for manufacturers, representatives and distributors.)

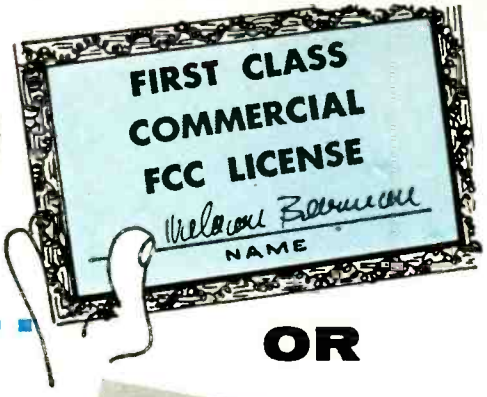
SCIENTIFIC KNOWLEDGE is getting a boost. The Department of Commerce is establishing a Foreign Technical Information Center. Announced by Secretary of Commerce Sinclair Weeks, the department has requested a special appropriation to initiate the program.

A central clearing house will be set up in the Commerce Department's Office of Technical Services. The center will collect, evaluate and distribute valuable scientific and technical literature for the use of American scientists and engineers.

Arrangements have been made to obtain copies of abstracts and translations of foreign technical articles, monographs and books. The items will be catalogued in the library of the Office of Technical Services. Abstracts will be printed and released to the technical press and copies of translations will be made available to the public.

ST. CLARE OF ASSISI has been proclaimed the patron saint of television throughout the world by Pope Pius XII. Roman Catholic TV performers and many TV networks and stations are expected to celebrate her feast, which falls on Aug. 12.

6 months from today



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Prentice Harrison, Lewes, Delaware	1st Class	27 weeks
W. E. Evey, Ottawa, Kansas	2nd Class	24 weeks
Raymond L. Gersig, Pittsburgh, Pa.	2nd Class	24 weeks
Francis W. Bartley, Danbury, Conn.	2nd Class	15 weeks

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West Coast Manufacturer: "We are currently in need of men with electronics training or experience in radar maintenance. We would appreciate your referral of interested persons to us."

Our Trainees Get Jobs Like These Every Month

CHIEF ENGINEER

"Since enrolling with Cleveland Institute I have received my 1st class license, served as a transmitter engineer and am now Chief Engineer of Station WAIN. I also have a Motorola 2-Way Service Station. Thanks to the Institute for making this possible."

Lewis M. Owen, Columbia, Ky.

TEST ENGINEER

"I am pleased to inform you that I recently secured a position as Test Engineer with Melpar, Inc. (Subsidiary of Westinghouse). A substantial salary increase was involved. My Cleveland Institute training played a major role in qualifying me for this position."

Boyd Daugherty, Falls Church, Va.

Names of Trainees in Your Area Provided on Request

Carl E. Smith, E.E., President

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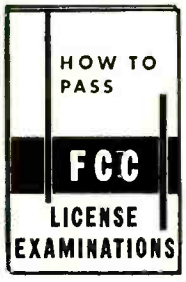

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In what kind of work are you now engaged?.....

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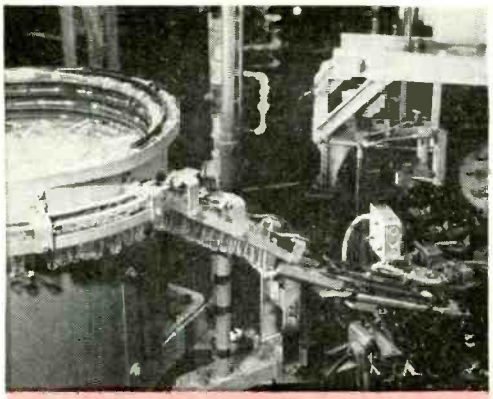
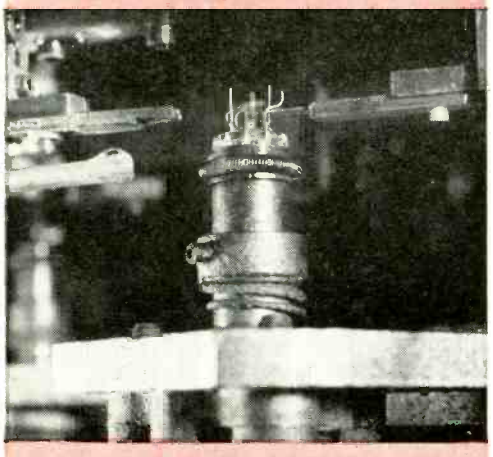
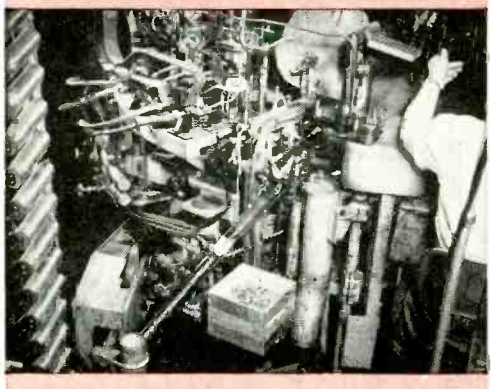


Cylindrical machine at left gently vibrates glass tube envelopes, urges them to climb inside track and automatically feed down ramp to tubulating machine. Tubulating machine etches tube type on envelopes, cuts glass to precise tube size, attaches exhaust tube to envelope to allow creation of a perfect vacuum.



Close up of the button on which tube elements are mounted. Fingers, left and right, move in to swiftly make complicated bends which must be kept extremely precise to insure proper positioning of tube's elements.



This exhaust machine seals the glass envelope to the stem of the mounted tube. Pumps then create a perfect vacuum in the tube, the inside parts are "bombed" (heated white hot) and the getter is then flashed to allow this perfect vacuum to be retained during life. Tubes are automatically discharged after they have been tipped, then slide down a ramp to a conveyor and are carried to the next operation.

IT'S NOT HUMANLY POSSIBLE

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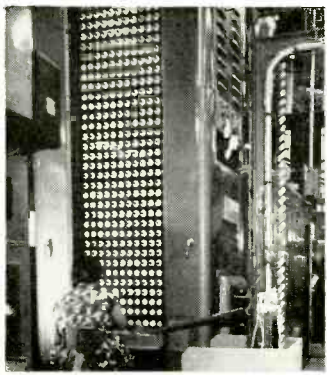

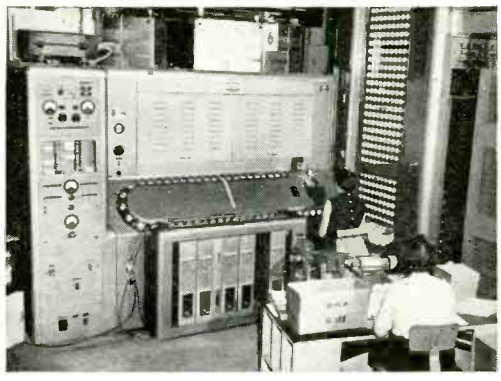

Left: Note the conveyor bringing the finished tubes from the exhaust machine to this rotary aging rack. The aging rack operates the tubes for ½ hour to eliminate early tube failure. Voltages are applied to stabilize the characteristics and season the tubes so that uniform results will be obtained through life. High voltages are applied to eliminate any weak tubes.

Right: This Raytheon designed machine performs many complicated tests — tests formerly dependent on human judgment — and automatically eliminates tubes not up to Raytheon standards of quality and performance.

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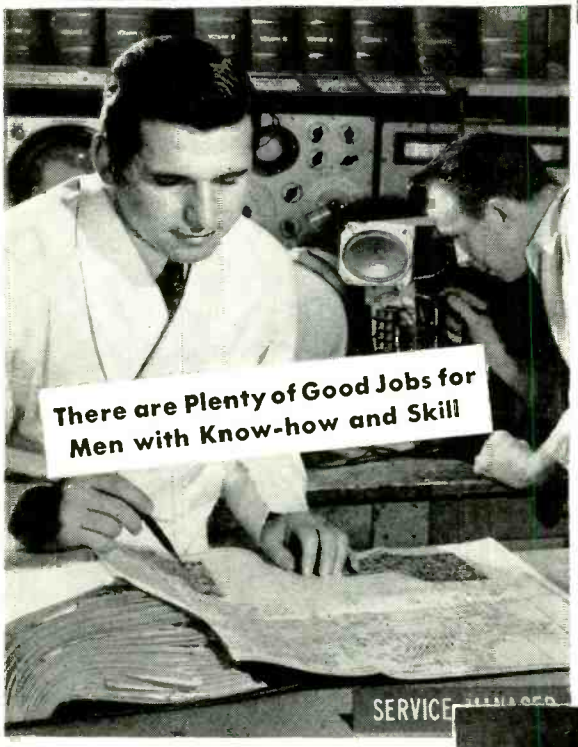

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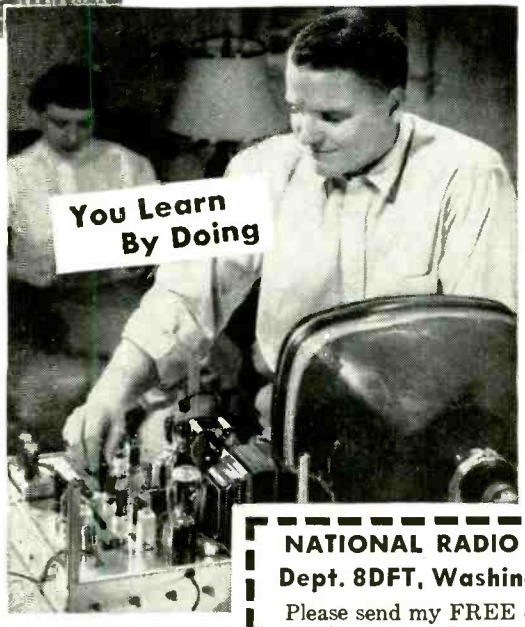

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It was recalled that, on Christmas Eve, 1252, from her sickbed in San Damiano, Italy, she saw and heard the midnight mass held in the Basilica of St. Francis some two miles away. She died the following year and was canonized two years after her death by Pope Alexander IV.

FOUR NEW TV STATIONS start off the spring season:

WRIK-TV, Ponce, Puerto Rico	7
KRSD-TV, Rapid City, S. D.	7
KRTX, Kennewick-Pasco, Wash.	25
KIRO-TV, Seattle, Wash.	7

WROM-TV, Channel 9, quit the air as a Rome, Ga., outlet and now telecasts from Chattanooga, Tenn., with the new call letters of WTVC.

These changes alter the total of US operating stations to 534 (441 vhf and 93 uhf), 30 of which are noncommercial.

A 15,000-CYCLE TELEPHONE LINE between Chicago and New York is bringing live broadcasts of the Chicago Symphony to New Yorkers each Thursday night, thanks to FM radio station WBAI. The 706-mile run of this high-quality line makes it the longest of its kind now in use. Ordinary network audio lines are only about 6,000 cycles. The everyday voice-telephone line has a 2,500-cycle top.

NEARLY 2 MILLION radio authorizations are on the FCC's books. This is the largest number in the commission's 23-year history.

For every broadcast facility there are nearly 50 other kinds of radio stations which serve the public, commerce and individuals. Altogether, about 1,250,000 transmitters are in use.

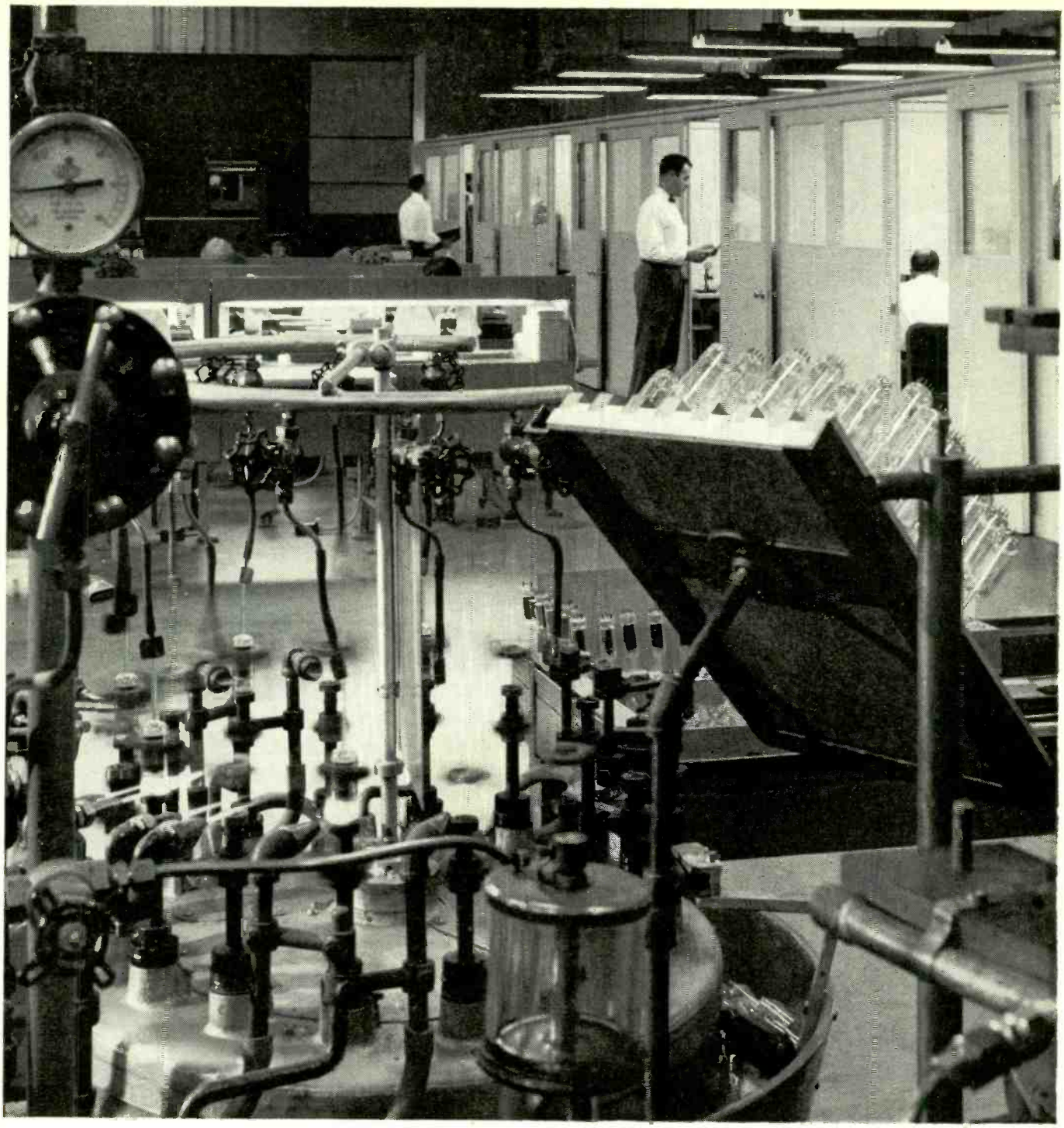
Use of these transmitters accounts for nearly a million and a half operator permits. These are made up of more than 1,300,000 commercial and over 160,000 amateur licenses.

Licensed transmitters, include 60,000 ground and air stations in the aviation service, 100,000 used by taxicabs, 50,000 by railroads, 33,000 by trucks and nearly 4,000 by buses. Industry uses 325,000 transmitters and nearly 2.5 million are employed in public safety services.

NEW US SPUTNIKS will speak only when spoken to, Dr. Henry L. Richter, research director at Jet Propulsion Labs, Temple City, Calif., reported recently. The high-power (60-milliwatt) transmitter in Explorer II will send information to IGY stations only on receipt of a code signal. The action will be somewhat similar to the IFF (Identification, Friend or Foe) equipment of the last war.

Only IGY stations will have the code needed to key the satellite transmitter, Dr. Richter said. Information will be recorded on a miniature tape recorder between IGY stations, for complete transmission on code command.

The low-power transmitter in Explorer II will operate continuously as in the first US satellite. END



CBS cuts call-backs through approved-for-production design

Here a tube from the laboratories of CBS development engineers is being readied in pilot production for mass production. It may be a CBS original, standard type, or improved tube. The aim is the same: To insure dependable, trouble-free performance through approved-for-production design. Teams like this test in pre-production all CBS tubes . . . receiving, special-purpose, cathode-ray ...and semiconductors. Their approved designs give you reliable products like the 6DQ6, 6626, CBS-Colortron and 2N155. It's easy for you to take advantage of this approved-for-production design. Insure yourself of minimum call-backs always by asking for CBS always.

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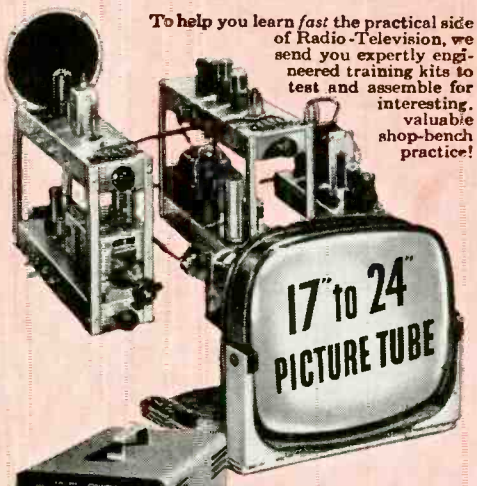

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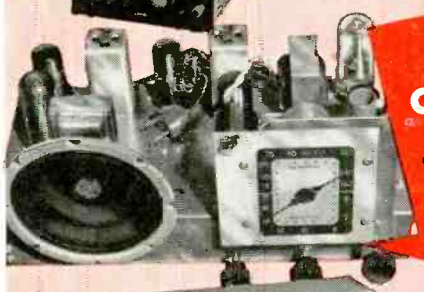

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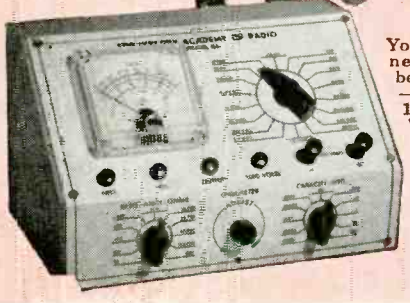

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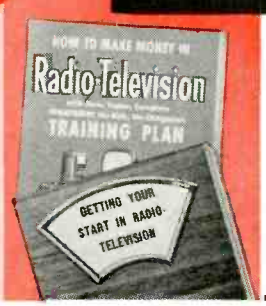

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Correspondence

IMPROVE YOUR AMPLIFIER

Dear Editor:

I have received nearly 50 letters about my article "High-Power Performance With a Low-Power Amplifier" (February, 1958, issue). Almost everyone has been highly successful with it. There were a few questions, however:

The TP-520 power transformer is shown as a 500-volt ct unit. This was the older one. The new unit delivers 570 volts ct. A 5V4-G was shown as the rectifier. It should have been a 5Y3-GT. The 5V4-G boosts B-plus 40 volts.

Some feel that plate and screen voltages on the 6Y6's are excessive. They are OK in an Ultra-Linear circuit. Some have asked where I got the tiny 175-ma 8 – 10-h choke. I actually used a 4-h unit, but would prefer an 8 – 10-h choke. The response shown is with the 4-h choke and a 5Y3-GT.

CHARLES BALDWIN

Philadelphia, Pa.

MORE ABOUT DOPPLER

Dear Editor:

In dedicating himself to the proposition that, if the peak-to-peak excursion of a direct-radiator loudspeaker exceeds .06 inch approximately, it is producing an intolerable amount of Doppler distortion, Mr. Paul Klipsch[1,2] reminds me of a hill-billy who was being interviewed by an itinerant anthropologist. When asked whether the necessities of life were not hard to come by in such a habitat, he answered, "They sure are and, even when we get 'em, they ain't always fit to drink." An obvious corollary to Mr. Klipsch's proposition would be that if the low-frequency output of a direct radiator is audible, it is producing intolerable distortion. Mr. Klipsch cites the work of several persons of scientific eminence to substantiate his contention. Whether these references lend weight to his argument can be ascertained easily in the nearest engineering library.

In the meantime, Mr. Edgar Villchur, in his letter to the editor (March, 1958, issue), has pointed out the easily verifiable fact that none of the references cited by Mr. Klipsch bear out his contention. Where then is the "vast supporting literature" on the subject of Doppler distortion to which Mr. Klipsch refers in his article[2]? The answer seems to be that there is no considerable amount of literature on this subject. Of the references cited, only Beers and Belar[3] concerned themselves with the problem. Shower and Biddulph[4] investigated the audi-

(*Continued on page* 22)

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Griffin Kane, 3125 Wabash Ave., Los Angeles, Calif.	2nd	9
Beamon Meares, 1536 - 17th St., NW, Washington, D.C.	1st	11
Larry Pacifico, 65 Main St., Roseto, Pa.	1st	12
Tooru Iwahashi, Honohina, Hakalua, Hawaii	2nd	8
Basil D'Imperio, 2223 H St., NW, Washington, D.C.	1st	12
John Ward, 407 E. Cowden Ave., Midland, Texas	1st	10
Herbert Halbig, 315 Park St., Tupper Lake, N. Y.	1st	11
Vregh Godoshian, 312 E. Wilson St., Pontiac, Mich.	1st	11
Antone Mello, 68 Union St., Nantucket, Mass.	1st	10

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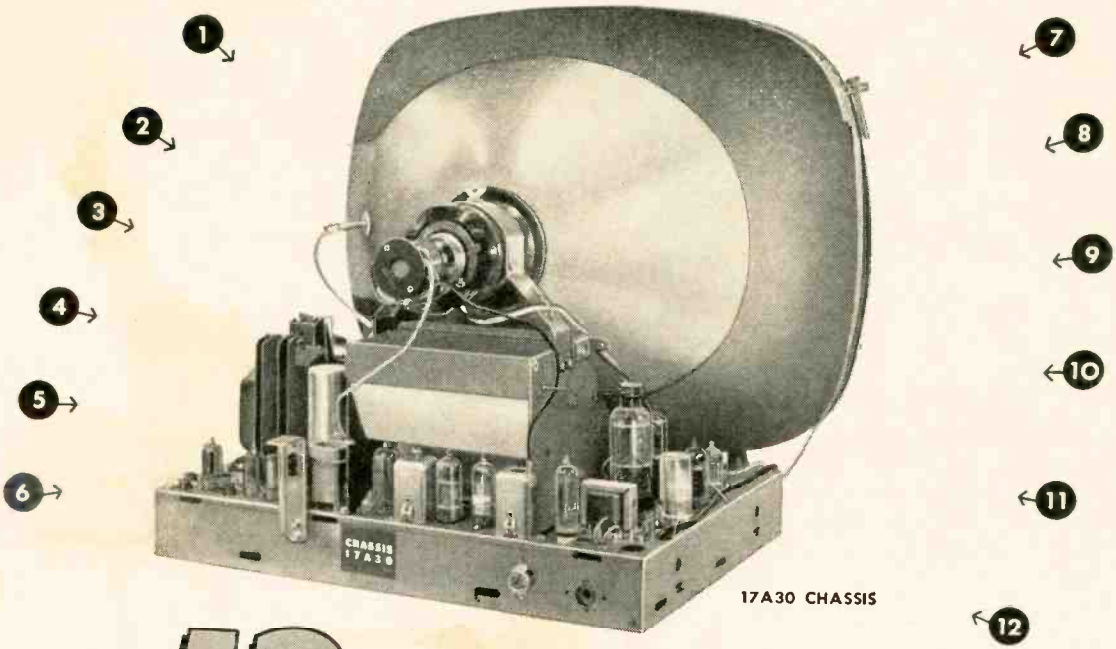

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bility of "wow" when a pure tone was being "wowed" at a rate of 1 cycle to about 10 cycles. But more recently the investigation was extended to include "wow" frequencies up to 1,000 cycles by E. Zwicker[5] and Scott and Axon[6], using as the "wowed" material both pure tones and complex material.

Because of the refinement of the techniques used by Scott and Axon, their data seem to be more significant than any that were accumulated and reported upon earlier. Instead of an undefinable waveform of the type reportedly used by Shower and Biddulph at the "wow" frequency, they used definable waveforms, including a sinusoid and a square wave; and instead of "wowing" only sinusoidal material, they also "wowed" piano and organ music. By using a single loudspeaker to reproduce both "wowed" and "unwowed" material, they eliminated one indeterminate variable that was present in the tests of Beers and Belar, who used two loudspeakers.

These are some of the findings of Scott and Axon: To be audible, Doppler distortion in piano music must be much greater than in pure tones. Their graphs, on page 652 of their article[6], show that when the modulating frequency ("wow" frequency) is 50 cycles, Doppler distortion must be at least 1% to be barely audible. This means that on piano music, and presumably on similarly complex material, the *barely perceptible* Doppler distortion is ten times as great as the maximum listed by Mr. Klipsch as *barely tolerable*, and that if this figure of 1% is used to calculate the maximum peak-to-peak excursion of a cone at 50 cycles for just barely perceptible distortion, it turns out that the cone must travel over 0.75 inch, peak to peak. Let's neglect for the sake of simplification the fact that the modulating frequencies applied to a low-frequency loudspeaker are transient rather than steady state, that the average power as well as the peak power is concentrated not at the very low frequencies but in the hundreds-of-cycles-per-second region, that in any loudspeaker system that is worth all this fuss the woofer is not called upon to reproduce frequencies above 2,000 cycles, and that a loudspeaker capable of such excursions is not available on the present market. Let's just look at the acoustic power that would be radiated by a 12-inch cone executing 0.85-inch peak-to-peak excursions at 50 cycles. The acoustic power radiated under the conditions specified by Mr. Massa[7] would be about 0.7 watt. Translated into living-room conditions, with the rest of the audio spectrum being reproduced in perspective, the situation would be intolerable, indeed. Anyone willing to imperil his aural apparatus would be restrained from such excess out of regard for the architectural stability of his living quarters.

The findings of Scott and Axon seem to suggest a proposition that is the

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antithesis of the one suggested by Mr. Klipsch. Scott's and Axon's data suggest that, if you can stand the sound level produced by a 12-inch direct-radiator loudspeaker reproducing complex program material in an average living room, then you can't hear the Doppler distortion. An obvious corollary to this proposition would be that before you can hear Doppler distortion from a 12-inch direct-radiator loudspeaker reproducing complex program material in an average living room, the intense aural discomfort produced by the acoustic pressure levels will induce an irresistible impulse to turn the gain control rapidly in a counter-clockwise direction!

ARTHUR A. JANSZEN
Janszen Laboratory Inc. 69 Harvey St. Cambridge, Mass.

[1]Paul W. Klipsch, RADIO-ELECTRONICS, May, 1957, page 18.
[2]Paul W. Klipsch, RADIO-ELECTRONICS, October, 1957, page 44.
[3]Beers and Belar, "Frequency-Modulation Distortion in Loudspeakers," *Proceedings of the IRE* 31, page 132 (1943).
[4]Shower and Biddulph, "Differential Pitch Sensitivity of the Ear," *Journal Acoustic Society of America 3*, page 275 (1931).
[5]E. Zwicker, "Die Grenzen der Horbarkeit der Amplitudenmodulation und der Frequenzmodulation eines Tones," *Akustiche Beheffe 3*, page 125 (1952).
[6]A. Scott and P. E. Axon, "The Subjective Discrimination of Pitch and Amplitude Fluctuations in Recording Systems," *Proceedings of the Institution of Electrical Engineers 102*, page 643 (1955) (British).
[7]Frank Massa, "Acoustic Design Charts," Blakiston Co., Philadelphia.

A SHOCKING SITUATION

Dear Editor:

Several times recently you have published articles about the dangers of "hot-chassis" electronic equipment — TV, radio, appliances, etc. — due to the possibilities of electrical shock. I just serviced a set which had a very dangerous condition due to a cause which I have not seen described in print.

The trouble, which occurred in an Airline model BR-4005A, could occur in any hot-chassis metal-cabinet set where one side of the speaker's voice coil is connected to the cabinet. A short developed between the output transformer's primary and secondary. This placed the full B-plus voltage on the metal cabinet. Luckily, the set was placed where it was some distance from any grounded object and I found the short before anyone got between the cabinet and a good ground. I was not called for the short *although the owner's children had been shocked when they touched the set.*

I have had an opportunity to check only a few sets, but connecting one side of the voice coil to the speaker frame, which is fastened to the metal cabinet seems to be fairly common. A similar condition could also take place in many ac–dc radios. It seems that the insulation in output transformers is usually good, as this is the first such case I have heard of, but it is a possible hazard that you should check for as a part of routine service operations.

W. J. STILES
Keytesville, Mo.

END

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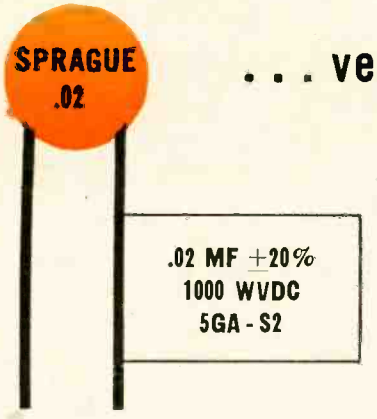

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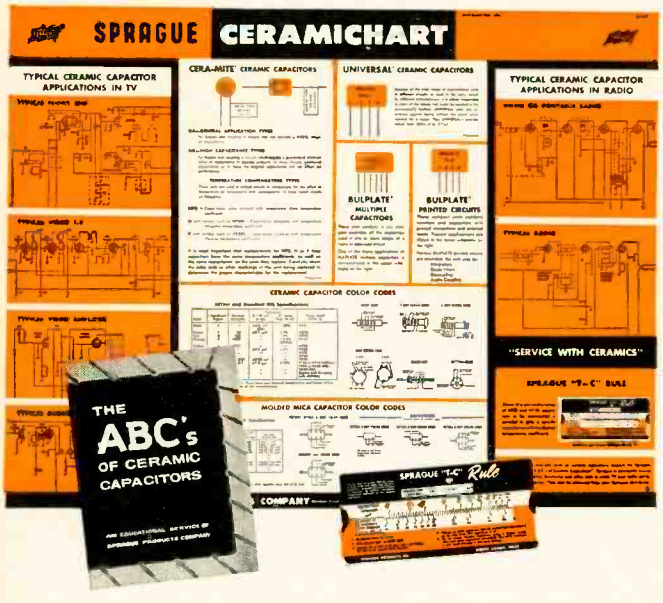

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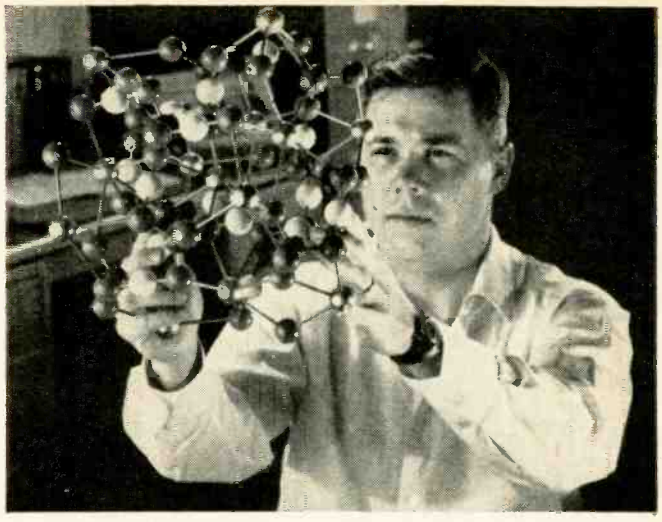

Dr. Walter Brown, physics graduate of Duke and Harvard Universities, bombards crystalline solids with one-million-volt electrons to study the nature of simple defects in crystals. Objective: new knowledge which may help improve transistors and other solid state devices for new and better telephone and military systems.

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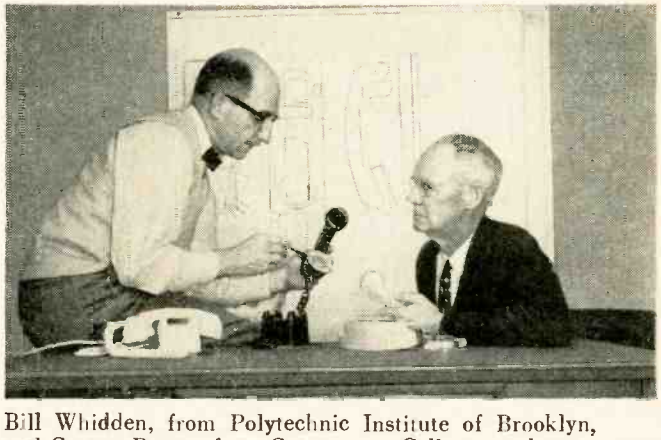

Bill Whidden, from Polytechnic Institute of Brooklyn, and George Porter, from Georgetown College, study new experimental telephone instruments designed to explore customer interest and demand. Objective: to make your future telephone ever more convenient and useful.

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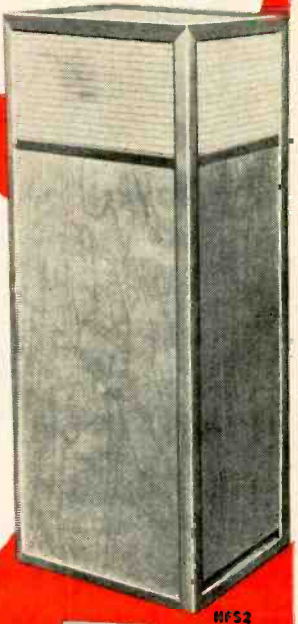

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HF61 Preamplifier

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HF50 50-Watt Ultra-Linear Power Amplifier with extremely high quality Chicago Standard Output Transformer. Identical in every other respect to HF60 and same specifications up to 50 watts. **Kit $57.95. Wired $87.95. Matching Cover E-2 $4.50.**

HF30 30-Watt Power Amplifier employs 4-EL84 high power sensitivity output tubes in push-pull parallel, permits Williamson circuit with large feedback & 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.**

HF20 20-Watt Integrated Amplifier, complete with finest preamp-control facilities, excellent output transformer that handles 34 watts peak power, plus a full Ultra-Linear Williamson power amplifier circuit. Highly praised by purchasers, it is established as the outstanding value in amplifiers of this class. **Kit $49.95. Wired $79.95. Matching Cover E-1 $4.50.**

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William A. Stocklin, Editor, RADIO TV NEWS

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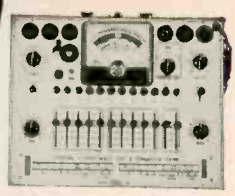

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COMPLETE with steel cover and handle.

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

NEW! TV-FM SWEEP GENERATOR & MARKER #368

KIT $69.95 WIRED $119.95

Entirely electronic sweep circuit (no mechanical devices) with accurately-biased inereductor 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. Varible 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.

5" PUSH-PULL OSCILLOSCOPE #425

KIT $44.95 Wired $79.95

7" PUSH-PULL OSCILLOSCOPE #470

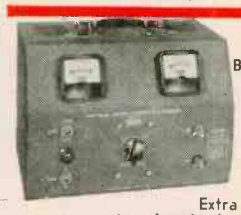
KIT $79.95 Wired $129.50

TUBE TESTER #625

KIT $34.95 Wired $49.95

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

Pix Tube Test Adapter $4.50

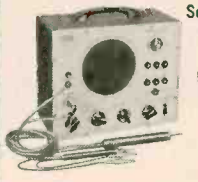


6V & 12V Battery Elim & Charger #1050:

KIT $29.95 Wired $38.95

Extra filtered for transistorized eqpt, #1060:

KIT $38.95, Wired $47.95



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KIT $24.95 Wired $39.95

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20,000 Ohms/Volt MULTIMETER #565

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1000 Ohms/Volt MULTIMETER #536

KIT $12.90 Wired $14.90

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

KIT $19.95 Wired $29.95

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

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Peak-to-Peak	$4.95	$6.95
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SCOPE PROBES		
Demodulator	$3.75	$5.75
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NEW! RF SIGNAL GENERATOR #324

KIT $26.95 WIRED $39.95

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

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

KIT $29.95 WIRED $49.95

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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.

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FIFTY YEARS HENCE

. . . *The Electronic Future begins in its past* . . .

LOOKING back 50 years to 1908, one is struck immediately with the extreme primitiveness of the electronic art of the time. Even the term *radio* was unknown—it was *wireless* then. Instead of frequencies, we spoke of wavelengths. There was no wireless communication law; anyone could help himself to his own wavelength if he wanted to transmit intelligence. This, incidentally, was the day of the long waves—short waves, little understood then, were still in the comparatively distant future. To detect the waves, we used coherers, auto-coherers, electrolytic detectors and, a bit later, crystal detectors. Yes, in 1908 there was also Marconi's magnetic hysteresis detector, used in all Marconi stations, but it never became popular—it was too expensive for the average experimenter and amateur. Dr. Lee de Forest's audion, the vacuum-tube detector just invented, was not to appear on the market for several years.

Most electronic instrumentation—the components—were naturally crude in those days, too. Wood seemed often the best, perhaps the most used, insulator, at least for receiving components. The wood was paraffined or heavily shellacked. A little later hard rubber—much more expensive—came into use. Then a "new" plastic, of which most phonograph records were made, became fashionable in wireless. This plastic was shellac and powdered mica or sealing wax. Radio amateurs had a better—if less elegant—term for it: mud!

In those days one dreamt only of communication over long distances, ship to shore and what records could be achieved, using a 1-inch spark coil and four dry cells—(90 miles was the record, incidentally). The more imaginative of us thought of sending messages to Mars, while the really foolhardy forecast eventual transmission of the human voice by wireless through empty space—then called the ether. Curiously enough, many of today's electronic wonders never were even anticipated by the most astute and foreseeing men in 1908. We will only mention a few: broadcasting, pocket radios, electronic computers, amplifiers, radar, microwaves, radio astronomy, telemetering, cathode-ray tubes, transistors and scores of others.

As one looks back to 1908 and ascends the time plateau of 1958, the temptation becomes strong to peer into 2008—50 years hence—and extrapolate the electronic future from a long pioneering past.

One thing seems quite certain before we embark on such a long-term prognosis. As the past has shown, *we will miss the really big ones* that will be commonplace in 2008, because the great discoveries in electronics still lie in the future.

Nature of Electron. In 1909 Nobel Prizewinner Prof. Robert A. Millikan first discovered the nature of the electron, it was established that its mass is 1837 times smaller than the hydrogen atom. We still do not know the exact constitution of the atom, much less that of the elusive electron. By 2008 we will know far more about both, but we will probably not have seen them directly.

Atomic Electronics. The electron being part and parcel of the atom, neither seems to be able to exist without the other. Yet so far the electronic art has made little use of atomics, i.e., electricity direct from the atom. In atomic fission, radiation dangerous to humans is generated. Yet this radiation is electromagnetic. Hence, instead of using present-day makeshift shielding, the radiation should be transformed directly into electrical current. By 2008 this goal should have been accomplished. This would then free all electronic apparatus of batteries and outside sources of electricity.

Medical Electronics, a comparatively recent branch, is also one of the most important ones. Medical diagnostics today is still a hit-and-miss endeavor. Even such instruments as electrocardiographs are crude and out of date. They do not give the correct picture. Far more sophisticated electronic cardiac means are in sight. We also believe that a sure early cancer diagnosis will be in everyday use in 2008, and it will most probably be electronic.

Electronic Mineralogy. Since the advent of atomics, prospecting for uranium via the Geiger counter—an electronic instrument—has brought us untold wealth in new mines. Yet most of our mineral riches are still within the earth's crust, undiscovered. Our greatest metal mines will be brought in during the next 50 years by means such as *electronic-power triangulation in depth*, electronic seismic methods and others.

Electronic Meteorology. During the last decade, man has finally begun to do something about the weather. A number of scientists have studied the seeding of clouds and changing the weather, at least locally. Meteorologists today know that much of our weather is due to electric trigger action. By 2008, electronic weather control over our large cities and farmlands should be routine procedure. We can visualize the *modus operandi* somewhat as follows: Surrounding the city (or farm) we have a ring of *ionization-power towers* 1,000 to 2,000 feet high. Near the top of the towers are huge blowers directed skyward to carry the intensely ionized air upward. The oncoming air mass is then ionized positively or negatively according to the desired result. The atmosphere over the towers can thus be electronically charged or discharged, to either clear the air or to bring down precipitation.

It is realized that intense storms or other powerful atmospheric turbulences cannot be treated locally. The only way to handle such disturbances would be before they are developed, during their birth or formation. This could be done by a large fleet of ionization-power planes, flying direct to the originating point of the meteorological disturbance. These points in our hemisphere are often in the high North. Much experimental pioneering work in this direction remains to be done to perfect such a system.

Electronic Mating. Nearly all of our states now demand blood tests before marriage. This is *one* health safeguard. But what about heredity, blood types and RH factor, compatibility, sexual factors, general health, allergies and nearly a hundred others? Marriage by and large is still a fearful lottery. A surprisingly large percentage of people should never marry their blind choice, although the same people could be ideally happy with another *correct* choice. Who then is the right choice? You may rest assured that in 2008 the state will tell you by giving the candidates an obligatory electronic mating test. We have spoken about such an innovation for over 20 years and we feel certain it is a step in the right direction. The test should not take more than an hour and will pay large dividends to all concerned. No, the state will not force you to break with the only person you feel you *want* to marry. But the state will withdraw many future 21st-century benefits that will make you consider carefully your course of action.

Obvious Developments. Many developments, held back for technological and economic reasons, will certainly be commonplace in 2008. We have room to cite only a few: two-way phone television; electronic traffic regulation; electronic automobile-collision prevention; electronic semiconductor house-heating and cooling units; mental (electroencephalic) recording and dictating machines. A good many of these are already in a developmental stage. —*H.G.*

5 NEW AUDIO CIRCUITS

TV sound for your hi-fi system, FM band on your TV, baby sitter that overrides TV sound, electronic crossover and speaker switching panel are the usual and unusual functions of new developments in the audio world

By ROBERT F. SCOTT
TECHNICAL EDITOR

A NUMBER of new and interesting audio devices have been placed on the market within the last few months. Those discussed here are (1) a separate 4.5-mc FM if strip and detector for picking up 4.5-mc sound radiation from intercarrier TV sets, detecting it and feeding a hi-fi amplifier; (2) a converter for receiving FM sound broadcasts on a TV receiver; (3) a baby-listening intercom that works through the speaker on a TV or radio set, automatically silencing the set's audio when the baby cries or calls; (4) an electronic crossover network for feeding power amplifiers in a two-channel audio system and (5) a switching panel for controlling one to six remote speakers while maintaining the proper load impedance on a hi-fi or public-address system.

TV-Tone adapter

Anyone who has ever fed, or tried to feed, the audio output of a TV receiver into a wide-range audio system probably found that the job was not as simple as it appeared. Excessive hum, poor frequency response, motorboating and, in transformerless receivers, the difficulty of finding a suitable ground return are common problems that plague the audio technician and hi-fi enthusiast.

The TV-Tone adapter (Tapetone, Inc., 10 Ardlock Place, Webster, Mass.) is designed to provide superior FM sound from the average intercarrier TV set and provide trouble-free connections to a wide-range audio system. The TV-Tone is a high-quality 4.5-mc if amplifier and FM detector whose output is fed to an audio amplifier.

The circuit (Fig. 1) uses three 6AU6 if amplifiers, a 6AU6 limiter or ratio-detector driver and a 6AL5 ratio detector. The if bandwidth is 200 kc and the audio response is within 1 db from 20 to 20,000 cycles.

A small, molded loop antenna at the end of a 6-foot length of 300-ohm ribbon line picks up the 4.5-mc rf beat—unavoidably radiated from the video detector and sound if circuits in the TV receiver—and feeds it to the input transformer in the TV-Tone. The signal is amplified by V1, V2 and V3 and then limited by V4 to remove AM, CW and impulse type interference that may be picked up. After detection by V5, the audio signal is fed through a 5-foot shielded cable to the audio amplifier.

FM TeleVerter

Regency's model RC-103 FM TeleVerter (I.D.E.A., Regency Div., 7900 Pendleton Pike, Indianapolis, Ind.) is a stable and inexpensive all-transistor converter for receiving FM broadcast signals on a television receiver. It provides an FM sound carrier and a "picture carrier" 4.5 mc away for intercarrier operation. The unit connects

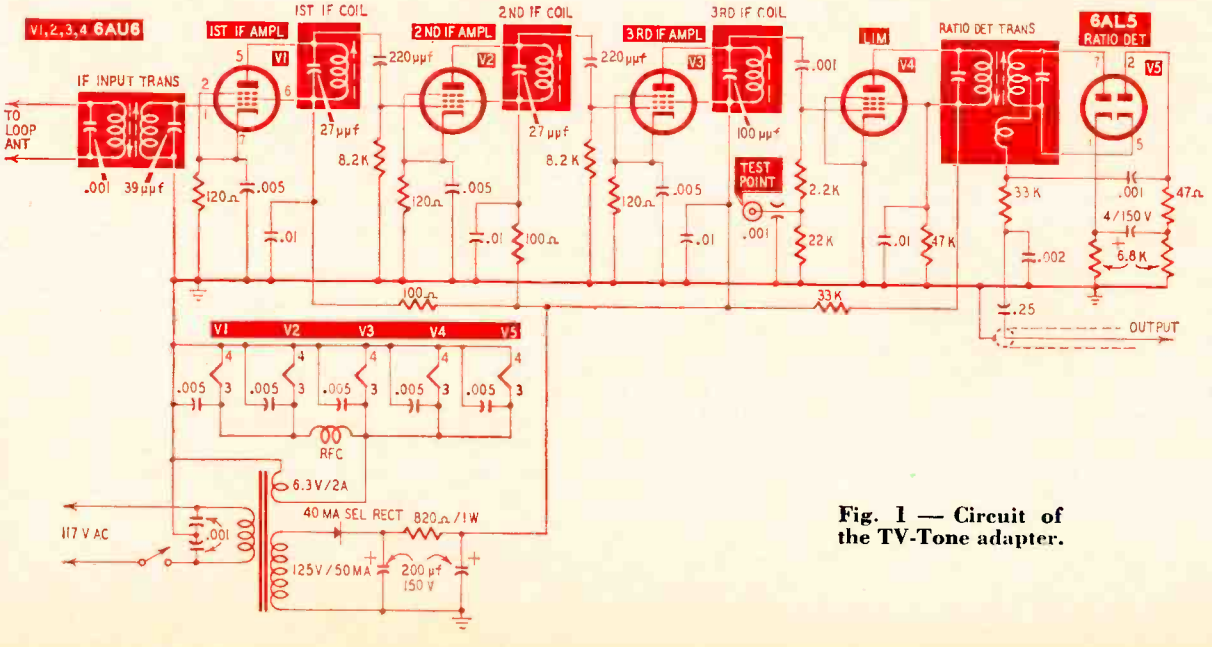


Fig. 1 — Circuit of the TV-Tone adapter.

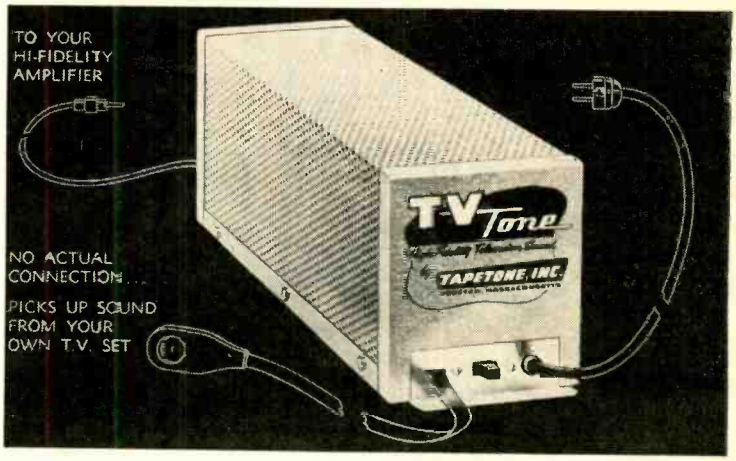
between the antenna lead-in and the antenna terminals on the TV set. It operates from three penlight cells and the antenna is automatically switched to the TV antenna input circuit when the unit is turned off.

The TeleVerter is designed to operate on TV channels 3 and 4. Best results are obtained by using channel 3 for FM stations between 88 and 100 mc and channel 4 for stations between 100 and 108 mc. The FM output of the converter will usually override—through capture effect—a local TV station unless it is exceptionally strong. In some locations, it may be best to use channel 2 for stations on the low end of the FM band and channel 5 for the high end.

The circuit of the TeleVerter is shown in Fig. 2. A p-n-p transistor is used as a converter or mixer–oscillator in an autodyne type circuit. L5 is the oscillator coil tuned by C3-b over a range of 30.83 to 37.50 mc. A part of the collector signal voltage developed across L5 is tapped off a capacitive voltage divider (C8–C9) and fed back to the emitter through a winding on output coil L6. Thus, oscillation is developed and sustained by feedback between collector and emitter.

The incoming FM signal from the antenna passes through channel-6 traps L1–C1 and L2–C2 and is coupled to rf coil L4 through antenna coil L3. The signal developed across L4 is applied to the base of the transistor. The heterodyne signals are taken off the emitter circuit and fed to the receiver through output coil L6.

An intercarrier TV receiver requires two carriers spaced approximately 4.5 mc apart for sound reception. The difference frequency resulting from heterodyning the incoming FM signal and the oscillator fundamental produces an FM sound carrier in the output. The second harmonic of the oscillator is 4.5 mc removed from the FM sound carrier and is used to produce the 4.5-mc beat in the output of the TV set's video detector.



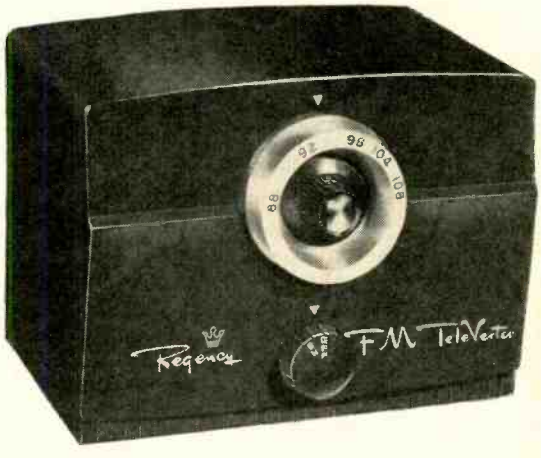
Tapetone's TV-Tone adapter.

The oscillator frequency is always equal to one-third the sum of 4.5 mc and the FM signal frequency in megacycles or $\frac{3}{4.5 + FM}$. For example, when the TeleVerter is tuned to 88 mc its oscillator is tuned to 92.5/3 or 30.83 mc. The beat between the oscillator and the 88-mc FM signal produces a 57.17-mc FM sound carrier falling about the center of channel 2. Simultaneously, the oscillator's second harmonic at 61.66 mc produces a "picture" carrier just 4.49 mc away from the sound carrier. The "picture" carrier falls in channel 3 but is easily tuned in with the TV fine tuning control.

Similarly, when the converter is tuned to 108 mc, 70.50-mc sound and 75.00-mc "picture" carriers fall in channels 4 and 5, respectively. The signal is tuned in for best sound with the TV fine tuning control or by a slight readjustment of the TeleVerter's oscillator frequency.

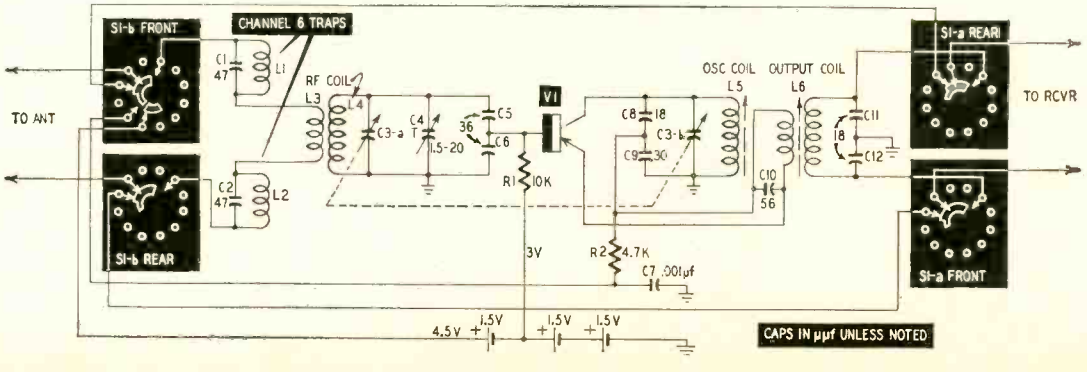
TV Governess

The model TVG-120 TV Governess (Dynamic Electronics-New York, Inc., 73-39 Woodhaven Blvd., Forest Hills, N. Y.) is an intercom type electronic baby sitter that connects to any TV or radio set. It squelches the TV's audio when the baby cries or calls. The picture remains on the screen and you hear the baby's call through the TV speaker. The TV audio is automatically restored seconds after the baby stops crying. The unit works with the television set turned either on or off.



The Regency FM TeleVerter.

Fig. 2 — Circuit of Regency's one-transistor FM TeleVerter.



NEWS for the AUDIOPHILE

Details of the Minter compatible stereo disc system—it uses an ultrasonic subcarrier for the stereo information—and the ESL C-60 moving-coil cartridge are carefully analyzed

By HERMAN BURSTEIN

THESE columns are normally devoted to the examination of new circuitry or equipment recently introduced in the audio field. However, there are times when an idea which has not been put into practical application—and in some cases may never reach that point—is so interesting and contains such possibilities that it merits description with already working equipment. The proposed stereo disc system below seems to fit those specifications.

Minter stereo disc

A new and truly compatible method of putting stereo sound on discs, using a 25-kc carrier for the stereo information, has been developed by Jerry B. Minter of Components Corp. in association with ESL (Electro-Sonic Laboratories). A private demonstration of MSD—*M*inter *S*tereo *D*isc—in New York City in late January gave convincing evidence that this system, although fresh out of the laboratory, must be taken seriously. While industry approval of the 45/45 Westrex system renders the adoption of this system improbable, it is nevertheless well worth describing for its technical features, and—who knows?—it may even eventually triumph over apparently better established techniques.

MSD employs laterally cut grooves, just as monaural records do, which means that a conventional pickup can be used *if its response extends to 30 kc.* Although only a few pickups on the market now have such a response, the inventors believe that cartridge manufacturers face fewer problems in extending the response of their present cartridges than in designing radically new ones to play vertical–lateral or 45/45 stereo discs[1].

The MSD system is compatible—it permits stereo to be reproduced with a monaural type pickup and also provides completely satisfactory monaural sound if the signal from the pickup is fed directly into a conventional monaural preamplifier. Moreover, there is compatibility in recording for a cutter of basically new design is not required. However, the cutter must have adequate high-frequency response, extending above 30 kc.

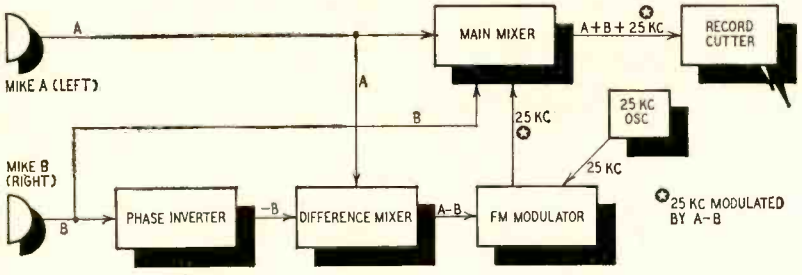


Fig. 1—Block diagram of the recording setup for the Minter stereo system.

MSD presently achieves at least 30-db, and sometimes as much as 40-db, separation between channels. Other single-groove techniques offer only about 20-db separation. Vertical orientation of the stylus is not critical in the MSD system. Other methods require that the stylus be perfectly at right angles to the groove, or cross-talk and distortion increase substantially. MSD is claimed to be inherently more distortion-free than the other techniques.

In the vertical–lateral and 45/45 systems, the stylus moves along two axes—that is, in two dimensions—and operates two transducing elements (magnetic, capacitive or piezoelectric), which convert stylus motion into an electrical signal. One element corresponds to the left channel and the other to the right. The stylus mass is necessarily greater than for a pickup that moves only in one dimension and operates only one transducing element. Thus, the problems of high-frequency plastic resonance within the audio range and rapidly declining response above resonance, which increase with stylus mass, are accentuated for the two-dimension systems. In the MSD system, however, the stylus moves only laterally, so that its mass may be much smaller, proportionately reducing problems of resonance as well as record wear, needle talk and surface noise.

How it works

The MSD system is ingenious and can be explained in essence with the aid of Figs. 1 and 2. Assume two microphones, A and B (Fig. 1) are used for stereo recording and that they generate an A and a B signal, respectively. The A and B signals are combined in the main mixer, which feeds an A + B signal to the record cutter. Therefore, if the record is played by a conventional cartridge, all the sound picked up by the two microphones will be reproduced, although in monaural fashion. Also fed into the

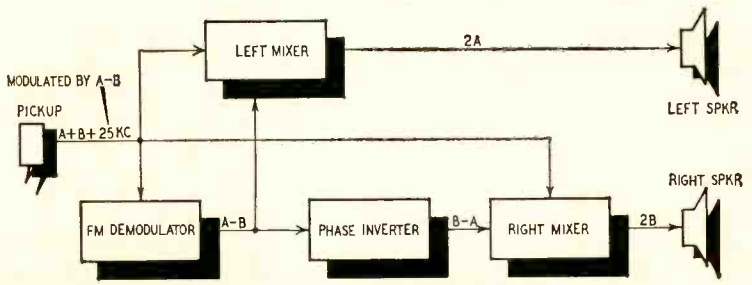


Fig. 2—The playback setup in block form.

[1] See the excellent article on stereo recording by Norman H. Crowhurst, "Single-Groove Stereo Discs," RADIO-ELECTRONICS, January, 1958.

main mixer, and from there into the cutter, is a 25-kc carrier, frequency-modulated by what is called a difference or A − B signal—this contains the stereo information. The B signal is phase-inverted so that it becomes −B. Addition of the A and −B signals in the difference mixer produces an A − B signal, which is used to modulate the 25-kc carrier.

In playback (Fig. 2), the cartridge picks up the A + B signal as well as the modulated 25-kc one. These are fed into a special preamplifier. The 25-kc signal is demodulated by a counter type circuit, which is noncritical as to tuning and minimizes noise. Thus the A − B signal is recovered. The A − B signal is added to the A + B signal in the left mixer, thus cancelling out the B portion of A + B and leaving what may be called a 2A signal, which is fed to the left speaker. The A − B signal is also fed into a phase inverter, changing it to B − A. The B − A signal is added to the A + B signal in the right mixer, cancelling the A portion of the latter and leaving what may be called a 2B signal, which is supplied to the right speaker. Although not shown in Fig. 2, the 25-kc frequency does go through the left and right mixers into the speakers. However, it has previously been attenuated by an R-C filter and by RIAA treble de-emphasis, and is too high to be heard, unless the record is slowed down.

The A + B signal fed into the cutter contains frequencies to 18 kc. However, the A − B signal in the present stage of development is limited to 5 kc, because it was initially feared that sidebands of the 25-kc carrier would intermodulate with the A + B information. But it is planned to extend the stereophonic A − B information to about 8–10 kc. This has been shown feasible in practice.

Even when the A − B signal is limited to 5 kc, it is able to provide a substantial stereophonic effect. Increasing the stereo information to 10 kc would leave little to be desired.

The regular information, A + B, is recorded at an average of about 8 cm/sec and a maximum of about 12 to 16 cm/sec, so that chances of loss of contact between stylus and groove are minimized. This velocity results in a recording level about 3 to 4 db lower than that on a monaural disc of high quality. On the other hand, the lower recording level makes possible finer groove spacing, which permits more music on a record.

When the stylus momentarily loses contact with the groove, the 25-kc carrier is, of course, lost and a moderate bass thump is heard in the speaker. To overcome this problem, the next stage of development will add a locked oscillator that will briefly continue whatever the signal frequency was at the time groove contact was lost. This may be thought of as an electronic flywheel.

MSD is brand-new and, as indicated, there are improvements to be made. But it does work, which is the main thing. It is compatible, and its underlying idea is elegant but not really complex. Of the four stereo disc systems that have appeared, including MSD, only one has been substantially ruled out, namely that which uses two sets of grooves and a pair of pickups side by side. Between the 45/45 and vertical–lateral methods, the former seems to have preference and will probably be adopted by EIA as the industry standard.

ESL C-60 cartridge

Among the best, and costliest, of phonograph cartridges are dynamic (moving-coil) pickups. The lateral stylus movement of these cartridges is translated into an inherently distortion-free motion of a coil in a constant magnetic field. But the problem arises of keeping the mass of the armature (coil and core) small, to maintain high-frequency response, minimize groove and stylus wear and prevent groove resonance (which depends in part upon compliance of the groove wall) from coming down into the audio range.

To keep the mass of the armature down, the number of turns of wire must be limited. As a result, moving-coil pickups have the lowest output of the various types of magnetic cartridges. This is the price paid for quality. However, new models and brands have recently appeared with substantially increased output, yet without deterioration in quality.

One of these is the ESL (Electro-Sonic Laboratories) C-60 series (see photos), which is a successor to the ESL Concert series. The C-60 has about five times its predecessor's output, but maintains or exceeds its performance. Output of the C-60 is about 5 mv at 5-cm/sec rms velocity, which is sufficient to eliminate the need for an input transformer when used with most preamps. (By comparison, the familiar G-E cartridge has only about 6 db more output.) This saves not only the price of a good transformer, about $15, but also the effort of connecting the transformer into the system and finding a hum-free location for it. The C-60 is noncritical as to load; any value above 200 ohms prevents high-frequency roll-off in the audio range.[2]

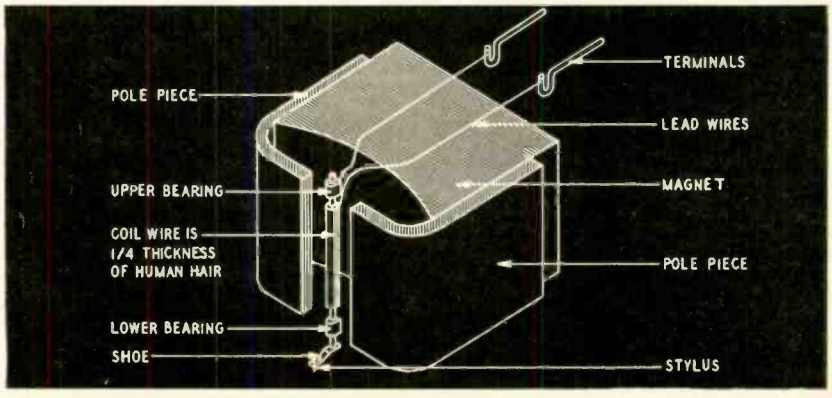
The C-60's higher output is partly due to a more efficient magnetic structure obtained through use of materials with superior magnetic characteristics. However, increased output is mainly due to more turns of wire. To have more turns without increasing the mass of the armature, ESL uses a wire about one-fourth the thickness of a human hair. Although wire this fine is not uncommon, several years of research were devoted to developing one with the necessary strength and flexing characteristics for use in a moving coil.

The C-60 is more rugged than the Concert series. The bearings that hold the armature have been enclosed for protection against dust and dirt, as in the ESL Professional series. And a rear support bearing has been added to prevent vertical motion of the armature due to action of a changer arm, accidental dropping of the tone arm, etc.

During several hours of comparative listening to the C-60 and Concert series, I found it very difficult to discern any appreciable difference in quality between the two, although the C-60 seemed to have slightly better definition. In any event, listening indicated that increased output was not accompanied by a sacrifice in quality. END

[2] In magnetic pickups, cartridge inductance and load resistance form a low-pass filter.

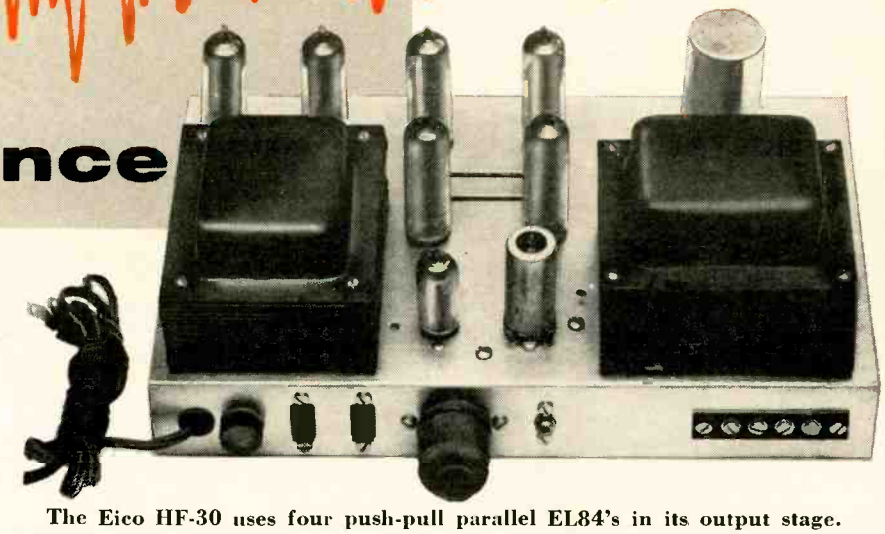
Closeup of the ESL C-60.



Exploded view of the ESL C-60 moving-coil cartridge.

High-Fidelity Amplifier Design and Performance

A study of basic power-amplifier circuits



The Eico HF-30 uses four push-pull parallel EL84's in its output stage.

By MANNIE HOROWITZ

OFTEN overlooked when the versatility of a preamp or the virtues of a speaker system are discussed, is the power amplifier. Yet it is equally important and requires the same careful design as the equipment which precedes and follows it.

A good 10-watt power amplifier is usually sufficient for home installations. In crowded city apartments, where the average listening level is frequently limited to a maximum of 1 watt, a 10-watt undistorted peak in music should be adequate.

People living in homes remote from their neighbors may find a 20-watt unit more desirable.

A 50- or 60-watt amplifier is frequently used by the critical listener who feels that a unit with good characteristics at 50 watts will certainly perform better at average listening levels. This power level is a must when operating an inefficient speaker system.

An amplifier typical of the circuitry commonly used today is the Eico HF-30 (Fig. 1). It will be used as the basis for the discussion in this article, though some examples may be drawn from other circuits. The signal from the preamp is fed to the INPUT jack, where it is amplified by a 6AV6 troide (the diode sections are not used). The 6AV6's output is direct-coupled to the phase inverter, a 6C4. This feeds four European output tubes, EL84's (6BQ-5's), connected in a push-pull parallel circuit. There is 20 db of feedback around the entire circuit and output transformer through the 33,000-ohm resistor (R15) and 56-$\mu\mu$f capacitor (C6). Capacitors C1, C2 and C4 are in the interest of stability. This is known as a Williamson type amplifier.

The most popular phase-inverter–driver amplifier used during the past few years was the Williamson. In this circuit the split-load phase inverter feeds a driver amplifier which in turn drives the output tubes (see Fig. 2-a). Excellent results can be achieved with this configuration once it has been adjusted for maximum stability. Equally good results are achieved using the so-called Williamson type amplifier, which omits the extra driver tube (Fig. 1—V1 and V2). Here the output tubes work directly off the split-load phase inverter (Fig. 2-b).

A circuit which is somewhat superior and more efficient than the Williamson

* Project engineer, Electronic Instruments Corp.

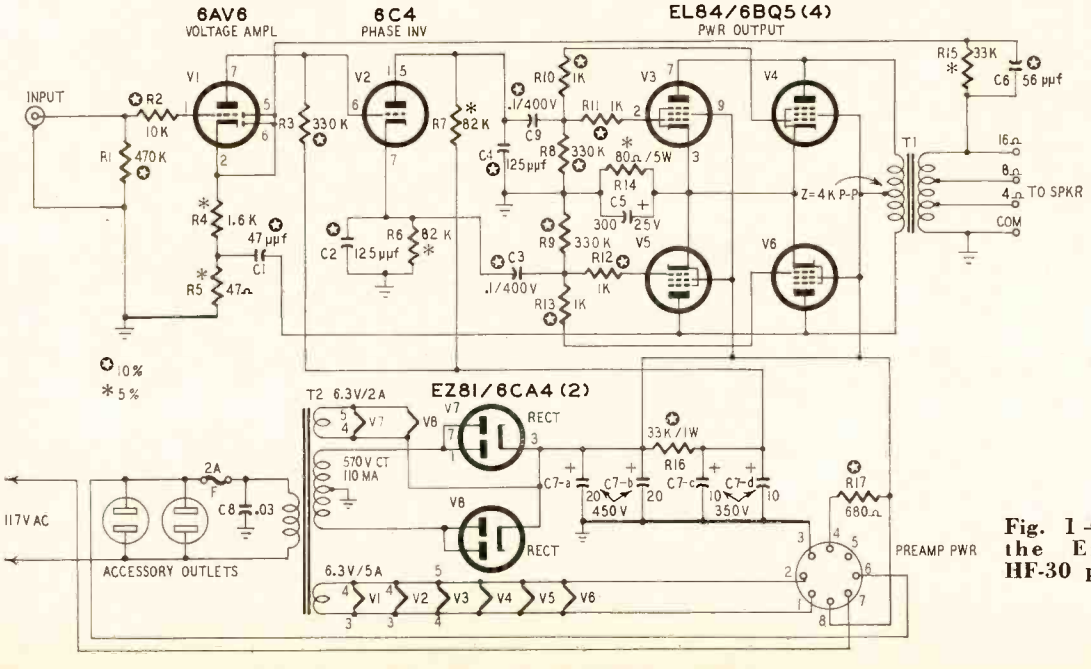
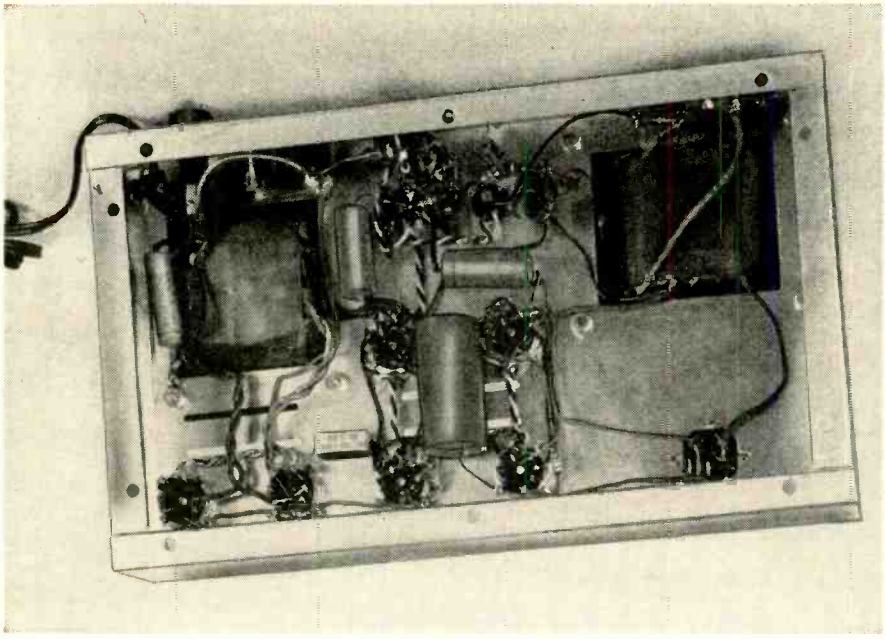


Fig. 1 — Circuit of the Eico model HF-30 power amplifier.



Component layout, under the HF-30's chassis.

has been used by manufacturers throughout England. Using the Clare cathode-coupled phase inverter, this circuit drives the output tubes directly (Fig. 2-c). There is usually an added input tube in front of the driver to supply added gain and provide a convenient point for applying feedback. It has the advantage of maintaining excellent balance through the entire audio spectrum.

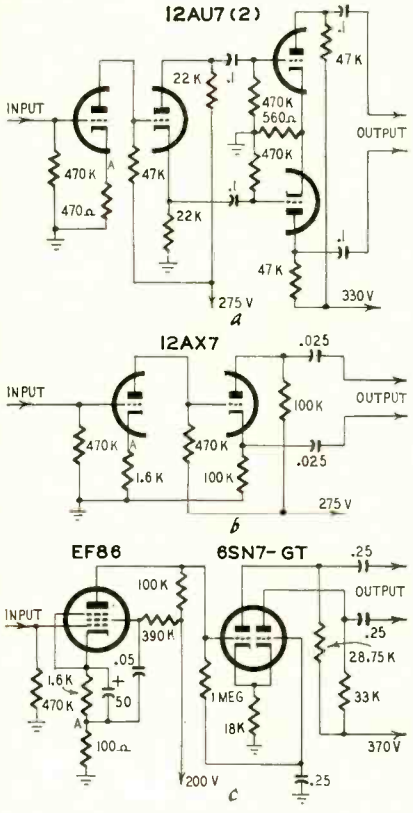


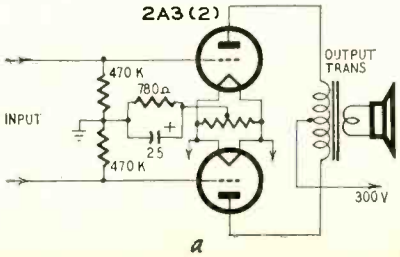
Fig. 2—Phase inverters currently used in hi-fi equipment: a — Williamson Cathodyne inverted/driver; b—Williamson type Cathodyne; c—Clare cathode-coupled inverter.

The phase inverter supplies two equal voltages, 180° out of phase, to drive the grids of push-pull output tubes. In the 30-watt amplifier of Fig. 1, the output tubes are the four EL84's in push-pull parallel. Here, V3 and V4 are in parallel, being supplied by the voltage developed at the plate (across R7) of the 6C4. V5 and V6 are in parallel, being supplied with an equal voltage, but 180° out of phase to that supplied to V3 and V4. This time the voltage is developed across R6 at the cathode of the 6C4. The EL84's are in pentode operation.

Output tubes

In the early days of high fidelity, it was thought that the best results distortionwise could be achieved only with triode output tubes. This was considered true due to the greater degree of triode curve linearity compared to that of pentodes. Currently, pentodes are being used in output circuits capable of delivering high pentode power while at the same time being as distortion-free as triodes. The most popular one of these is Ultra-Linear—its popularity probably being due as much to its economy and simplicity as to its excellence. Cathode feedback or circuits using regulated screen supplies can also give good results, but are considerably more expensive for the builder than the Ultra-Linear (Fig. 3).

A satisfactory amplifier delivering up to about 8 or 9 watts can be built using the 6V6 or its miniature equivalent, the 6AQ5. Better results, with higher power capabilities, are realized when European-made EL84's are used. Experimentally, I have found it possible to get a clean 15-watt output using EL84's, with Ultra-Linear operation offering no visible or audible advantage over pentode operation.



Higher power, up to about 20 or 25 watts, can be achieved with 6L6's. Their advantage is particularly noted at these powers with Ultra-Linear or regulated screen supply circuitry. A more ruggedized version of the 6L6, the 5881, is a direct replacement with equivalent results. The RCA 1614 is an excellent but expensive replacement for the 6L6, with outstanding results.

Power outputs up to 100 watts can be delivered by several 6L6's in push-pull parallel or by the specially made 6550. An excellent European tube for higher power application is the EL-34/6CA7. A 60-watt amplifier can be made using this tube with a power supply delivering only 470 volts. This

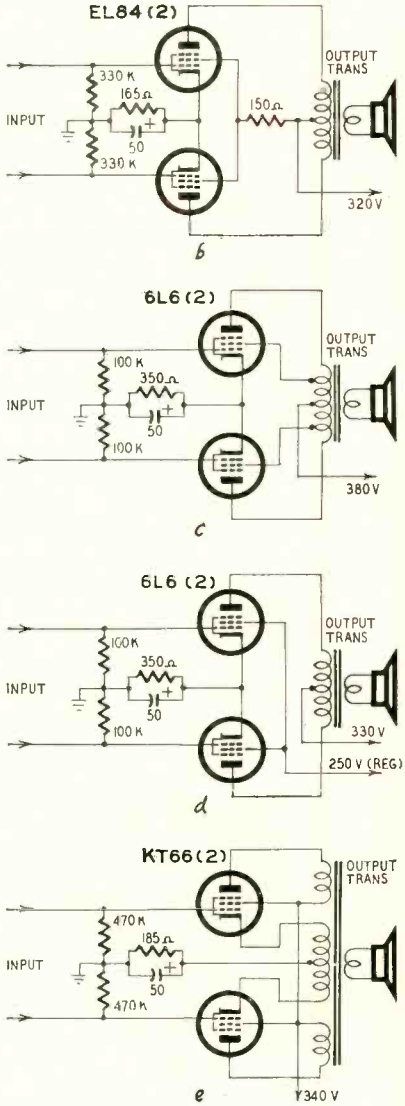


Fig. 3 (left and above)—Types of power-output circuits: a—triode; b—pentode; c—Ultra-Linear; d—regulated screen supply; e — cathode feedback.

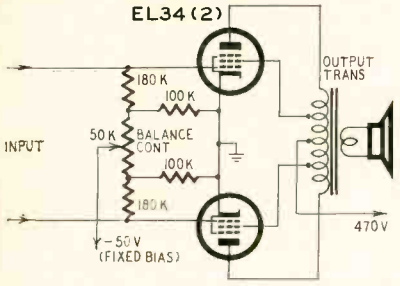


Fig. 4—Ultra-Linear output stage using fixed bias and adjustable balance control.

result is achieved with fixed bias (Fig. 4). Under similar supply voltage conditions, using cathode bias, as much as 35 watts of clean power can be realized (Fig. 3-c).

Equal in importance with the power output tube is the output transformer. The transformer should be capable of reproducing a minimum audio band of 30–15,000 cycles, within 1 db of the amplifier's rated power output. This requires the use of grain-oriented steel and interleaved windings in the transformer's construction.

The primary function of an output transformer is to match the speaker load to the output tubes. It is important to adhere carefully to this match to minimize distortion and achieve the maximum output power. Tube manufacturers specify the impedance their tubes must see under various conditions of operation. In turn, transformer manufacturers specify impedance ratios of the transformers they manufacture. Matching one to the other then becomes obvious.

It is further advisable to have several output taps on the transformer (4, 8 and 16 ohms) to match any speaker or group of speakers that might eventually be used with the amplifier.

The complete amplifier shown in Fig. 1 has one notable omission—variable damping. Although widely advertised, experiments show that its greatest advantage is realized when poor speakers are used. Although a few speaker manufacturers of quality units recommend the use of low damping factors to deliver the proper bass response, any loss in the bass due to overdamping can usually be satisfactorily compensated for with tone controls. Most hobbyists will not miss this feature, especially when the possibilities of instability due to positive-current feedback, frequently used in this circuit, are considered. Of even more importance is that a low damping factor on any speaker can lead to inadequate damping over most of the audio spectrum.

The HF-30's power supply is a conventional full-wave rectifier type. Two tubes are used to increase its current capacity and improve regulation. The output of this power supply feeds voltage directly to a separate preamp.

As with the preamp, many circuit combinations are possible. The signal from a preamp is fed to the input of a phase inverter (see Fig. 2). Assuming sufficient driving voltage, any of the phase-inverter types shown in Fig. 2 can feed any of the power amplifiers shown in Figs. 3 and 4 simply by connecting the phase inverter outputs to the output tube grids. Feedback can be arranged around the output transformer, as shown in Fig. 1, and applied to point A in Fig. 2. Take care to avoid oscillation due to improper phasing of the output transformer and excess feedback.

To eliminate parasitic oscillation, parasitic suppressors such as R10, R11, R12 and R13 in Fig. 1 can be used. Resistors of much smaller value can be used in the plates and screens.

Achieving complete stability is the toughest problem in amplifier design. To attain this goal, slow-rolloff capacitors such as C2 and C4 (Fig. 1) should be used. When these capacitors are large (about 250 $\mu\mu$f), omission of C1 is usually permissible. Capacitor C6 in the feedback loop should be adjusted for the best square waveshape at 10,000 cycles. END

Reviewed by
CHESTER SANTON

Stereophony on tape continues to occupy the more nimble brains in the audio field. The scramble of the moment, unfortunately, appears to center on how best to lower stereo's existing standards. On the theory that 7.5 stereo tape is too expensive to attract a wide market, work is under way on two new ideas. The first could be called quarter-track stereo tape. Under this system a pair of stereo channels at 7.5 ips would be squeezed into the area now occupied by one channel. The term quarter-track seems logical because the former half-track area is split in two. By recording the pair of channels in both directions, stereo's cost could be cut in half. The other idea calls for 3.75 speed applied to the present pair of stereo channels, occupying the full width of the tape in one direction. It, too, could halve the cost of stereo tape. The 3.75 system, already feasible with some existing heads, faces one major threat from quarter-track. There is a possibility that some giant firm in the industry may be tempted to set up its own quarter-track tape playback system aimed at the "half-price" stereo tape market. A lowering of tape standards occurred once before when 15 ips gave way to the commercial speed of 7.5. Luckily, stereo came along to help the new speed. The first commercial stereo releases were aired on my WQXR program two years ago—one channel going to the AM transmitter, the other to the FM. With professional tape equipment at my disposal, I have been able to follow every improvement attained in the past. By now, some of the better tapes rank with the finest home stereo machines. Because so much has been accomplished, I hate to see any action aimed at the lowering of present standards.

The King of Organs
Bill Floyd at New York Paramount Theatre Organ
Cook Laboratories Stereo Tape 1150
(7 inch; playing time, 34 min. $12.95)

If current standards are important to you, don't miss this one—the latest of the 60 Cook original stereo masters just released. Having shown how to make records in the early 'Fifties, Emory Cook now offers for our amazement a stunning sample of his newly developed stereo tape process. This organ recording should wake up the low end of even the middle-class speakers. It has a natural bass response of great warmth—denoting excellent stability in the mastering equipment and, more important to the purchaser, real care and precision in the duplicating process. You'll enjoy the carefree tunes of the 'Twenties and 'Thirties by Gershwin, Porter, Rodgers and Hart and others as played on this smoothly powerful Wurlitzer. The other stereo tapes announced by Cook Laboratories contain material known to audiophiles everywhere, having appeared on monaural as well as the original two-channel discs employing two tone arms. The Cook decision to issue tape confirms the belief of numerous persons that tape has arrived as a high-fidelity stereo medium.

BERNSTEIN: *West Side Story*
Original-Cast Stereo Tape (2 reels)
Columbia TOB-13
(Playing time, 57 min. $23.95)

I haven't seen the Broadway show but the cast has just completed a special performance in my living room. This musical portrayal of juvenile gang warfare on New York's West Side pulls no punches. Every jab in the savage Bernstein score registers with greater impact than you find in the LP. The disc version of the musical is technically outstanding. However, in stereo—with a low hiss level on a very clean tape—you can follow the movements of the cast as the players obey their stage directions. The duets of the young stars, Carol Lawrence and Larry Kert, have a smooth, easy separation and presence impossible on records. In the miking, a wider pickup is effectively employed in the scenes featuring the chorus. Having sat through the show from beginning to end, I am convinced that original-cast albums in stereo will make inroads into the home TV audience where nothing else has. If another *South Pacific* comes along, the same neighbors who invited themselves over to watch a good TV show in the early days will barge in to hear a good stereo setup.

Dixieland Jamfest in Stereo
Reeves Soundcraft Bonus Recording
(Playing time, 30 min. Price: see text)

To get this recording—stereo or monaural—you add 75 cents to the price of a 7-inch reel of Soundcraft tape, returning the tape to Reeves to be recorded. This new idea is garnished with proven talent from the higher echelons of jazz. The jam session features Coleman Hawkins, Henry "Red" Allen, J. C. Higginbotham, Sol Yaged, Lou Stein, Milt Hinton and Cozy Cole. This special offer indicates what can be done today in a bright studio when a major tape producer records jazz at close range with Telefunken microphones. A fabulous buy.

Stereophony Sampler Vol. 1
C 80 (Playing time, 30 min. $4.95)
Stereophony Sampler Vol. 2
B 81 (Playing time, 18 min. $3.95)

These samplers cover the entire Stereophony catalogue. Vol. 1 contains popular jazz and novelties. The second sampler features their prestige items. Among these, the Strings by Starlight Orchestra, Sam Donahue's orchestra, the Voicestra and the Symphonic Band are exceptionally fine. Listen to these tapes on top-notch equipment and you'll appreciate one thing—they haven't skimped on quality in the tape used or its processing. An outstanding technical achievement.

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

Adventures in Sound
Columbia WL 101–123

Columbia Record's answer to the smaller firms who, in recent years, have capitalized on exotic music and breathtaking sound. With this series, a major firm has invaded this specialized field. In technical proficiency, these discs match any label in existence today. In the 19 albums, we find emphasis on seldom-heard music of foreign lands. Of particular interest to the sound enthusiast is the album containing the difficult-to-reproduce transients of the carillon (WL 115); *Sorcery*, with Sabu and his 11-drum percussion ensemble (WL 101) and *Delirium in Hi-Fi* (WL 106), which offer inventive use of changes in tape speed and other recording tricks. Clever splicing creates many bizarre effects. Processed as a deluxe series, the recordings offer uniformly quiet surfaces.

Popular Science Hi-Fi Test Record, Vol. 2
Urania UPS-2

The second "testing" record in this series is called *True Sounds of Musical Tones*. The material is aimed at the beginner, especially the stylus, pickup and high-frequency tests. The only interesting test is the one dealing with the lower frequencies of the tuba, double bass viol, piano, cello and organ. To get the sound energy that would put across their point, the producers miked these instruments at extremely close range. As the instruments are heard descending the scale, each note is repeated. The first note is heard at full range; the second is filtered at 120 cycles per second. In the next stage of the test, the cutoff occurs at 65 cycles. A word of warning: In view of the arbitrary nature of the mike placement, low-frequency response such as this should not be expected when listening to these instruments on other records. Most of side two is given over to 12 orchestral instruments in passages from classical works. We hear them first in a close studio pickup, then in their normal places in the orchestra. The idea is a good one but the recording of the orchestral sound is not up to present standards.

The Soul of Haiti
Jean Vincent and Instrumental Group
Vanguard VRS-9015

In these songs and ritual chants, the native performers seem unaware of the microphone. Four conga drums and flute accompany the singer, Jean Vincent, a native of Haiti. The atmospheric background sounds of sea, birds, thunder and so forth have been handled with imagination. The effect is spellbinding.

BRAHMS: *Variations on a Theme by Haydn*
Hungarian Dances
Antal Dorati conducting the London Symphony
Mercury MG-50154

If Hungary had a world-famous orchestra, this is how it would sound in the Brahms *Hungarian Dances*. The agile British instrumentalists toss off these seven exhilarating dances with all the flair demanded by Hungarian-born Antal Dorati. The warmth of the woodwinds in the Brahms *Variations* on the other side is a pleasant surprise. Too often Mercury has sacrificed the softer-voiced instruments in order to attain the loudest climaxes on records.

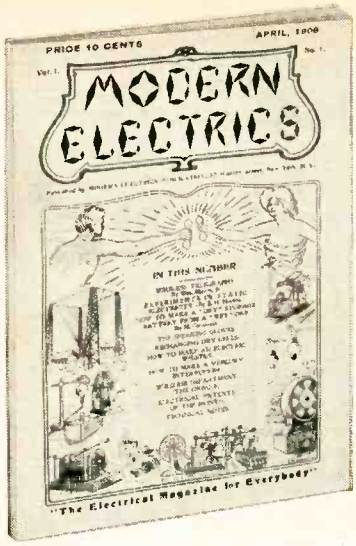
VIVALDI: *L'Estro Harmonico*
Mario Rossi conducting soloists and Chamber orchestra of the Vienna State Opera
Vanguard Bach Guild BG-572/4

The best-sounding version of Vivaldi's most famous violin concertos. Vanguard's recording curve, flatter than most, is ideally suited to the solo string instruments sharing honors with the main body of strings. These three records are offered for the price of two.

Sounds of New Music
Folkways FX-6160

Required listening for tape experimenters, this record is a good introduction to new techniques whereby raw sound is taped and then manipulated to form novel compositions. The "tape-music" of Vladimir Ussachevsky is created with two tape machines. Re-recording at changed speed, he transposes the sounds to different octaves. If you wish to startle your pickup or loudspeaker, go down a few octaves with him. In the *Sonata for Loudspeakers*, Henry Jacobs demonstrates his work with tape loops. Also included are some of the pioneer efforts in experimental music. The tape experiments are sure to interest the advanced collector of unusual sound. END

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



The first issue—*Modern Electrics* for April 1908.

From Coherer to Spacistor

50 years ago this month the world's first radio magazine was launched. It—and those that came after it—played an important part in the half century of electronic progress that followed.

By T. R. KENNEDY, Jr.

A HALF-CENTURY ago—April, 1908—*Modern Electrics*, the world's first publication designed to explain and popularize "wireless," was published. Its editor and founder, Hugo Gernsback, was a Luxembourgian who had come here in 1904 as a youth of 19, to market his first invention, a layer-built dry-cell battery.

With his new battery—which he had patented in Europe—the young inventor brought many new ideas and devices with him. It was not long, therefore, before a new company to import, manufacture and market devices for the electrical and the new group of "wireless" experimenters, made its appearance. Called the *Electro Importing Co.*, it occupied a small loft at 32 Park Place, later a larger one at 87 Warren St. and still later at 84-86 West Broadway, in lower Manhattan; a little later, there was added a retail store at 68 West Broadway, the world's first radio store.

Among other items, the E.I.Co. began marketing the first home or private radio ever offered the public. Called the *Telimco* (from The E.I.Co. name) wireless telegraph outfit, it was advertised in *Scientific American* in January, 1906. Sales were slow at first—the new company had to convince not only the public but the police that the device would send signals through the air without wires—but it soon became the most important product of the E.I.Co. The original Telimco model is now in the Ford Museum at Dearborn, Mich.

So much explanatory material was needed in those days to tell about what the Electro Importing Co. had to sell to electrical experimenters and wireless enthusiasts that the company's voluminous catalog often contained long explanatory articles. Gernsback found himself already a publisher of electrical and wireless information, and it was but a step to a regular monthly periodical.

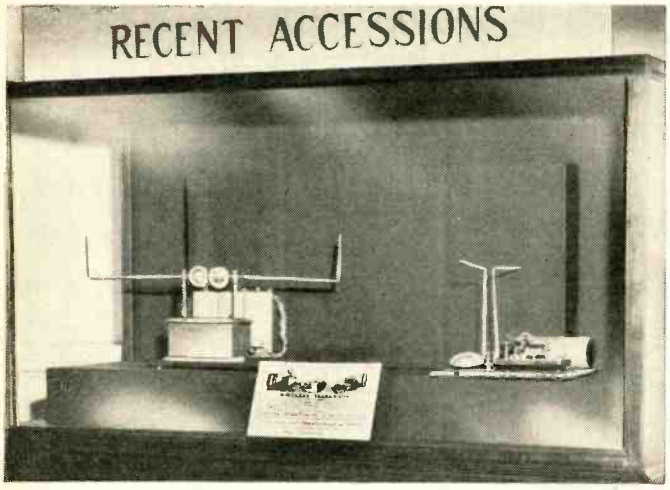
Though he used the conservative *Modern Electrics* as a title (a "radio" magazine pure and simple could hardly have survived in 1908) the very first article of that original April issue was entitled "Wireless Telegraphy." Another article "by our Brussels correspondent" described a wireless-equipped automobile. There was also a piece about long-distance records established by the United States fleet, whose transmissions from the west coast of Mexico had been received at San Francisco and at Pensacola, Fla.

The first issue contained 40 pages. Price was announced as 10 cents a copy—$1 per year.

In the very next issue of *Modern Electrics* (May, 1908), Gernsback elaborated on his Telimco dot-and-dash wireless with an invention he called the Dynamophone, in which the human voice, through a microphone, coupled to a spark coil, transmitted to a distant receiver enough energy to operate a relay and start an electric motor. This might be called the great-granddaddy of today's numerous voice-operated systems now used in oceanic radio and elsewhere.

In subsequent issues he commented on the electric tubes

Early picture of the Electro Importing Co.'s first retail store—the world's first radio store—and the type of equipment that was sold before 1910.



Replica of "the first radio set ever sold to the public," a small spark transmitter and receiver, now rests in Ford Museum at Dearborn. This set was demonstrated at the IRE convention in 1954, the last time spark transmission was authorized by the FCC.

then in existence, based on the Geissler and Crookes bulbs. July's *Modern Electrics* carried an article by V. H. Laughter on "Speaking Arc Lamp," forerunner of the high-power arc transmitters, the arc flame of which was "modulated" by stepped-up voice frequencies. About a year later, Valdemar Poulsen developed and announced an arc transmitter that covered 150 miles on first test. Laughter, incidentally, has continued as an author in these magazines to present times. One of his latest articles (June, 1950) was on "Making Large Electrets."

A "loud-speaking telephone," which could be heard without pressing the device against the ear, was offered by the *Modern Electrics* Berlin correspondent in the September, 1908, issue. Actual contact with the ear, and thus the possibility of picking up germs from the device, was said to be avoided. No other use was foreseen.

The *Wireless Association of America* was promoted in 1909, to further the interests of wireless telegraphy and "aerophony" in America. There were two conditions of membership—American citizenship and ownership of a sending or receiving set (or both). Lee de Forest was the first president. From the membership of this organization and the "Swatties," or Society of Wireless Telegraph Engineers, of Boston, grew the present-day Institute of Radio Engineers, which came into official being on May 13, 1912.

A prominent article in the May, 1909, issue was entitled "Signalling to Mars." In those days it was thought that a power of 70,000 kw would be necessary. This could be supplied, the article pointed out, by focusing many high-power long-wave stations on Mars from various spots on Earth, synchronizing them to operate at the same time from a single key.

Not content with pioneering in the new world of wireless, *Modern Electrics* boldly attacked the unattainable objective of sending pictures through space. In an article "Television and the Telephot" in December, 1909, several approaches and proposals by leading experimenters were described. All included a mosaic of selenium or other light-sensitive cells as a transmitter and a similar mosaic of small lamps to form the receiving screen. The state of the art had apparently not advanced to the point where a synchronized scanning system could even be visualized. Gernsback proposed a method whereby the large number of wires could be cut down by using different frequencies and tuned relays, and whereby varying light intensities could be reproduced with varying current strengths. This was said to be necessary to transmit images of objects in motion and to give a recognizable image. No patents were taken out on the device, as it was considered too complicated for practical realization in the form described.

Modern Electrics, now grown to a circulation of more than 30,000, lent its issue of April, 1910, to the complete

An early E.I.Co. scene. Not only was manufacturing and shipping carried on here, but *Modern Electrics* was edited on the premises too.

printing of the proposed Burke Wireless Bill, which was devised to "regulate and control the use of wireless telegraphy and wireless telephony." This was one of the first actions in the struggle against Federal attempts to "regulate" the amateur into oblivion or ineffectiveness, in which the Gernsback publications were to take so active a part.

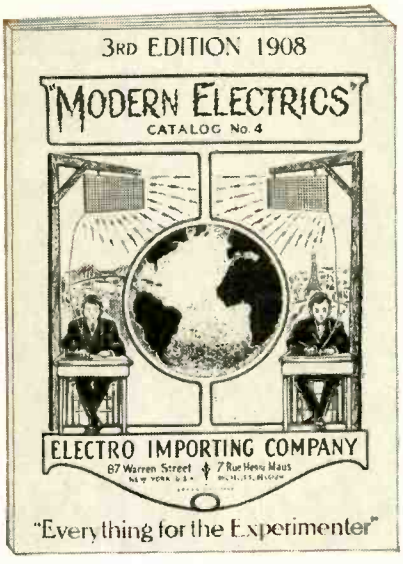
In *Modern Electrics* of May, 1910, it was learned that Bellini and Tosi, two Italian experimenters at Boulogne, whose work had been reported on in the March and May, 1909, issues, had devised a system of directing wireless waves in space. The process could be reversed—incoming waves could reveal the direction from which they arrived. And so was born one of the earliest direction finders.

In the same month the entire organization moved into a roomy 5-story building at 233 Fulton St. Celebrating the new quarters, *Modern Electrics* carried a leading story from Thomas A. Edison on a new nickel-iron storage battery, which Edison had toiled 6 years to perfect.

The editor told of his new "Detectorium" in July, 1910. It incorporated a silicon crystal detector as an integral part of a double-slide tuning coil. The blunt silicon point, held in a brass cup, contacted the coil wires as the slider was moved to tune. One actually "tuned with the detector." The issue also noted the formation of the *Wireless Association of Pennsylvania*, organized to fight the proposed Depew Bill, which would have limited the use of the air to commercial wireless interests.

In the April, 1911, *Modern Electrics* Gernsback leaped into the 27th century with the now-classic serialized story "Ralph 124C 41+," which, intended to give the reader a picture of the distant future, contained a considerable number of then astounding predictions that have since been realized. Among other things, it pictured the essential elements of radar, telling how pulsed radio waves could be bounced off objects near and far, then to return to the sending point to reveal the distance and direction of travel.

On April 1, 1911, it was announced that the *Wireless Association of America* had reached the then phenomenal number of 11,360 members. Somewhat reluctantly, notice was given that the cost of association buttons had to be raised to 20 cents. In the August issue Dr. Charles P. Steinmetz, the electrical wizard, discoursed on "Lightning Phenomena." A page ad in the October issue offered the "best Audion made in the United States." Price complete on a wooden stand, $4. In the same issue, Ralph 124C 41+ was seeking his sweetheart, Alice 212B 423, who had been kidnapped and whisked away into space by a villainous Martian. Ralph was hard on the trail of the abductor, whom he had located through his "polarized wave appara-



Early E.I.Co. catalog. These were the ancestors of *Modern Electrics*, not only in name but in partial contents.

Membership buttons of two of America's oldest radio associations, the Wireless Association of America—the world's first—and the Radio League of America, both organized by Hugo Gernsback.

tus" or long-distance radar—not so fantastic today as it sounded in 1911.

The US Naval radio station NAA at Arlington, Va., opened early in the year, and could be heard henceforth around the world, transmitting time signals at noon EST. On Dec. 11, the Alexander Wireless Bill had been referred to the Congressional Committee on the Merchant Marine and Fisheries and ordered to be printed. *Modern Electrics* carried the full text in the February, 1912, issue. The same issue's editorial practically wrote a constitution for the American amateur, so closely was it followed in the Wireless Bill as finally enacted:

Editorial

"Modern Electrics," Feb. 1912

"There should be a bill passed restraining the amateur from using too much power, say anything above 1 K.W. The wave length of the amateur wireless station should also be regulated in order that only wave lengths from a few meters up to 200 could be used. Wave lengths of from 200 to 1,000 meters, the amateurs should not be allowed to use, but they could use any wave length above 1,000. . . ."

Wireless Act of 1912

(Section 15)

Law enacted Dec. 1912

"No private or commercial station not engaged in the transaction of bona fide commercial business by radio communication . . . shall use a transmitting wave length exceeding two hundred meters or a transformer input exceeding one kilowatt except by special authority of the Secretary of Commerce and Labor contained in the license of the station. . . ."

The publisher announced that with the April issue the price of *Modern Electrics* would be 15 cents. On April 14 the *Titanic* had been sunk at sea. Wireless from the vessel brought aid and 700 lives were saved, proving the great value of the new medium. In the April issue Clapp-Eastham announced its Blitzen tuner, and Murdock its earphones, which, it was said, could bring in signals over 2,300 miles.

But *Modern Electrics* had about reached the end of a long and important life as a publication. The last issue was published in July, 1912, and Gernsback began to concentrate his ideas on something new, a type of publication dealing more with the affairs of the experimenter.

The Electrical Experimenter

"Long live the amateur, long live wireless!" shouted the opening article of a new publication, "*The Electrical Experimenter*," which had long been pondered but finally was born with the issue of May, 1913. Gernsback had terminated a campaign on the part of the American amateur in *Modern Electrics*, but he plunged at once into the affairs of hamdom in the *Electrical Experimenter* by publishing a lengthy but easy-to-read piece on "Building Large Spark Coils." He would not accept or print advertising matter, an announcement said. The periodical—which at 5 cents a copy was said to have been produced at a loss—would be strictly a service to subscribers and customers of the Electro Importing Co.

The assistant editor was Harry Winfield Secor, who had been with Gernsback on *Modern Electrics*, and who was destined to be a member of the organization—with brief interruptions—to the present day.

Lee de Forest in the June, 1913, *Electrical Experimenter* told of "Recent Developments at the Federal Telegraph Co." which he said "enjoyed the distinction of having no press agents."

In the February, 1914, issue, Gernsback reported on his "Radioson" detector, which was made by fusing a .0002-inch diameter platinum wire into a tube of special glass so that only the most minute tip of the metal was presented to the electrolytic solution. It was said to have been some 1,246 times smaller than the best bare-point Wollaston wire of the day. The wireless wavemeter, one of the fundamental tools of the art, made its appearance in the *Electrical Experimenter* of August.

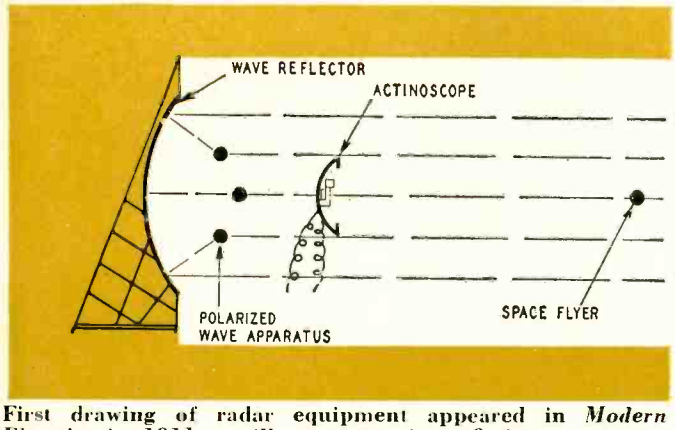
In the spring and summer of 1915, with Europe at war, radio and electronics began to move faster. On May 7 an SOS from the *Lusitania* revealed that the vessel had been sunk by a German U-boat. Wireless dramatically had proven again its usefulness.

In the winter of 1915–16, under the aegis of the *Electrical Experimenter*, radio leaders in this country formed the *Radio League of America*. Its purpose was to "promote the art of amateur wireless telegraphy and telephony in the US . . . to make available to the Government a complete list of US amateur stations . . . pledged to serve the country in time of national danger or need . . ."

There was plenty of opportunity for the magazine to take part in the country's service, and it carried on a campaign to educate the public—and the Government—to the dangers posed to the country's neutrality by the large German stations at Sayville, N. Y., and Tuckerton, N. J. The cover of the August, 1915, issue showed "Sayville Wireless Receiving German War Report," and the editorial pointed out, with examples, how simple it would be to send coded messages which would assist German U-boats to sink enemy (and neutral) shipping.

In the very next issue of *Electrical Experimenter* came the news that the Government had closed the station at Sayville, later reopening it with a full Government staff. Charles E. Apgar, wireless amateur of Westfield, N. J., had recorded Sayville's messages on wax records and turned them over to Federal authorities for decoding. These, when played back, furnished sufficient evidence to cause the Government to close the station.

Meanwhile, the part played by the magazine aroused sharp resentment from the old Sayville officials. Dr. K. G. Frank, head of the station, wrote a bitter letter to the



First drawing of radar equipment appeared in *Modern Electrics* in 1911, to illustrate a science-fiction story.

editor, the point of which was a little blunted by the fact that by the time it was printed, the Government had already closed Sayville. Dr. Frank, incidentally, was later convicted as a German Intelligence agent.

By this time *Electrical Experimenter* (it was in the spring of 1917) was carrying a few ads—the de Forest "Oscillion" for $60. Pacific Laboratories displayed and described double-end vacuum-tube detectors. Crystal detectors were still in the literature of the day, but many realized they were on the way out. An editorial on "War and the Radio Amateur," stated that the huge backlog of amateur operators could be inducted into the country's service at a moment's notice. "What other country could provide such a vast army of well-trained and intelligent men as this, whose very multitude is a priceless protection?"

Then on April 6 the US entered the war and President Wilson signed the order silencing the amateurs for the duration. Many, forthwith, went into the armed forces as an outlet for their activities. Gernsback promptly gave vent to his imagination in an editorial on the possibilities of "Shooting with Electricity," or magnetism, to be more exact. Thereafter, *Electrical Experimenter* explored many facets of the expanding use of electronics in warfare.

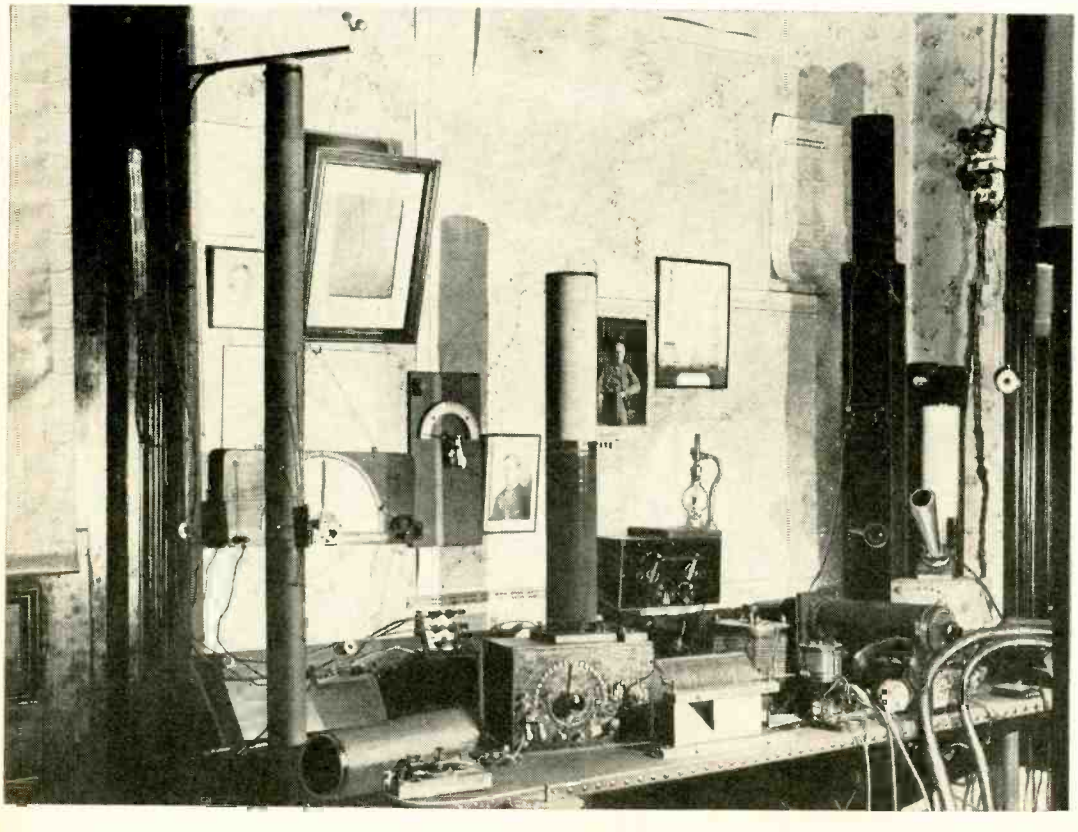
But for the *Electrical Experimenter* and its merchandising associate, the Electro Importing Co., a crisis was at hand. Its business—and inventory—has been increasing since 1908. Now President Wilson clamped down on the sale of radio equipment. There was a war on. With a fortune in parts on hand, there was no one to sell them to. One of Gernsback's first acts was to assemble simple telegraph outfits. He sold thousands, but this did not take care of the great bulk of apparatus on hand.

Then one night he stayed in the factory till 2 am, "rummaging over all the parts in the shop." Suddenly came the solution to the dilemma. He would assemble sets of lamps, batteries, keys, phones and other electrical components into a neat little box called "The Boy's Electric Toys." Sitting up late several nights, he compiled a 32-page profusely illustrated booklet of "100 Electrical Experiments" that could be performed with the outfit. This little publication may well have been the most important one the organization ever printed. With its aid the shelves were cleared and the day saved for the E.I.Co. and, of course, *Electrical Experimenter*.

The editorial of January, 1919, was entitled "Electric Music." It predicted telephone receivers covering every audible tone, with almost any required amount of loudness. Thus was anticipated the current world of high fidelity, the loudspeaker without a horn and the high-power amplifier to drive it. Even electronic or "concrete" music was predicted.

In the February, 1919, issue, *Electrical Experimenter* began a series of articles entitled "My Inventions" by Nikola Tesla. To persuade the great Tesla to write his own autobiography was no mean feat, and the editor still looks back on it as his greatest journalistic beat. The series ended in the May issue, with the author stating confidently that his proposed system of wireless transmission of power, temporarily defeated, would finally become a "triumphal success."

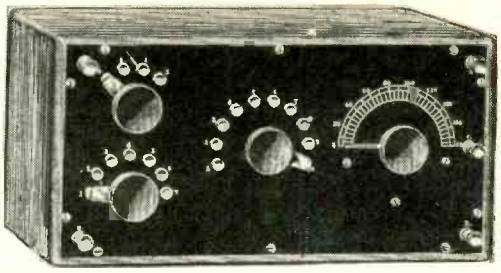
With the war over, the question of "regulating the amateur" came up again. The 65th Congress proposed to amend the Alexander Wireless Bill, but the proposed amendments forbade so many things essential to the amateur that the editor was moved to lampoon the bill in a bitter cartoon in the February *Electrical Experimenter*. The bill was



The amateur station of Charles Apgar. Equipment with which the Sayville wireless messages were recorded may be seen at right.

killed. The hated demon had been effectively exorcised by the power of the cartoonist's pen and of the printed word.

The Acting Secretary of the Navy announced that, effective April 15, 1919, all restrictions were removed on radio receiving stations other than those used for reception of commercial traffic.



A communications receiver, with regeneration, as used by amateurs about 1916.

Radio News is born

The opening of the broadcast era was at hand, and the *Electrical Experimenter* wrote of this and other marvels to come, in the January, 1920, issue. Among this bewildering maze of wartime inventions and discoveries, none was more dramatic in operation than the radio compass, described by Pierre Boucheron. It used a large Kolster coil or loop rotated by a handwheel to which was attached a compass card. Fixed below was a pointer to indicate degrees, hence the bearing of the ship transmitting the signal.

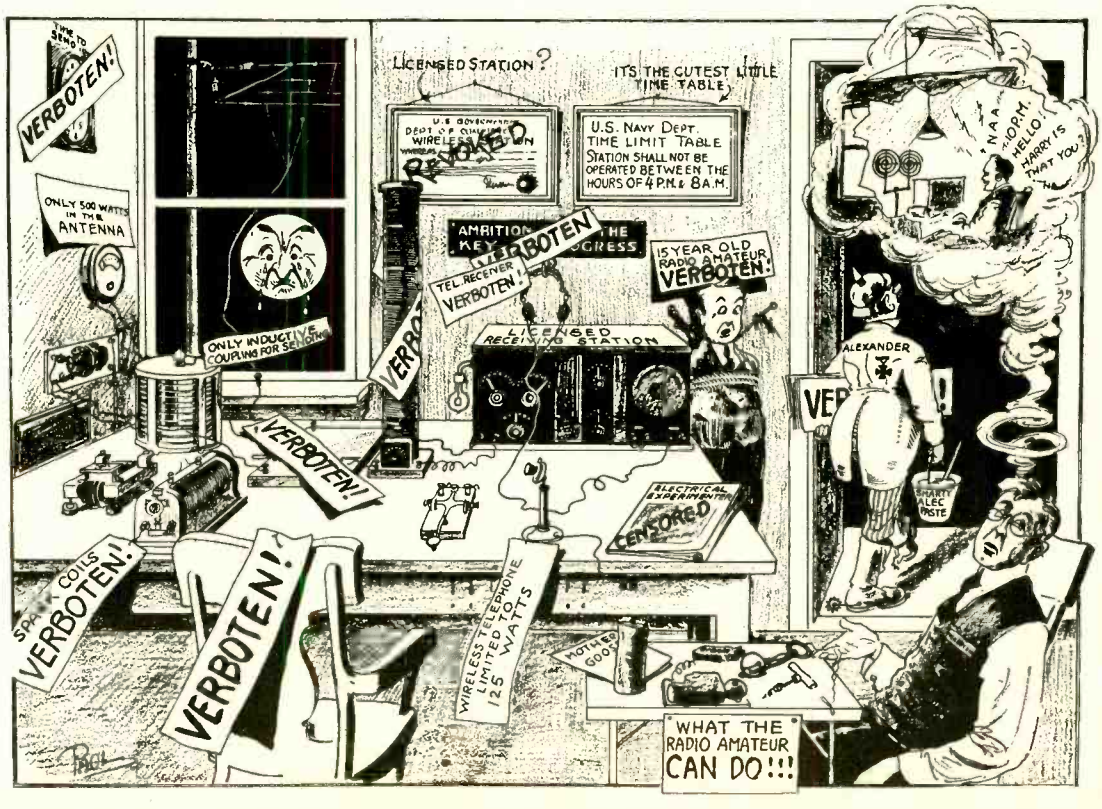
In July, 1919, Gernsback had begun a new publication, *Radio Amateur News*. It was his first strictly radio publication, "the logical outcome," he went on editorially, "of many attempts to put out a purely RADIO periodical, independent throughout and devoted to American Radio Amateurism." He explained that in 1908 he had started the "first magazine in America—*Modern Electrics*—in which many radio articles appeared, but radio amateurism then being in its infancy could not support a purely radio magazine." For that reason *Modern Electrics* devoted about one-quarter of its contents to radio. Then came the *Electrical Experimenter* in 1913, "which had been more prominent than any other on account of its very important radio section. Even during the war, with amateurism dead and nearly every radio magazine discontinued, *Electrical Experimenter* at great financial loss continued radio articles uninterruptedly, month after month, to keep alive the radio spark in the hearts of our amateurs."

But with the war won and a new law defeated that would have killed amateurism, he wrote, "we will witness the most wonderful expansion the radio arts have ever dreamed of. I predict an astounding growth in the next 10 years."

Electrical Experimenter had, for some months, been carrying on its cover a second title—"Science and Invention." In August, 1920, *Science and Invention* became the official name, leaving *Radio Amateur News* to cover practically all the wireless material formerly handled by it. *Electrical Experimenter–Science and Invention* carried tremendous prestige and was immensely useful. During its life—till 1929—it was virtually the electrical and experimental bible for countless youngsters and grownups—the primary stimulus for many a future career.

The October, 1919, *Radio Amateur News* carried a stop-press bulletin that "all restrictions on amateur radio are removed," and a longer mention appeared in the November issue. The world of the ham operator would resume its pre-war status under the Department of Commerce.

Inspired by the great possibilities of remote control of all kinds of systems by radio, the June, 1920, *Radio Amateur News* pointed out that "vast fields remain to be tapped in this category." The work of John Hays Hammond Jr. in this new field, the editorial stated, mystified those who watched torpedoes and small craft maneuvering without visible means of control. Radio, of course, was doing it, by transmissions from hidden shore stations. After June, 1920, the word "Amateur" dropped out of the name, and the magazine became simply *Radio News*.



The famous "Verboten" cartoon, said to have been an important factor in defeating the amended Alexander bill, which would have destroyed amateur radio as we know it.

Bettmann Archives Photo

Attending church with a crystal set in the early 1920's.

In April, 1921, a full-page ad announced Cunningham power tubes, type C-302, 5 watts output, price $8. Incidentally, RCA Radiotrons UV-200 and UV-201, the "best detector" and "best amplifier," sold for $5 and $6.50, respectively. The first annual Amateur Radio Show and Convention was staged at New York's Pennsylvania Hotel Roof Garden.

The first religious broadcast came over KDKA from the Calvary Episcopal Church, Pittsburgh, on Jan. 2, 1921. The 200-kw Alexanderson alternator went into service at Tuckerton, N. J., the same month. KDKA carried the first boxing match—Johnny Ray *vs* Johnny Dundee, on April 11, and that station also broadcast the first theatrical performance from the Davis Theatre May 9.

In an experiment conducted early in 1922 at the request of the Italian Government, a portrait of King Victor Emmanuel was transmitted by facsimile equipment devised by Dr. Arthur Korn. Dr. J. H. Miller of the Navy's Radio Research Bureau devised a radio-frequency amplifying system with a range of 800 to 20,000 meters (375 to 15 kc), "with some gain as low as 150 meters" (2,000 kc).

The famous *Amrad Basketball* variometer was advertised —$6.50 to $11.50. General Radio of Cambridge, Mass., put a quality audio transformer on the market—$5. Magnavox got out an 18-inch gooseneck horn dynamic loudspeaker—$85; "for those who wish the utmost."

Broadcast stations on the air by August, 1922, reached 227 and, by December, 569 *Radio News* reported. Major Armstrong announced his superregenerative circuit on June 28. By August, WEAF, New York City, was sending from the Telephone Co. Building in lower Manhattan. That same month it broadcast the first sponsored program ever put on the air—10 minutes for $100—sponsored by the Queensboro Corp., to sell real estate.

Networks begun

January of 1923 saw the first "network" broadcast, a 3-hour hookup of WEAF in New York City and WNAC in Boston. Dr. J. A. Fleming, the great British inventor of the Fleming valve rectifier, began a series of articles in February. It was titled "Electrons, Electric Waves and Radio Telephony."

It was a period of great concept and invention. Prof. Louis A. Hazeltine described his soon-to-be-famous *Neutrodyne*, based on a mathematical principle, to the *Radio Club of America*. An editorial in the August, 1923, issue pointed out the tremendous field of research open to the radio amateur on waves between 1 and 10 meters, "where static almost vanishes, and new and unsuspected phenomena await the experimenter."

Some 600 variable condensers were on the market at one time in that period. All had to bear the label "low-loss" or they wouldn't sell. Louis Gerard Pacent created one of the first of the new order of inductances. He called it the "duolateral" and pronounced it the most efficient ever.

On the cover of *Science and Invention* in November, 1923, Gernsback showed his *Osophone*, the first bone-conduction device with which the deaf could hear through the teeth.

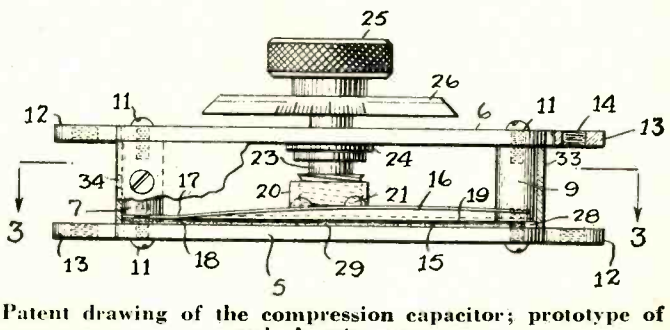
Another invention ("the only patent that ever brought me in any money") was filed for patent on Sept. 27, 1923. It was a variable condenser, comprising ". . . a condenser plate, secured on the base . . . and a cooperating resilient plate . . . means for flexing the resilient plate." In clearer language, it was the compression capacitor, now used almost universally as a trimmer, to track the sections of a variable capacitor gang. The device was sold to Crosley and was used as a "book condenser" in the Crosley *Trirdyne* receiver.

In *Radio News* in December, he advocated a "single-knob control" for radios, adding that "one of these days" we will tune in with one knob ("and possibly an additional one for volume") and get along without all the multi-control paraphernalia of the usual receiver of the day. He had visited the television laboratory of C. Francis Jenkins and called what he saw there the "most marvelous thing of this age." Crude television, but impressive then.

Maj. Edwin H. Armstrong had brought back from his wartime service in the US Army in France an unusual receiver called the *superheterodyne*. It outshone all others for sheer sensitivity and selectivity. Those who dared could buy the diagram and parts and build one of these "supers" —if they had the skill, patience, time and sheer luck. This was the heyday of the hookup, and *Radio News* published accounts of them all. Experts and nonexperts built the Reinartz, the super, the Autoplex, the Solodyne, the Neutrodyne and scores of others that caused sleepless nights to thousands of tinkerers. Even *Radio News* had its pet circuit, called the *Ultradyne*, and told the story of its development in February, 1924. It was an improved superhet, devised by the associate editor—Robert E. Lacault—and gained wide popularity.

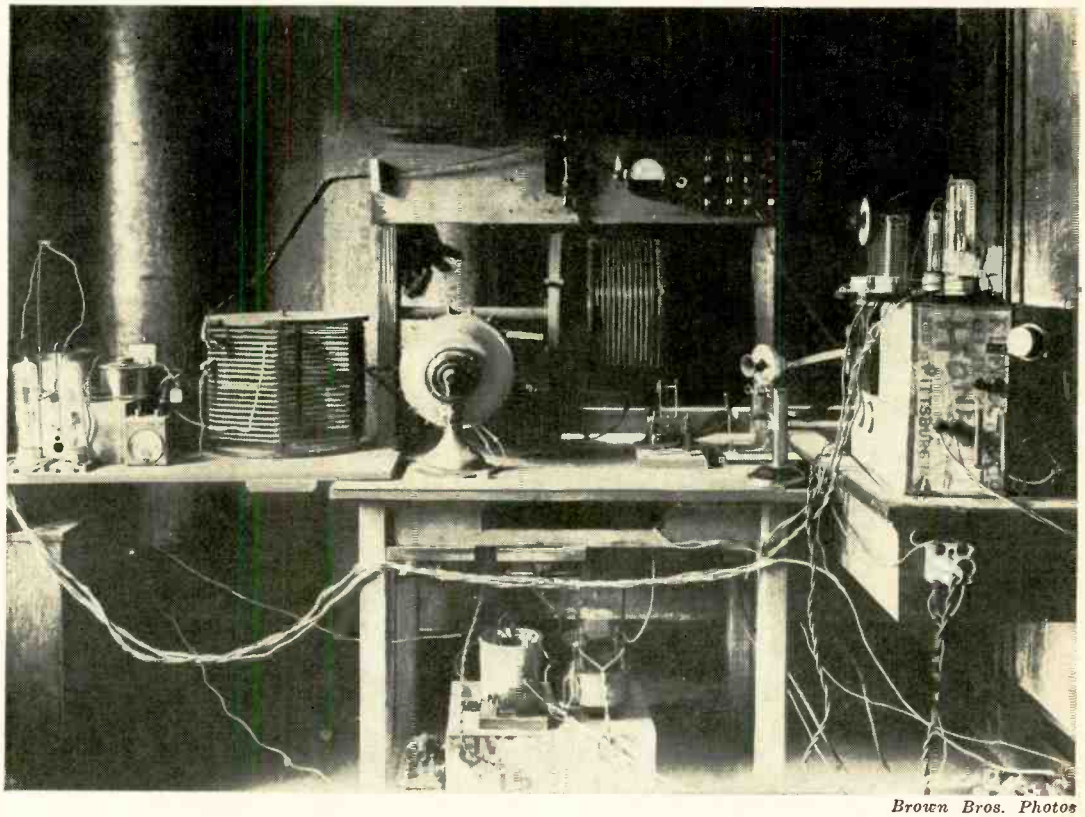
The oscillating tube appeared in a new role—a producer of music—with the *Staccatone*, conceived by Gernsback and developed for him by Clyde Fitch. It consisted of a Hartley oscillator with a large tapped inductance consisting of several 1,500-turn honeycomb coils. The instrument's keys were connected to the taps, and two large capacitors could be switched in to increase the range. It was used as a 2-note interval signal on WRNY (a very useful device at a time when a station might be silent a few minutes between selections without announcement or apology) and was apparently the first interval signal to be used so. The musical 16-note instrument had been heard on the air before—over WJZ in November, 1923, and had been demonstrated in conjunction with an orchestra under the direction of Dr. Hugo Riesenfeld. Its construction was described in the March, 1924, issue of *Practical Electrics*.

In May, 1924, H. C. Harrison of Western Electric Co. received a patent on the electrical recording of sound, greatly increasing the tonal quality of the phonograph



Patent drawing of the compression capacitor; prototype of today's trimmers.

Major Armstrong and his superregenerator, with its 1200- and 1500-turn honeycomb coils.



The humble beginnings of pioneer station KDKA in the upper story of Dr. Frank Conrad's Wilkinsburg, Pa., garage, near Pittsburgh.

Brown Bros. Photos

record. Western's sister company, Bell Laboratories, worked out an improved acoustic phonograph with an exponential horn to take advantage of the new electric recordings, which could not be heard to full advantage on older phonographs. In March, 1925, a contract for commercial use of the new recording method and the new phonograph was signed with the Victor Talking Machine Co., and in November the new *Orthophonic* line of phonographs and the new records were put on the market. At practically the same time, Brunswick offered an *electrical phonograph*, the *Panatrope*, with a pickup designed and manufactured by General Electric, in which records could be played through an amplifier, an improvement even on Victor's new acoustic Orthophonic system.

A regular 6-city broadcast network was set up with WEAF as the key station in October, 1924. It had increased to 12 cities by the spring of 1925. Thus was networking firmly established.

Other publications

During the '20's, when it was hard to supply all the information needed in the new art, new publications were welcomed and read avidly. Beside the *Experimenter*, Gernsback published an annual *Radio News Amateurs' Handibook*, which ran from 1923 to 1929, and *Radio Review*, "A Digest of the Latest Radio Hookups," ran from 1925 to 1927, when the hookup craze had started to die down. *Radio Internacional*, which was *Radio News* in Spanish, ran through 1926 and 1927. *Radio Listener's Guide and Call Book* was published in 1927 and 1928 as a quarterly, giving broadcast stations and shortwave transmitters. There was also the *Radio Program Weekly* around 1927—the only weekly ever published by the organization. *Television*, the world's first TV magazine, came out in two annual issues—1927 and 1928. Later, in 1931 and 1932, a bi-monthly, *Television News*, was also to be the only television magazine of its time.

Books as well as periodicals were also in demand. The organization had been printing books since 1910, when the first call book of amateur stations was printed under the sponsorship of *Modern Electrics*. The Electric Library, whose second publication was the one-time famous *The Wireless Telephone*, published from the earliest days. During the *Electrical Experimenter* period it gave way to the Experimenter Library, a title that proved so popular that it was revived in the 1920's for a new series of books. These were usually small, stiff paper-covered works dealing with simple radio subjects. Gernsback in 1922 wrote a larger work of 291 pages, entitled *Radio for All*, which was published by Lippincott.

In November, 1921, another new magazine, *Practical Electrics*, was announced. Beginners were finding *Radio Amateur News* a bit over their heads most of the time, and the new magazine was slanted to "the electrically inclined layman, the electrical professional man, the experimenter, the student and the beginner." In 1924 the name was changed to *The Experimenter*, and the magazine continued to February, 1926. It was then merged with *Science and Invention*, which carried on a number of its departments for the experimenter and student.

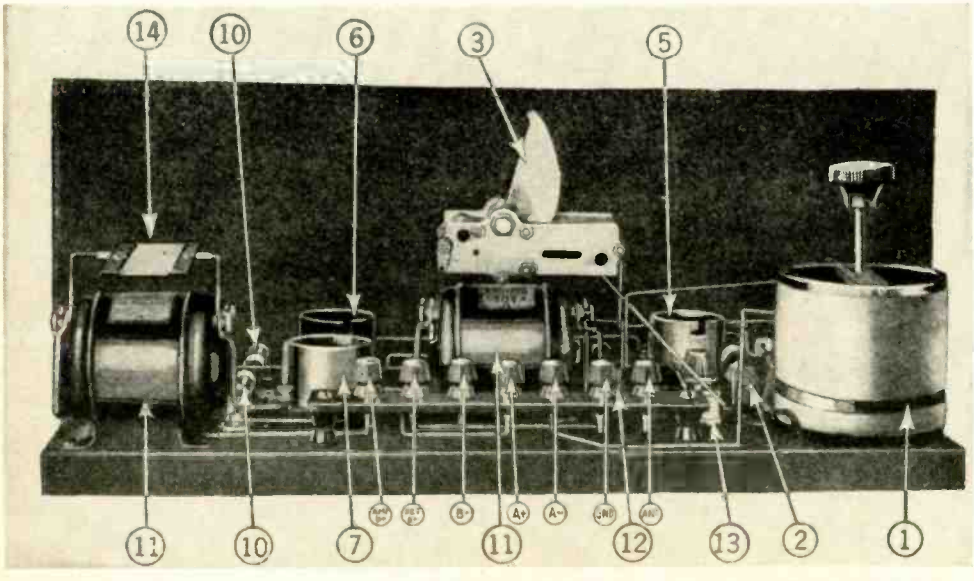
The Experimenter of November, 1924, envisioned a military "radio television plane" which would fly without a living person aboard. Its movement would be controlled by radio from the ground. The plane would be equipped with "eyes" to look in six directions at once. Miles away, and safely behind the lines of the battlefront, the control operator would be able to inspect what was taking place in the plane's vicinity better than an aviator in the plane could do. The radio-controlled craft could be directed to reconnoiter, or to drop bombs on the enemy. It was a fantastic picture of warfare then, but by no means so today, viewed from the vantage point of some 35 years of technical progress.

In January, 1925, *Radio News* began the story of Prof. Reginald A. Fessenden. It was perhaps one of the most important autobiographies in radio literature. He is credited with more than 300 inventions, without which the art today would not be what it is. In the issue of January, 1925, Dr. Greenleaf W. Pickard, one of the most consummate experimenters of his day, described his discovery of the oscillating crystal, giving the credit for it to Dr. W. H. Eccles. The average *Radio News* was a big periodical by now—200-odd pages in the April issue, with a monthly print order of 400,000 copies.

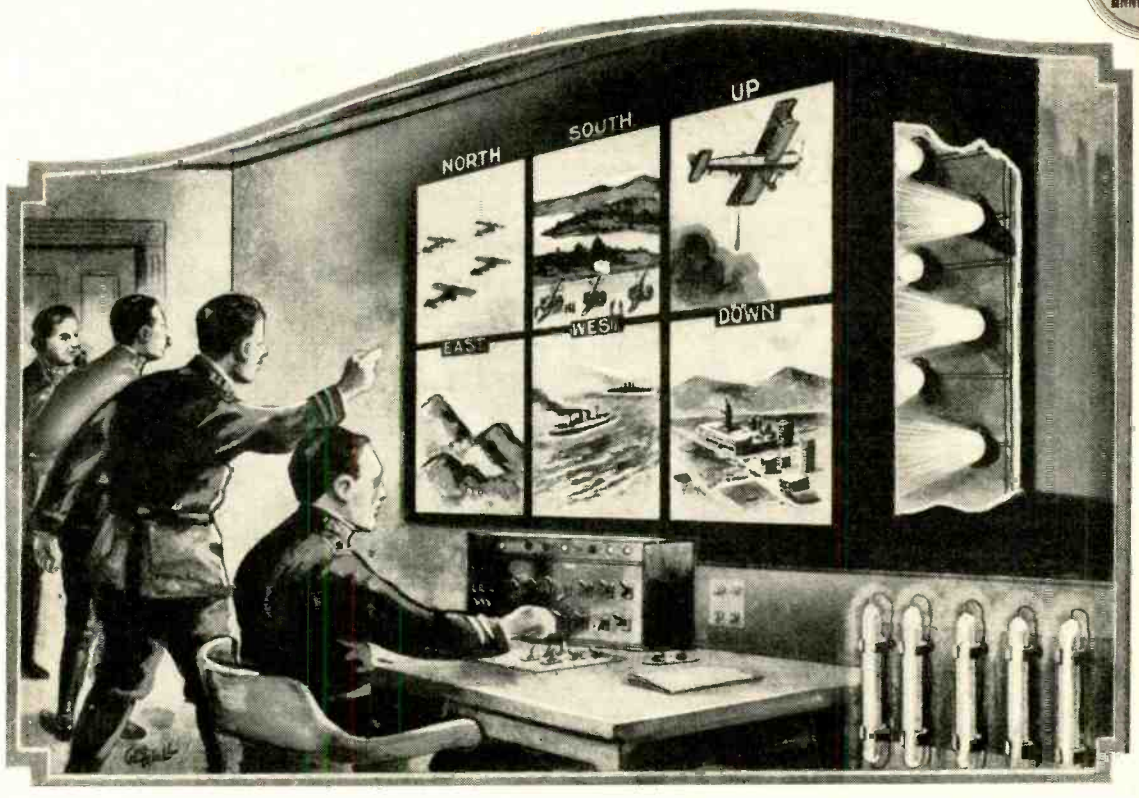
There were 564 broadcast stations in the country by June, 1925, operating on 100 channels. Crowding was a big problem, but with time-sharing and geographical separation there were channels for 550 stations. Then the broadcast band was extended downward and 100 more channels came into use. As a result, 800 stations operated under conditions short of ideal because high-quality transmission was being used, and 10-kilocycle separation was not adequate for best reception. *Radio News* explained the situation editorially. New sets would be made to bring in the extended channels, but existing receivers could do nothing about it economically, if at all. In July, 1925, *Radio News* launched its own broadcast station, WRNY, which later (in 1928) achieved the distinction of being the first broadcast station to transmit television.

Then came a new idea in radio. It was the ac tube, chronicled in *Radio News* of June, 1925. A low voltage was applied to the filament from a transformer, through terminals at the top of the tube which could be plugged into the sockets of a battery receiver. These *Kellog* tubes disappeared when more advanced ac types arrived.

In *Radio News* of September, 1925, Gernsback described a rather unusual receiver of his own development. It was a four-tube single-dial tuner with a crystal in the grid circuit of the second tube, which would normally have been a grid-leak detector. He called this receiver the *Interflex* and stated that his detector–amplifier stage gave "great amplification with unusual stability of operation." The *Interflex* was later improved by balancing the rf stage and in December, 1925, the "Regenerative Interflex" was described. It had the crystal in the grid circuit of the first tube, with a tickler coil to produce regeneration, thus combining rf and af amplification in a single tube, with a direct-coupled diode detector.



The regenerative *Interflex* receiver, using a diode detector in the grid circuit of the first audio tube.



This picture from the *Experimenter*, in 1924, was the first description of military television. A remote-controlled plane was represented as being equipped with television cameras looking in the four directions as well as up and down, and the scenes would be projected on a six-paneled screen at general staff headquarters.

The spring of 1926 had come. "What in your opinion will be the next great development?" the editor of *Radio News* was asked one day. "Undoubtedly," he replied editorially in the May issue, "it will be the ability of man to see objects at a distance—any distance. Why not? Through practically the same medium—radio—we hear from all over the world!" He went on to describe television—today's television—at considerable length, and visualized whole networks of stations operating from a single program source, "capturing with the utmost detail all the features of a face or landscape, with sound of highest quality."

When remarks attributed to Edison charged that "radio is a commercial failure with waning popularity," the editor of *Radio News* flew to its defense, pointing out that interest is "steadily increasing" and that "radio dealers are now making money." Radio sales in 1926 alone would top $520 million.

The National Broadcasting Co. was formed by RCA on Dec. 9, 1926. RCA had purchased WEAF in July, taken over its 18-city Red Network, and in December added the WJZ Blue Network. The World Series that fall had been carried by the Blue Network, as the Yankees and Cardinals fought it out. The Edison Phonograph Co. had released a 12-inch disc capable of playing 22 minutes—the world's first long-playing record.

"Hello, London! Are you there, New York?" And thus—on Jan. 7, 1927—went 2-way trans-Atlantic voices over the first overseas radiophone service ever offered for public use. Single-sideband transmission was used. The preliminary story on the project had been carried in *Radio News* of December, 1925, and a complete report given by G. C. B. Rowe in the March, 1927, issue.

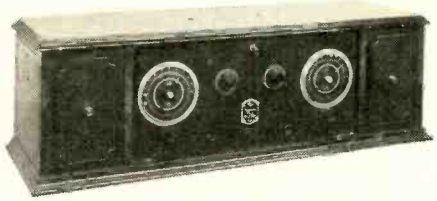
"Can We Radio the Planets?" was the title of a Gernsback article in the February, 1927, issue. It was proposed to erect a powerful beam transmitter on one side of the earth, bounce signals off the moon or planet, and pick up the signal at a station on the opposite side of the earth. This forecast became a reality 19 years later when US Signal Corps scientists first established radio contact with the moon. Interestingly, the January, 1958, *Proceedings of the Institute of Radio Engineers*, in an article "Lunar Radio Echoes," refers to this early article as the first serious proposal to send signals to other heavenly bodies "and return."

Thus went the round of invention and development. John L. Baird, Scottish inventor, described his television system at Glasgow, Scotland. A Washington's Birthday address by President Coolidge was carried by a 50-station network from a joint session of Congress. Wire television was demonstrated between Washington (D. C.), New York and Whippany, N. J., by the Bell Telephone Laboratories. Secretary of Commerce Hoover spoke at the Capital City and was seen and heard at this end. Later in 1927, the Labs demonstrated *color* television.

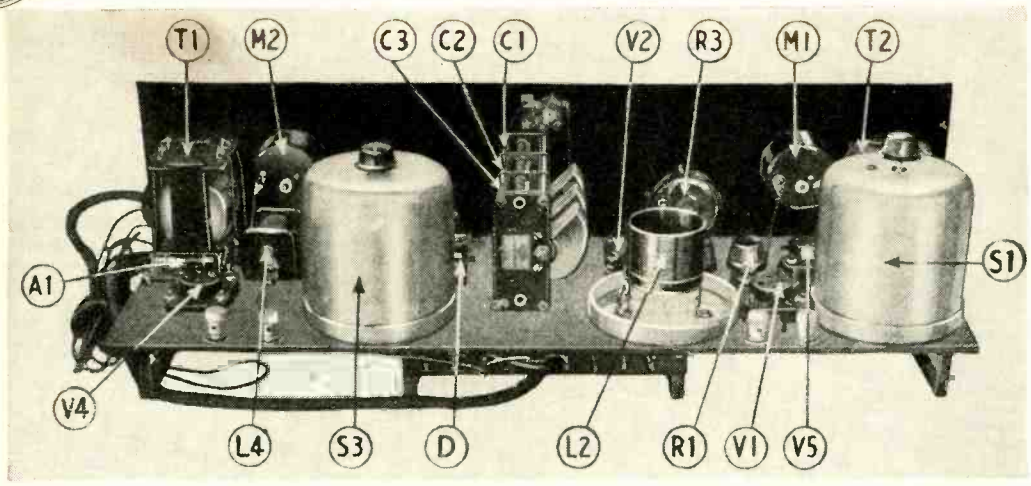
"When broadcasting was established in this country," Gernsback wrote in an editorial for *Radio News* of July, 1927, "the universal opinion was that it would always be free." And thus he disposed of the question of "wired *vs* space radio," venturing that toll radio would always be a challenge to the ingenuity of builders to overcome it and get something for nothing—the bootlegger would take what he could.

In the November, 1927, issue of *Radio News*, the publisher disclosed for the first time a new principle in receiver construction called the *Peridyne*. It embodied a new method of "shield tuning" designed to bring the various rf stages into perfect interstage alignment, hence to operate at maximum possible efficiency. He did this by placing above the coil a metal disc that was moved up and down with a threaded rod. The so-called "slug" or "shield" thus compensated for inequalities in the inductance of the tuning coils, raising or decreasing the inductance in accordance with its distance from the turns of the coils. The Peridyne principle is the first use of nonferrous slugs or plates as tuning or trimming devices, and introduced the service technician to the screw-adjusted trimmer.

True ac-operated sets began to come on the market in



The first "portable radio," an RCA superhet of the middle '20's.



The *Peridyne* receiver, which introduced nonferrous trimming slugs for coil tracking.

the spring and summer of 1927. RCA had announced the ac-heated 226 and 227 tubes early in 1927. By the end of the year the ac era had arrived, and several articles in the November issue of *Radio News* confirm that fact. The Columbia Broadcasting system went into operation in September, 1927.

Radio News of January, 1928, announced that the double-grid tube had arrived, calling it "probably the only real advancement . . . since the invention of the triode." The tube had enjoyed tremendous popularity in Europe, but had been neglected here. Double-grid tubes had been described "for years in this magazine" and had been used in the Solodyne, which eliminated the B-battery.

The electrodynamic cone loudspeaker was developed by the Bell Telephone Laboratories and demonstrated in April, 1928. *Radio News* carried the news at that time and touched on it again in November issue. The device revolutionized techniques of sound reproduction. Twenty-one manufacturers were putting out such units by late 1928. Installed atop a New York office building, one dynamic speaker was heard three miles away on the New Jersey shore. So great was their popularity that stores could not get them fast enough, and reproduction was considered faithful from the lowest to the highest tones in the range of human hearing.

"During the past few months," editorialized in *Radio News* in September, 1928, "a new era seems to have opened that will be known hereafter as the 'Shortwave Cycle.'" Short waves, it was explained, are not new, having originated back in the days of 1908 when amateurs began first to converse with each other on waves below 200 meters with dots and dashes. Marconi, in October, 1927, speaking at the Institute of Radio Engineers, had predicted that the short waves "are destined to be vital in radio and television." The editorial went on: "As time passes the interest in short waves becomes greater and greater. . . . It would not surprise me at all if during the next 5 years, both sight and sound would be transmitted completely on short waves, and the upper channels from 200 to 600 meters were abandoned completely." The *Radio News* station 2XAL, WRNY's transmitter on 30.91 meters, which had started in the spring of 1928, "had poor reception within 200 miles of New York, but beyond that it gets better and better."

Start of Radio-Craft

In the spring of 1929, *Radio News*, *Science and Invention*, *Amazing Stories* and associated magazines, were sold to other interests. *Radio News* of April, 1929, was the last Gernsback issue. In July of the same year he created a new magazine in the fields of the set builder, shortwave fan, radio serviceman and amateur. He named it RADIO-CRAFT. It would devote itself to the experimenter and constructor, he editorialized, noting that in the United States and Canada there were some 250,000 to 350,000 active radio enthusiasts. RADIO-CRAFT would not carry "re-hash stuff," but new material, "edited first, last and always for its readers."

Under the heading "the Constructor," the first issue of RADIO-CRAFT carried a story about the "Supreme Power Amplifier" which had two CX-350 tubes in the output stage. Another story was on the "Harkness Screen-Grid De Luxe." The magazine also described the Pilot "Super-Wasp," which became one of the most famous shortwave sets, in an article by John Geloso (now one of the leading Italian manufacturers of electronic and hi-fi equipment). Other authors included Jack Grand, H. G. Cisin, Clyde J. Fitch and Charles Golenpaul.

The permanent-magnet dynamic speaker made its appearance in 1931. It was recommended for use with battery portables—scarcely anyone then foresaw it as the universal speaker it is today.

In June, 1930, *Short Wave Craft* magazine had begun. It noted the huge buildup of the art, which "promises to assume large proportions in the years to come." In the June–July issue of 1931 it was reported that 7-inch waves had spanned the 21 miles of the English Channel between Calais and Dover, and that amateurs were blazing trails with contacts throughout the world. The boys were getting started on channels as short as 5 meters. A 15-watter had been heard almost around the globe.

With the May issue of 1937 the publication had a new name—*Short Wave and Television* (later *Radio and Television)*, and combining the fields of the shortwave and television experimenter, had the largest circulation of any such periodical in existence. In the May issue, John V. L. Hogan, who then owned and operated New York City's WQXR, wrote on "Short Wave Broadcasting." The publication continued to dominate the radio–video field until 1941, when it was merged with RADIO-CRAFT.

One of the decisive tube inventions of the early 1930's was the "variable-mu" (also known as super-control or remote-cutoff) tube. It could be biased to control rf gain gradually, hence was a highly effective device in automatic volume control circuits. It also eliminated cross-modulation, a bad feature of earlier screen-grid rf tubes. Based on the variable spacing of grid wires, it was the invention of the late Stuart Ballantine of Boonton, N. J.

Gernsback Publications put out an *Official Radio Service Manual* late in 1930, collecting for the service technician many hitherto unobtainable schematics of the sets he had to service. Editions followed annually, and in July, 1933, a *Consolidated Manual*, combining the first three volumes, was announced. One of the most important and valued radio documents of the day, it sold more than 80,000 copies.

Meanwhile, British tube makers had produced Catkin metal tubes, and American manufacturers were quietly experimenting with the metal types.

In 1932 the Radio-Craft Library appeared. This was a collection of practical radio books, some of which were made up of material from the magazine. They were larger than most of the earlier books published by the organization, running about 64 pages. Subjects ranged from radio set analyzers to frequency modulation. The library ran to 28 books and suspended in 1941, due to war shortages. Some of these red-covered booklets are still to be seen in old-timers' collections. *Short Wave Craft* published a number of blue books on shortwave construction and operation. One of these, on coil winding, was so useful to the constructor that inquiries for it are still received occasionally.

In February, 1933, RADIO-CRAFT announced "The Greatest Set of the Year," a complete *ac–dc receiver* which could be held in the hand. The famous International Kadette opened an age of table midgets, though its size (8⅝ x 6½ x 4 inches) would not be startling today. Indeed, it was a three-way portable, for it could also be used with a 6-volt (auto) battery and B-batteries! The set, incidentally, was not a superhet—it had one stage of rf, power detector, an audio stage and a small mercury-vapor rectifier which had been designed for automobile B-power units.

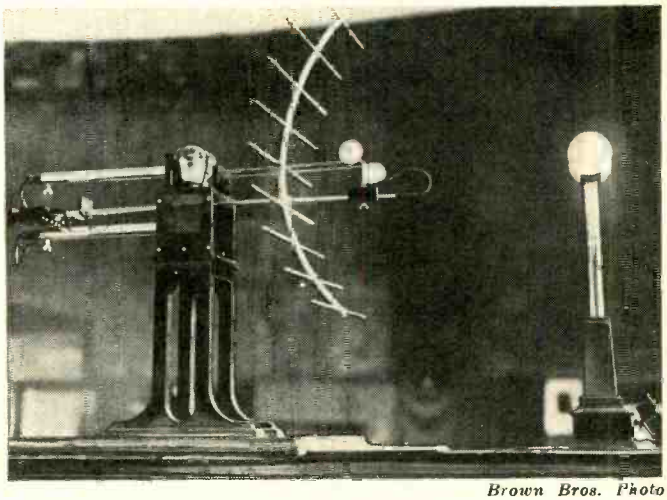
RADIO-CRAFT of December, 1933, carried a feature article on an even smaller set, called the "Kaydette," by the same company. It sported two tubes and an indoor antenna.

Elaborating further on his *Osophone* of 1923, Gernsback described in RADIO-CRAFT of March, 1934, a later idea in the field, the *Phonosone*. It was a Baldwin balanced-armature loudspeaker phone attached to a headphone headband and worn against the forehead, permitting vibrations generated by the output of a radio to be transmitted to the bones of the head, to lighten the world of the deaf and near-deaf. The Osophone was the first description of a bone-conduction hearing-aid unit. In the July issue was a story on a light-sensitive device worn on a strap around the neck. Equipped with a battery and buzzer, it would help guide the sightless.

An editorial in RADIO-CRAFT of August, 1934, noted that the television "picture is still pitifully inadequate," going on to remark that "as long as we cannot have an image at least a foot square of excellent detail that can be viewed in broad daylight, it is obvious that the television set has not arrived."

Radio, meanwhile, had grown into a multi-million dollar industry—RCA alone in May, 1935, announced plans to spend $1 million for field television tests. The radio servicing industry had grown likewise. The July, 1935, issue announced that "the service business has advanced to where it must now be recognized as a separate industry, its dollar sales are in the millions." Estimates from all sources "have established the amazing figure of some $30 million in labor costs alone in 1934." Added to equipment costs this swelled the total to $45 to $50 millions annually. "And this is only the beginning."

Metal radio tubes, similar to those we now have in the shops, came from American tube makers in the middle 1930's. October RADIO-CRAFT of 1935 carried an exhaustive semitechnical story about their design and capabilities. Glass tubes, then, appeared to be on the way out. However, in RADIO-CRAFT issues of late 1936, 16 or more new receiving tubes were pictured and described. Only one was a true metal tube.



Brown Bros. Photo

Marconi's early "microwave" equipment. Apparatus with parabolic antenna at left is transmitter; that at right the receiver.

"Good servicemen need not be worried about the quackery practices by the so-called 'gyps' of the game," who were "outnumbered and certainly would be eliminated," editorialized the July, 1937, issue, pointing up to present-day readers that the gyp apparently always has been with us. The same issue reported that the Department of Commerce had installed ultra-shortwave fan type markers to aid air traffic at landing fields.

A special, more than double-size number of RADIO-CRAFT in March, 1938, celebrated the 50th anniversary of radio as dated from the production of the first radio waves in 1888 by Heinrich Hertz. It was filled with articles on the progress of radio, its early history, memoirs of old-timers, and included a few predictions for the future. The most striking feature was the illustrations, which depicted radio equipment and installations from the earliest days. Numbers of the better-established radio companies reprinted advertisements that had appeared originally nearly two decades before. Not the least valuable contribution made by the "Jubilee Issue" was the preservation of historical material in some of the articles and the old-timers' reminiscences, some of which would be hard to uncover today.

The best news of summer, 1938, came—television-wise—when the NBC revealed plans to broadcast 5 hours of visual programs weekly. Pictures were 441 lines, with a 5 to 6 aspect ratio (10 by 12 inches, said July's RADIO-CRAFT).

A typical radio store of the mid-'20's. It was operated by United Cigars—believe it or not. The same company had four service stations in New York City.

Brown Bros. Photo

The International Kadette, earliest of the true small ac-dc radios.

Meanwhile, at the convention of the IRE, Vladimir Zworykin and R. R. Law of the RCA Laboratories had projected pictures on an 8 x 10-foot screen.

With the July, 1939, issue 10 years of uninterrupted publication of the magazine had been completed. Gernsback wrote: "I take this occasion to voice our heartfelt thanks to the thousands of loyal followers of the magazine and to the large majority of those who have read it through all these years. Radio has come a long way since then. In 1929 we had no pentodes, no variable mu, no metal tubes, no tuning eyes, no octal, loctal or acorn tubes, no black-and-white cathode-ray tubes that finally made television possible."

A. P. King of the Bell Labs had demonstrated that megaphone horns could launch 15-cm waves along a wire over distances to the horizon, adding in the November, 1939, issue that the fidelity of transmission was "flat within 1 db over a bandwidth of 250 mc," enough to carry 40 or 50 TV channels. Dr. George Southworth of the same organization was experimenting with coaxial cables and waveguides,

FCC Form 452
April 1954

UNITED STATES OF AMERICA
FEDERAL COMMUNICATIONS COMMISSION

STA

RADIO STATION LICENSE

K E P X S X
(Call sign)

EXPERIMENTAL (DEVELOPMENTAL)
(Nature of service)

S-406-SD-56
(File number)

EXPERIMENTAL
(Class of station)

NAME HUGO GERNSBACK

KINGSBRIDGE ARMORY, New York, New York
(Location of station)

(Location of authorized remote control point)

Subject to the provisions of the Communications Act of 1934, subsequent acts, and treaties, and all regulations heretofore or hereafter made by this Commission, and further subject to the conditions and requirements set forth in this license, the licensee hereof is hereby authorized to use and operate the radio transmitting facilities hereinafter described for radio communication.

Frequency	Emission Designator	Authorized Power (Watts)	Privileges
Above 30 Mc	Type B	100 watts input	Authority is granted to operate this station without transmission of call letters.

Equipment: Composite, spark excited transmitter of early design

Hours of Service: Not to exceed 5 seconds during each 15 minute period.

Purpose: To demonstrate radio transmitting equipment of early design at the annual meeting of the Institute of Radio Engineers.

Communications: In accordance with Section 5.252 of the Commission's Rules.

This authority is granted upon the express condition that no ground connections or elevated antennas will be employed; that no interference is caused to any other station or service and may be cancelled at any time without hearing if, in the judgment of the Commission, such action should be necessary; and that all transmissions shall be discontinued immediately upon notification of interference caused thereby.

The above frequencies are assigned on a temporary basis only and are subject to change at any time without hearing.

This authorization is granted subject to the condition that no interference is caused to any other station or service and may be cancelled at any time without hearing if, in the judgment of the Commission, such action should be necessary.

This license is issued on the licensee's representation that the statements contained in licensee's application are true and that the undertakings therein contained, so far as they are consistent herewith, will be carried out in good faith. The licensee shall, during the term of this license, render such service as will serve public interest, convenience, or necessity to the full extent of the privileges herein conferred.

This license shall not vest in the licensee any right to operate the station nor any right in the use of the frequencies designated in the license beyond the term hereof, nor in any other manner than authorized herein. Neither the license nor the right granted hereunder shall be assigned or otherwise transferred in violation of the Communications Act of 1934. This license is subject to the right of use or control by the Government of the United States conferred by Section 606 of the Communications Act of 1934.

This authorization effective March 7, 1956 and
will expire 3:00 A.M. EST March 25, 1956

FEDERAL COMMUNICATIONS COMMISSION.

eg

Mary Jane Morris
Mary Jane Morris,
Secretary.

P.C.C. - WASHINGTON, D. C.

FCC's special authorization for use of Gernsback spark transmitter at 1954 IRE exhibition. Note that this 1906 equipment was well up in the vhf range.

and told stories about removing the inner conductor of a quartz-insulated cable without affecting the efficiency of transmission, and then of removing the outer conductor, allowing the microwave signals to be "conducted" by the insulating quartz alone.

By early 1940, frequency modulation had earned for itself an almost permanent niche in the Monthly Review department, as the continuing progress in that field was appraised. Much experimental work was going on. Major Armstrong's Alpine (N. J.) station W2XMN had been on the air for some time. On Oct. 31, 1940, the FCC issued the first commercial FM licenses. The December issue carried an ABC primer of FM prepared by authorities.

In the issue of March, 1942, RADIO-CRAFT carried some 30 pages devoted entirely to what leading American radio engineers thought about FM and its future. Major Armstrong wrote a lengthy piece. *The New York Times* paid a million dollars odd for WQXR and W2QXR. The NBC had installed its FM station—W2XWG—atop the Empire State Building. There was a station on Mount Washington, N. H. The radio map of FM was rapidly filling up.

But most radio activity was grinding to a stop because of war duties and war shortages. The service technician was compelled—and urged as a patriotic duty—to keep America's receiving sets operating without new tubes or components RADIO-CRAFT instituted a special Wartime Radio department, beginning in the August–September, 1942, issue. Articles began to appear on servicing volume controls, rf coils and other components formerly replaced. There was even a story on "Wartime Transformer Rewinding" and the long series of tube-replacement articles began with "Wartime Tube Replacements" in February, 1943. Dozens of such articles—and even a few books—were printed. The service technician became adept at substituting practically every tube in the manual, and even repairing a few!

About this time, with the US in the middle of World War II, the ugly head of "radio censorship" made its appearance and Wendell Willkie demanded: "Let's not have any more of this nonsense." RADIO-CRAFT, editorially, echoed those sentiments in December, 1942. Dr. Lee de Forest, father of radio, had celebrated his 70th birthday at Los Angeles on Aug. 26, 1943, and his comments on radio in general were printed in the October issue, following the anniversary.

Nikola Tesla, possibly the greatest inventive mind of all history, died Jan. 7, 1943. The next issue of the magazine printed a complete article on the life and inventions of the almost-forgotten genius who had given us our now-universal alternating current, had pioneered in high-frequency, radio remote control and in power transmission by viscosity of liquids, but had in most cases seen his patents run out long before society was technically able to put them to work. Expressions of appreciation from the leading figures in the electronic world indicated that more than one had cut his scientific teeth on the *Inventions, Researches and Writings of Nikola Tesla, published in 1894.*

Beginning with the May issue of 1943, the RADIO-CRAFT cover had begun to show the name "RADIO-CRAFT and POPULAR ELECTRONICS," advertising that the periodical would henceforth cover the ramifications of the broader field. A monthly section headed Electronics was carried thereafter in all issues, and grew rapidly in size and importance. One of the first comprehensive stories therein covered the evolution of the Klystron, and a serial "Practical Electronics" had begun under the authorship of Fred Shunaman, then associate editor.

The Age of Television

On August 21, 1945, the FCC lifted its wartime ban on one amateur band—112–115.5 mc. The other bands were freed Nov. 15, permitting some 60,000 stations to resume

operation after 4½ years of silence. In November, RCA announced that postwar TV sets, priced from $200 to $450, would be available in 6 months. Other manufacturers were following suit. By September, some 515 FM stations had been applied for, also 129 TV transmitters and 265 AM outlets.

The book-publishing division of the organization picked up in 1946 where the Radio-Craft Library had left off. Under the title of Gernsback Library, a number of smaller paper-covered books were printed. Starting in 1951 with Frye's *Basic Radio Course*, larger, cloth-bound editions were printed, with such excellent results from the viewpoints of both publisher and reader that smaller books were dropped almost entirely, and only full-length works printed, though they can still be obtained in paper-covered as well as cloth-bound editions.

The 40th anniversary of the invention of the vacuum tube by Lee de Forest was marked by a special issue of RADIO-CRAFT of January, 1947. The inventor was then 73 and still inventing. Articles by de Forest himself, Frank E. Butler, his chief aid during the inventive years of the early 1900's, and others who remembered or were associated with the birth of the Audion, were included.

RADIO-CRAFT in January, 1948, published its first Special Television Number. It was the first of 10 annual television issues, the earlier ones of which especially filled a need for detailed and consolidated information which could not be obtained elsewhere. The special TV issues were discontinued only when such information became general and easily available.

On June 30, 1948, the Bell Telephone Laboratories announced and demonstrated the *transistor*, a crystal that could amplify an electric current like a vacuum tube. The discovery was heralded throughout the world and was the subject of a feature article "End of the Vacuum Tube?" in the September issue. Treating the coming of the transistor later (in the January issue of 1949), Gernsback declared: "It will play an increasingly important role in the future. When we look back at the humble beginning of the crystal detector, we marvel at the spectacular comeback it has made in the form of the new transistor, destined some day to supplant the vacuum tube."

Late in the spring of 1948, a letter had been addressed to the older subscribers by the publishers. The name RADIO-CRAFT no longer seemed to be the proper name for a publication that had so much to do with the modern world of electronics. "Would the readers suggest a new title?" And so RADIO-CRAFT, at the end of 20 years of existence, became RADIO-ELECTRONICS with the issue of October, 1948. Gernsback promised that the publication would ever be in the forefront of radio-electronic happenings the world over.

One of the first articles in it was about the new LP microgroove phonograph record announced by CBS and Columbia Records to the newspapers in the spring of 1948 and discussed subsequently at technical meetings.

Radio waves had long been directed through the air and carried over wires, and much experimenting had been

Gernsback Electronic Publications 1908–1958

Modern Electrics—1908–1912
Electrical Experimenter (Science & Invention)—1913–1929
Radio News—1919-
Practical Electrics—1921–1924
Radio News Amateurs' Handibook — 1923–1929
The Experimenter—1924–1926
Radio Review—1925–1927
Radio Internacional (in Spanish)—1926–1927
Radio Questions and Answers—1926–1929
Radio Program Weekly—1927
Radio Listener's Call Book—1927–1928
Television—1927–1928
Radio Dealer's Personal Edition Radio News—1928
Radio-Craft (now Radio-Electronics)—1929–
Television News—1931-1932
Short Wave Craft—1930–1936
**Short Wave and Television—1937–1938*
**Radio and Television—1938–1941*

*The name SHORT WAVE CRAFT was changed to SHORT WAVE AND TELEVISION in 1937, and to RADIO AND TELEVISION in 1938.

Large-screen television of 1939. The tube stands upright, projecting an image upward to a mirror on the slanting cabinet lid, from which it is reflected to the viewing screen.

RCA Photo

The silver tribute awarded to Hugo Gernsback by the radio-electronics industry in 1953.

done with more advanced methods of guiding those of ultra-high frequency. In its December, 1948, issue RADIO-ELECTRONICS told the story of the microwave guide, which channeled the uhf waves like water through pipes. This was a project of the Bell Labs at its Holmdel, N. J., field laboratory, based on pioneering work done for years by Southworth and others. The work is still going on at Holmdel—with round guides—and is considered one of the most promising fields of research for the future of long-distance communication.

Television was getting into high gear in the spring of 1949. "When broadcasting began in 1920 it engendered the first major radio boom, but now we are in the middle of another similar cycle," commented RADIO-ELECTRONICS editorially in March. "This time it is television that is gaining rapid momentum. The difference is that the present boom will make the first look small by comparison." As of Jan. 1, the editorial pointed out, only 1,037,000 homes were TV-equipped and the public had paid some $432,429,000 for sets. Authorities had predicted that in 1949 the public would own a minimum of 2 million sets at a cost of some $650 million. "All in all, it will be seen that television will enrich our economy by $1½ to $2½ billions at least."

By Jan. 1, 1950, 98 TV stations were operating in 24 cities. Noting TV's advantages, the Navy had begun to use it in teaching.

The January, 1948, issue had carried a short note on the American Telephone & Telegraph Co.'s plans to connect New York and Boston telephone-wise by microwave. Experimental transmissions had been made as early at Nov. 13, 1947, with Washington hooked in by coaxial cable. On May 1, 1948, this circuit was inaugurated as the Bell System Eastern Network. A Midwestern network opened Sept. 20, and on Jan. 11, 1949, the Eastern and Midwest networks were linked, extending the system from the East Coast to St. Louis. Sept. 4, 1951, saw the beginning of coast-to-coast television.

RADIO-ELECTRONICS reported in October, 1949, on a new lightweight *printed circuit* introduced in the Telex model 200 hearing aid. It was some 1 x 2 inches in size and with all components weighed 1/16 ounce. How to build a see-in-the-dark *Snooperscope* with war-surplus materials was described and pictured in the same issue.

RADIO-ELECTRONICS noted in December, 1950, that the FCC had picked the CBS sequential color TV system as standard for the country. It had been tentatively approved on Sept. 1, but now was finalized and commercial broadcasting had begun Nov. 20. An estimated 7 million sets then in the public's hand would need an adapter to tune in the programs correctly and convert to color—the cost per set: $125 to $150. Calling the FCC decision a "bombshell" to the TV industry, Gernsback editorially called it "Choleric Color TV," stating that "color television should be allowed to develop naturally," just as radio did. "To use forceps to force a premature birth may mutilate the color TV child for life." And most of the TV industry agreed.

"Electric Spaceships" was the subject of an article by the German rocket expert, Prof. Hermann Oberth, who touched on the use of electrical repulsive forces to drive the rocket into space. It ran in the December, 1950, and January, 1951, issues. Once free of the earth's atmosphere, he went on, "we can then build machines which collect energy from the sun . . ." At the time the article was considered almost fantasy (but fantasy backed up with rigid mathematics) and even Gernsback would scarcely have dared to predict that by 1957 we would have a space vehicle in flight.

Phonevision, the first proposed toll TV system, was advocated by Zenith. *Subscriber-Vision*, engineered by Skiatron, had also been undergoing tests over New York City's WOR-TV. The picture was given an electrical "jitter" by the transmitter in both these systems. It could be taken out at the home receiver by a call to the phone operator or by inserting a special card key that introduced a correcting voltage.

By May, 1951, television and the various subjects associated with it were occupying a clear majority of the pages of the magazine. Ultra-high frequency was the keynote of the national IRE convention summarized in the June RADIO-ELECTRONICS. In the same issue it was announced that Western Union had organized a television service outfit. Opening shop first in New Jersey, it would handle Du Mont installations and do service work in several counties at rates commensurate with Du Mont's regular charges. RADIO-ELECTRONICS treated the topic editorially in the July issue. Conclusion: Western Union "has still to learn the business, and that they cannot do overnight." The furor subsided.

"Oldest member of the staff"

One of the oldest members of the staff is the invisible Martian office boy, Mohammed Ulysses Fips, who in the early days of *Modern Electrics* had his own department, *The Martian Spark*. Now, grown to a grave and long-bearded consultant, member of many learned societies with unheard-of name, he confines himself to the description of one wonderful discovery a year, usually in the April issue. These range from a radium-operated one-tube receiver, so powerful that it needs a throttle rather than a volume control, to a means of keeping an office quiet by picking up the noise with a microphone, amplifying it and reproducing it at equal volume, but opposite phase, to the original sound. Thus complete silence would result. Fantastic, when published, but patented within 2 years by one of the country's

greatest acoustic researchers. Other ostensible April Fool stories were trial balloons, stories of things a little too far-fetched to be predicted with confidence, but which might or should be invented. Such was the *Westingmouse* 1933 vest pocket receiver, so ridiculously small for the time as to arouse the indignation of engineers, but a clumsy and bulky set by today's standards, or *Electronic Brain Servicing*, screamingly funny in 1950, but quite serious when described in July, 1956, as manufactured by Lavoie Laboratories.

"A radically new type of teaching now becomes possible," Gernsback editorialized in the September, 1951, RADIO-ELECTRONICS. Television had now made many things possible that were not easy before. With television in all public schools, wired with a city TV Education Center, 50 brilliant teachers could reach the city's 800,000 students, whereas, with the usual system, 35,000 teachers were needed.

An editorial in the November, 1951, issue pointed out that "the radio-electronics industry will soon be one of the top three" in the country, ranking next to steel and aircraft production. More than $7,600,000,000 in electronic contract's will have been awarded by the year's end, Dr. Allen B. Du Mont reported.

Tape recording, a new field of the electronics industry, had been growing rapidly. In the August, 1952, issue it was noted that newspaper opinion held that a "revolution was taking place in the science of capturing and reproducing sound" and was being used widely in many fields—entertainment, business, education and professional.

The January, 1953, issue—the sixth annual television number—noted editorially that as the issue went to press "the first closed-circuit telecast of the Metropolitan Opera was about to be carried to a number of theaters.

In April, 1953, Gernsback predicted that "intercontinental TV programs are feasible." He added that the idea was not original with him—Baird had actually bridged the ocean with images as early as 1928 but with low frequencies—present-day TV used high ones. It would be necessary "to build many relay stations to skip from island to island" over any large bodies of water. Where natural islands were not available, "iron islands" in the form of steel caissons were advised for the relays.

In the April issue there was also an article on a new German electrostatic speaker—not a new idea exactly, but a new design. In June, the editorial told of a new "booming field for video—closed-circuit television," which, the editorial went on, "is certain to rise in the next 10 years to unimagined heights." Du Mont had produced three-dimensional or stereoscopic TV for use in atomic research.

In May, 1953, several hundred leaders of the electronics industry awarded the editor and publisher of RADIO-ELECTRONICS, at a Radio Industry Banquet in Chicago, a trophy, a large sphere cradled in rare metals, mounted atop a handsome silver base set in ebony. The whole stands 27 inches high. On it were engraved the names of his many friends and associates (33 firms and 97 individuals) who contributed to the award, as well as the names of 75 living and dead "immortals" in the field of electronics.

Part I of a series of special articles on "High-Quality Audio" began in the September, 1953, issue. An important feature of the series, it was said, would be to go beyond the purely technical details and treat the subject as an extension of the art of music in general, as one would like it in the home. Richard H. Dorf was the author. The FCC, which had granted a limited tentative approval to the NTSC compatible color TV system in midsummer, now brought the year to a happy close by granting full approval on Dec. 21, thus opening the door to our present system of color TV broadcasting.

Use of the G-Line, invention of Dr. Georg Gobau of the US Signal Corps, was described as an ideal facility for long uhf-TV transmission lines in the March, 1954, issue. The pros and cons of "High-Fidelity Loudspeakers" were discussed in this and subsequent issues by the British authority, H. A. Hartley. The August issue carried a Bell Laboratories story on the solar battery, which operated a small transmitter and was the first practical attempt to obtain real electrical power from light.

"'How foolish we once were,' our children will say in future, 'to allow our great scientists to speak to only a few dozen, or perhaps a few hundred pupils when the great man could lecture to 500,000 at the same time,'" Gernsback editorialized in the February, 1955, RADIO-ELECTRONICS on the topic of "Tec-Teleducation," the substance of which he had proposed as far back as December 1950 in "Newspeek," a prognostic spoof on the times. "Fortunately," he went on, "we have in our hands today the means of making Teleducation a reality in the immediate future. . . . Just as we have a national closed-circuit TV network, there will be a similar one for grade and high schools, colleges and universities, covering the entire country . . . Teleducation will not displace our teachers—it will supplement and augment them."

More than 42,000 radio engineers registered at the 1955 national convention of the Institute of Radio Engineers. Ultrasonics was one of the chief subjects. It drilled teeth painlessly and was useful in internal diagnostic work. RCA exhibited a new tri-color vidicon tube, and Du Mont displayed the *Iconumerator*, which counted a million small objects in the twinkle of an eye.

In the August RADIO-ELECTRONICS was a story of reliable TV "scatter" communication over 188 miles between Holmdel, N. J., and the Round Hill station of the Massachusetts Institute of Technology, near New Bedford, Mass. Sixty-foot antenna "dishes" beamed the 4,000-mc waves over the horizon, and scattered bits were recovered at the receiver and reproduced as the complete image.

The Philco "Apple" cathode-ray tube for color reception was described in the last special television issue, January, 1957. It is a 21-inch single-gun device coated with a repeating array of red, blue and green stripes arranged vertically. The term "Apple" is a Philco code word and has nothing to do with apple characteristics.

The picture-on-the-wall TV tube, which had been predicted for some time by many, "has at last reached the advanced laboratory stage," reported Eric Leslie in the March, 1957, issue. The account was from English sources and described a flat tube in detail. Others in this country are experimenting with similar devices and have pooled their patents with the British developers, the article revealed.

Dr. H. C. Ko, of the radio observatory of Ohio State University, wrote in August, 1957, about the 96-helix radio telescope being used there to sound outer space for galactic signals, and gave some hints to would-be radio astronomers. The *Solion* and the *Spacistor*—new amplifiers neither like tubes or transistors—were described in the November, 1957, issue. An editorial about the same time wondered about them, and what would come after them, but closed on the note: "The greatest scientific discoveries still lie in the future—the art has barely begun!"

ABOUT THE AUTHOR

To prepare an article of this type required an unusual combination of qualifications—expert knowledge and wide experience in the fields both of journalism and electronics, Radio-Electronics *found this combination in Tom Kennedy, recently retired associate radio editor of the New York Times. His acquaintance with radio goes back to 1907, when as a high school student he assembled a crystal set from parts bought from the E.I.Co. (following it up the next year with a 12-inch spark). He studied electrical engineering at the Carnegie Institute of Technology in Pittsburgh, then worked on radio compasses, first as Radio Compass Officer in the Navy (World War I) and later as civilian employee, installing equipment on more than 50 destroyers and a dozen land stations. He was radio editor of the* Pittsburgh Post and Sun *and technical radio editor of the* Philadelphia Evening Ledger *before joining the* Times *in 1927. Since his retirement Mr. Kennedy has done some consulting work in high-fidelity (his activities in the high-fidelity and amateur recording field were the subject of an article in* Fortune, *October, 1946) and free-lance writing in electronics and kindred fields.*

Synchronized ELECTRONIC SWITCH

Printed-circuit wiring makes this unit compact and gives it a professional appearance

By TOM JASKI

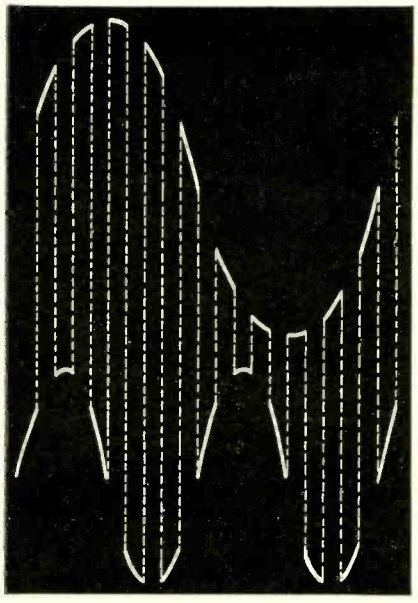


Fig. 1—Many electronic switches show traces alternately by rapid vertical excursions of the electron beam.

AN electronic switch—for viewing two traces simultaneously—is an invaluable addition to the oscilloscope. This accessory has received much attention, and many types have been made. Some permit a display of as many as 32 traces at the same time on one C-R tube screen.

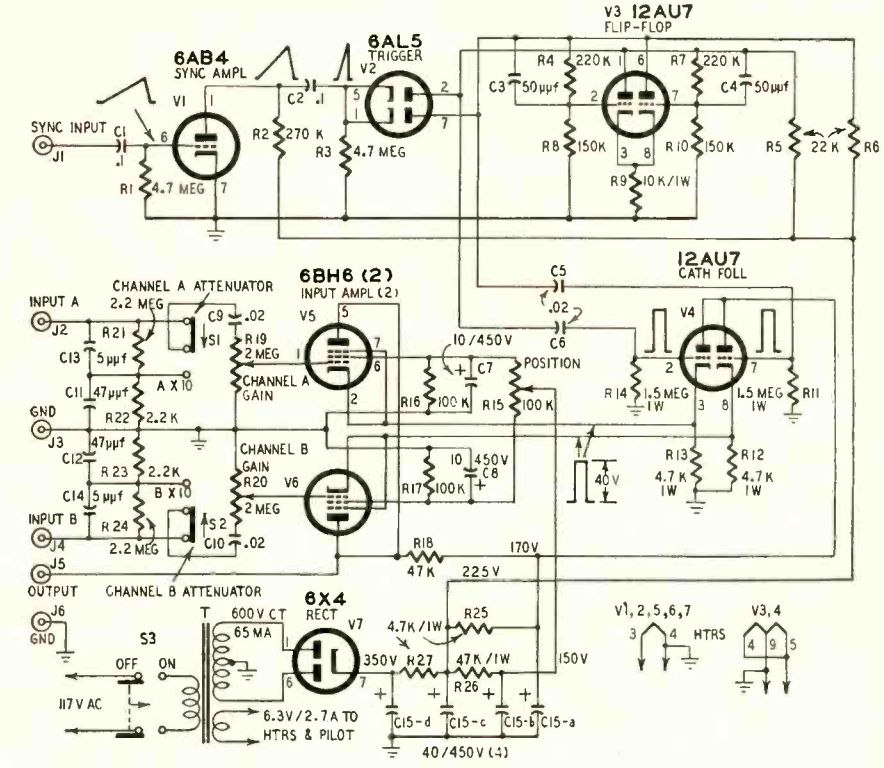
Two traces are usually quite sufficient for the experimenter. A number of electronic switch designs have been published and several are available in kit form. Most of these use a fixed-frequency oscillator to divide the sweep time between two traces. The oscillator gates two amplifier tubes which receive the two signal inputs and thus alternately a short section of each trace is shown (see Fig. 1).

A major disadvantage of this type of switch is that the switching signal, rapidly swinging the electron beam in the C-R tube back and forth, usually has to be larger than the input signals and the scope's sweep generator may have a tendency to synchronize with the switching frequency. If the signal and switching frequencies are nearly related as multiples or submultiples, the traces appear interrupted. If these frequencies are just slightly separated, it is almost impossible to get a good clear trace.

The switch described here uses a different principle. It makes use of the scope's sweep voltage to display two traces which are alternately swept across the face of the tube, thus presenting unbroken traces. Since sweep speed does not begin to show marked flicker until we get down to about 15 cycles, two clear traces can be obtained at frequencies from 30 cycles up. The top frequency is limited only by the scope's top sweep frequency. In my Heath O-10 this is about 500 kc.

The circuit

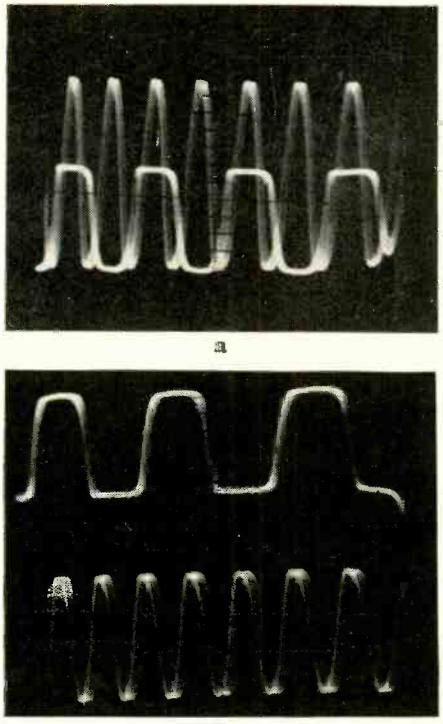
Fig. 2 shows the unit's schematic. The signal from the scope's sweep oscillator is applied to the grid circuit of the 6AB4 amplifier (V1). How we obtain this sweep voltage from the scope will be discussed later. The 6AB4 is a straightforward triode amplifier. The output from this tube, with some differentiation by C2 and R3, is applied to the cathodes of the 6AL5 trigger diode (V2). This tube triggers the 12AU7 flip-flop circuit (V3-a – V3-b), which is the well known Eccles-Jordan bistable circuit. The flip-flop is driven by the sweep voltage and changes state each time the trace travels across the cathode-ray tube face. Each half produces a square wave with alternate excursions. These positive excursions are applied to the grids of the cathode-follower triodes (V4 sections). The alternate positive voltages appear at the cathodes of this tube. These cathodes are tied to the cathodes of the 6BH6 input ampli-



R1, 3—4.7 megohms
R2—270,000 ohms
R4, 7, 22, 23—220,000 ohms
R5, 6—22,000 ohms
R8, 10—150,000 ohms
R9—10,000 ohms, 1 watt
R11, 14—1.5 megohms, 1 watt
R12, 13, 25, 27—4,700 ohms, 1 watt
R15—pot, 100,000 ohms, linear taper
R16, 17—100,000 ohms
R18—47,000 ohms
R19, 20—pot, 2 megohms logarithmic (audio) taper
R21, 24—2.2 megohms
R26—47,000 ohms, 1 watt
All resistors ½ watt unless noted

C1, 2—0.1µf, 300 volts, miniature tubular (C-D type TWH 3P1 or equivalent)
C3, 4—50 µµf, ceramic
C5, 6, 9, 10—.02 µf, ceramic
C7, 8—10 µf, 450 volts, tubular electrolytic
C11, 12—47 µµf, ceramic
C13, 14—5 µµf, ceramic
C-15—40-40-40-40 µf, 450 volts, electrolytic (Aerovox E4D8)
J1–6—3-way banana jacks
S1, 2—spdt, slide switch
S3—dpst, slide switch
T—power transformer; primary 117 volts; secondary, 600 volts ct, 65 ma; 6.3 volts, 2.7 amps (Triad R-5B or equivalent)
V1—6AB4
V2—6AL5
V3, 4—12AU7
V5, 6—6BH6
V7—6X4
Pilot-light assembly
Case, 9 x 6 x 5 inches
Knobs
Printed-circuit board
Sockets, 7-pin miniature (5)
Sockets, 9-pin miniature (2)
Line cord
Miscellaneous hardware

Fig. 2—Circuit of seven-tube unit.



a

b

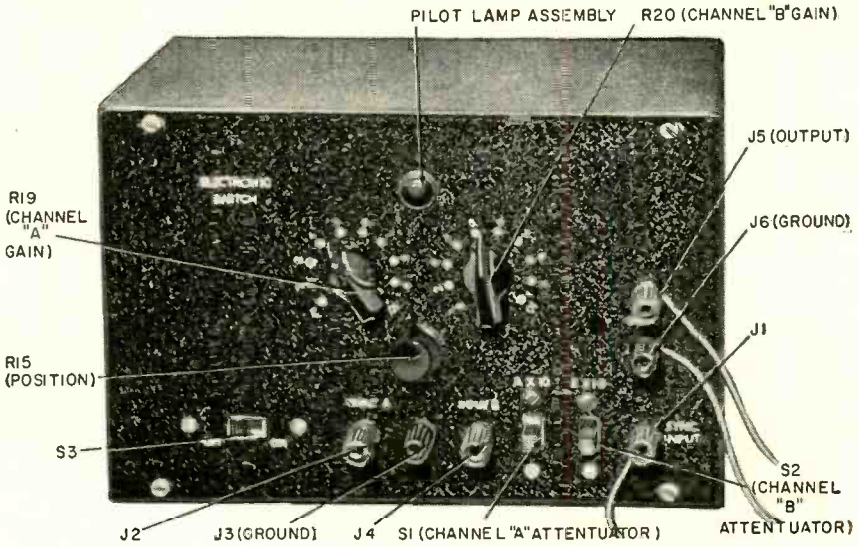
Fig. 3-a—Two scope traces viewed simultaneously and positioned to overlap; b —the same traces at a different setting of the position control.

fiers (V5 and V6). The 6BH6 pentodes, because of the high positive voltages (40 volts) on the cathodes are alternately inoperable. Thus each input signal is displayed on the tube face alternately, but because of the retention factor of the eye, they appear together.

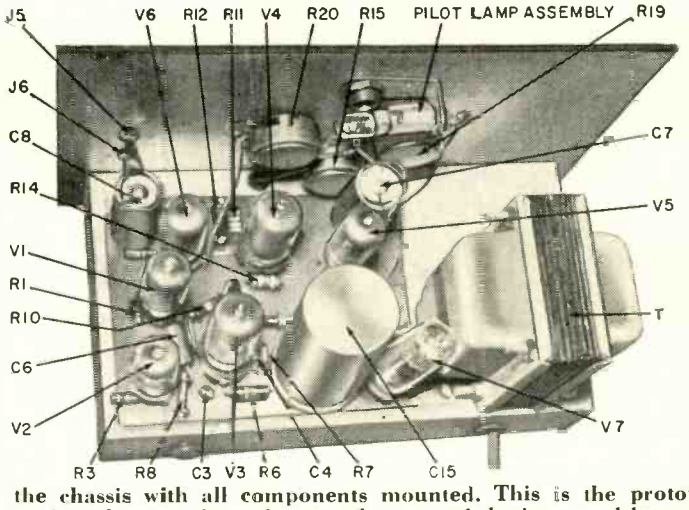
The positions of the traces (and their separation) are controlled by potentiometer R15 in the screen circuits. The plate current and voltage drop across plate resistor R18 are affected by the screen voltage of each tube. When one receives a higher screen voltage, the other gets a proportionately lower voltage, affecting the position of the trace for each signal. One side effect, seen in Fig. 3-a where the traces overlap, is that the amplification of the tube with the higher screen voltage is somewhat greater. Thus the traces which in Fig. 3-b appear almost equal in amplitude seem quite a bit different in Fig. 3-a even though the input attenuators weren't touched, only the position control. This feature must be kept in mind when calibration is required. A calibrating voltage will have to be applied to each switch input to determine the amplitude of that particular signal.

The power supply is entirely conventional. Selenium rectifiers could have been used. I happen to have a 6X4 on hand. For selenium rectifiers, corresponding changes in the circuit board would have to be made.

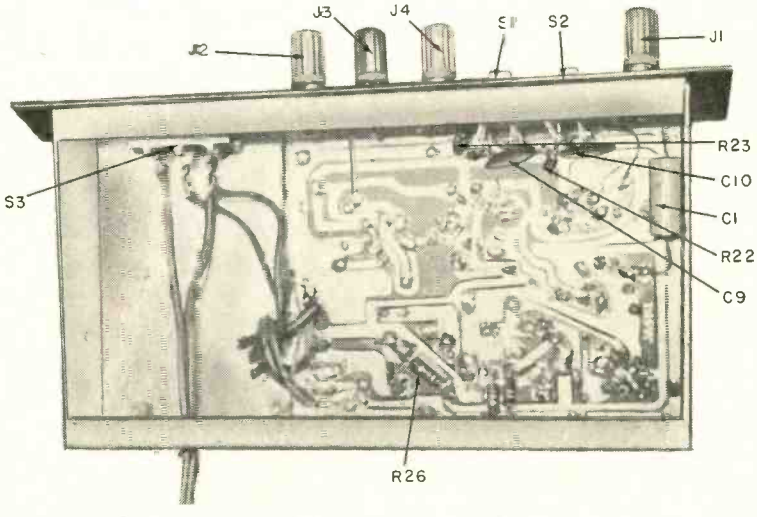
The gated amplifiers in this electronic switch are basically no different than in most types, except that they are gated once every other sweep cycle, rather than several times during each sweep cycle.



Front-panel arrangement of the electronic switch.



A look at the chassis with all components mounted. This is the prototype unit. Some changes have been made in the parts layout and the improved layout is shown by Fig. 4.



Bottom of chassis has an uncluttered appearance.

Construction

Because it made a nice compact instrument, the printed-circuit method was chosen for the wiring. (The method of laying out and making printed-circuit boards is described in RADIO-ELECTRONICS, September, 1955; December, 1955, and January, 1956.) All parts are easily obtainable although a few capacitors (notably C1 and C2, both 0.1) are miniature types. To use standard capacitors for C1 and C2 some allowance must be made on the circuit

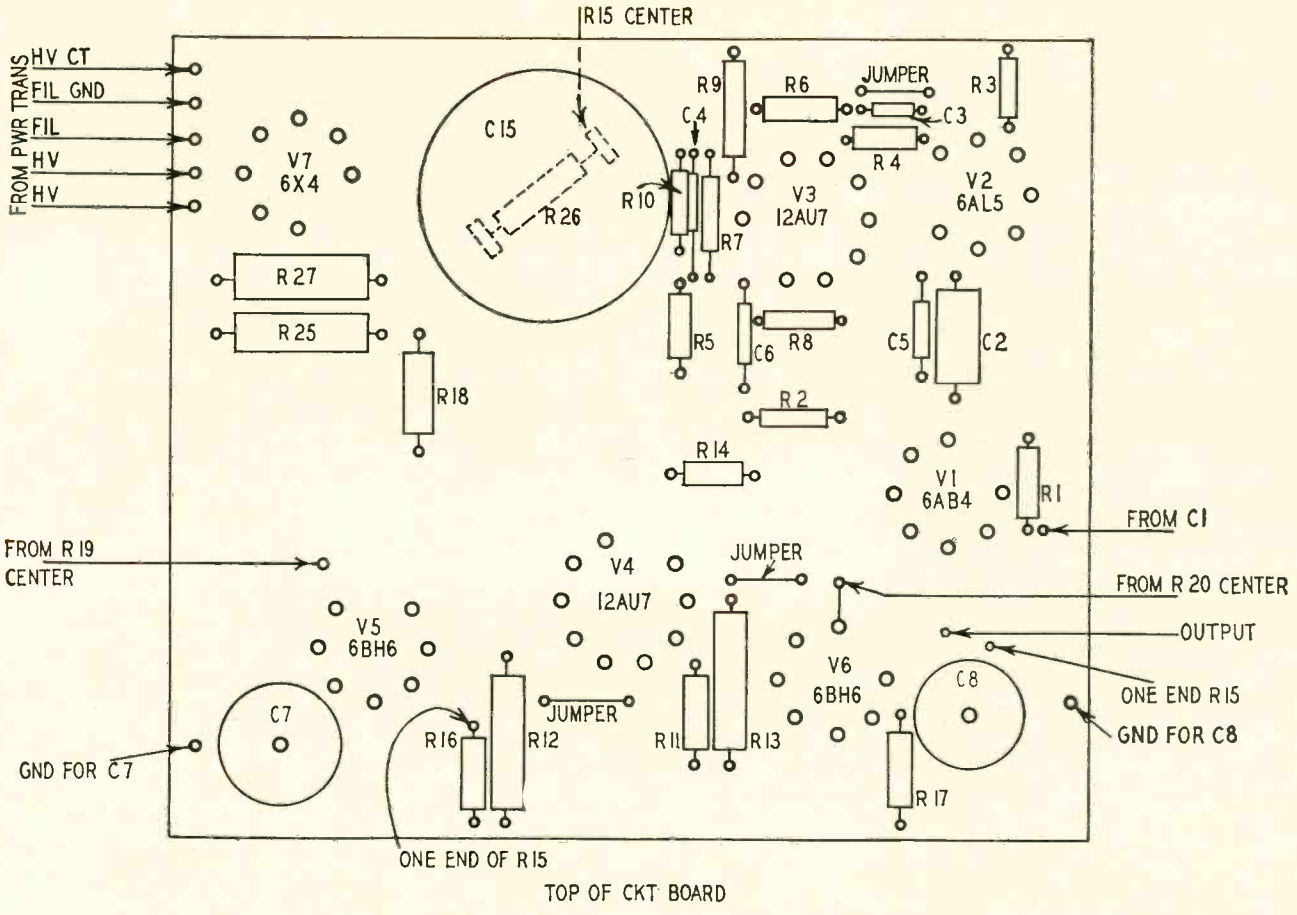


Fig. 4—Actual-size view of the top of the printed-circuit board.

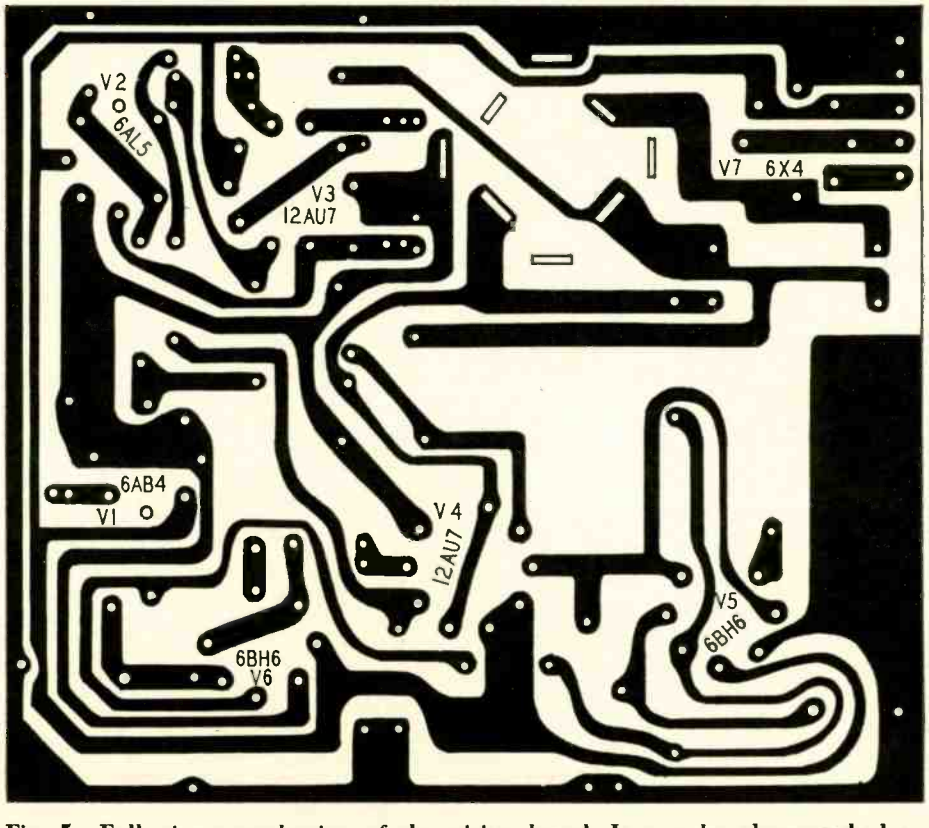


Fig. 5—Full- size reproduction of the wiring board. It may be photographed to produce the printed circuit. (See text).

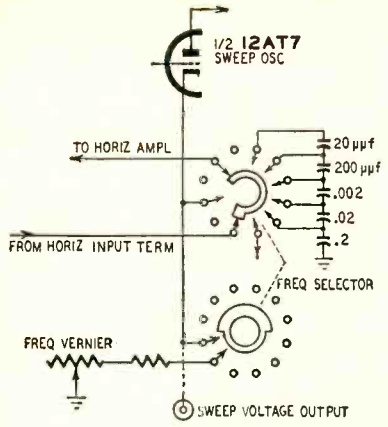


Fig. 6—Connection for obtaining sweep voltage from an Heathkit O-10 scope.

board to provide enough space. The wiring of the circuit board is self-explanatory; all external connections are marked on the parts layout diagram (Fig. 4). It should be noted that this figure matches the *reverse* of the circuit board showing the conductors (Fig. 5) because one is a top and the other a bottom view.

Conventional wiring can be used just as well, with some attention to keeping heater leads away from the sensitive input circuits. The only parts directly mounted on the chassis are the power transformer, controls, attenuator switches, pilot light and, of course, the terminals.

Resistors R21, R22, R23, R24 and capacitors C11, C12, C13, C14 are mounted on switches S1 and S2 and are connected to the printed-circuit board through potentiometers R19 and R20.

The tube sockets are standard miniature units. Pinch the lugs double with pliers, insert them in the holes in the printed-circuit board and solder.

Operation

To operate the switch we have to obtain sweep voltage from the oscilloscope. This can be done, for example, with the Heath O-10 scope as illustrated in Fig. 6. The circuit diagram shows how the extra terminal is connected to the cathode of the triode section of the sweep oscillator. This terminal serves several purposes.

It provides the sweep voltage for triggering the electronic switch. It also gives us an opportunity to attach an external capacitor in the sweep circuit, resulting in a slower sweep than previously possible. This can be carried to extremes, as illustrated in Fig. 7, which shows a partial trace of a 60-cycle voltage swept at 1 cycle. Here linearity limits of the horizontal scope amplifier have been exceeded.

Owners of the Heath O-10 or O-11 can obtain the synchronizing pulse from the Z-axis connection in the rear of the scope and avoid the use of an additional binding post connected to the sweep circuit.

For operation of the switch the new terminal is connected to the SYNC INPUT. The two signals we want to display are

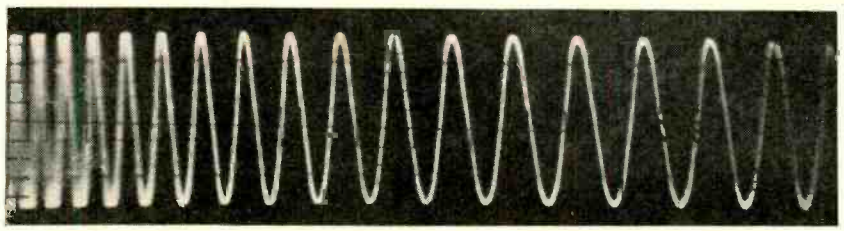


Fig. 7—Slow sweep speed may exceed scope's linearity limits.

fed to the two input terminals, ground connections are secured and the switch "output" connected to the vertical input of the scope. The input controls for the signals are adjusted to provide the desired vertical deflections. That is all; the two traces will appear on the scope face.

When the two traces are related in frequency, as is most often the case, synchronization will be no problem. However, if there is no relation at all, one of the traces should be made larger to give the scope sweep circuit a chance to synchronize with that trace. Or the input voltage should be applied to the external sync terminal on the scope. Otherwise the scope might alternately synchronize with the two traces and they would be very difficult to observe.

Other design features

If you are willing to obtain sweep voltage from one of the horizontal deflection plates, you can eliminate the sync amplifier (V1) and even the 6AL5 trigger diode (V2), for the voltage would then be sufficiently high to trigger the flip-flop directly. The method of triggering the flip-flop would be a little different, as shown in Fig. 8.

On the other hand, if you wish to trigger the switch from almost any voltage, such as, for example, one of the input signals (giving then only a single cycle per trace), we could use a Schmitt trigger circuit ahead of V1. This circuit, shown in Fig. 9, has the ability to provide sharp trigger pulses

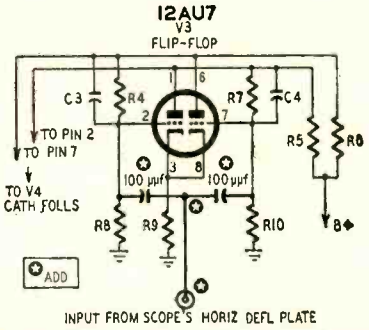


Fig. 8—Circuit for triggering the flip-flop with high-voltage sawtooth from the deflection plate.

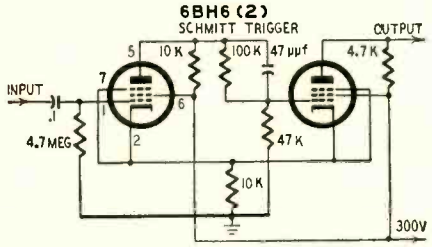
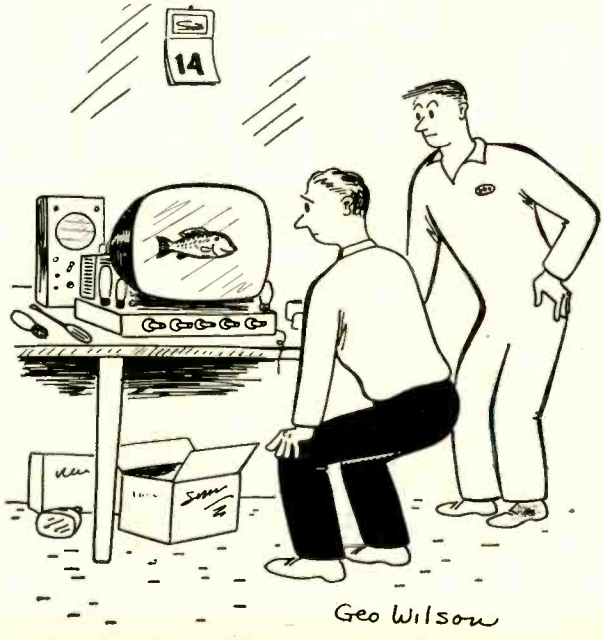


Fig. 9—This Schmitt trigger circuit permits use of any kind of trigger voltage, regardless of waveform.

from the input signal, no matter what the amplitude or the waveform may be. The Schmitt circuit is derived from a monostable multivibrator or, as it is sometimes called, a univibrator.

It is not recommended that the switch be powered from the oscilloscope, unless the scope's power supply was especially designed for such purposes. END



FIX YOUR SCOPE

Repairing an oscilloscope is not hard. Here are some troubleshooting techniques to help you along.

By RHYS SAMUEL*

TROUBLESHOOTING a defective oscilloscope should follow the principles of observation and deduction required in troubleshooting a defective radio or TV receiver. Like a radio or TV set, the scope can be divided into several sections, each of which has a specific function. If one or more of these sections fail, the effects show up on the cathode-ray-tube screen. The screen is a comprehensive trouble indicator and usually lets the technician pinpoint the source of trouble immediately. Because the scope is simpler in design than the TV receiver, the service technician should have little trouble correcting any defect.

Fig. 1 shows the basic design of a service type scope. The vertical attenuator is a switch which selects different R-C networks whenever the vertical-range switch is changed. Separate networks for each range are needed to preserve the scope's frequency-response and voltage-calibration characteristics throughout its rated response range. The output from the attenuator is fed into the vertical amplifier section, which amplifies the incoming waveform to a value suitable for application to the vertical deflection electrodes of the cathode-ray tube.

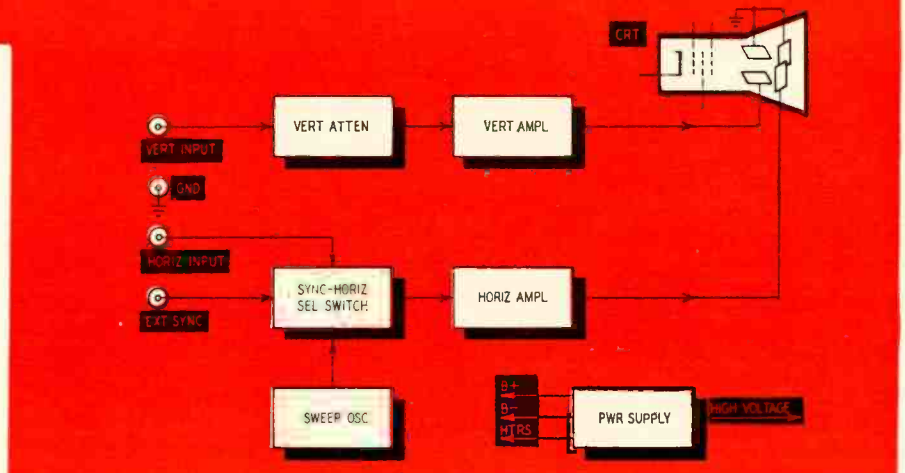


Fig. 1—Block diagram of a typical oscilloscope.

The sync–horizontal selector switch has several functions, including the selection of an external or internal source of synchronizing voltage for the sweep oscillator. One or two positions on this switch may be used to disconnect the sweep oscillator from the circuit when a signal is to be fed directly into the horizontal amplifier. Because design practices differ, these functions may be combined in a single front-panel control or divided between two.

The sweep oscillator generates a sawtooth waveshape which is amplified by the horizontal amplifier before it is applied to the cathode-ray tube. This amplified sawtooth provides the horizontal time base along which the incoming signal is displayed. The scope's power supply provides the various heater voltages, as well as B-plus, B-minus and high voltages for the vertical and horizontal amplifiers, sweep oscillator and cathode-ray tube.

The first step in the analysis of a defective scope is to check it out on all functions. If a spot or trace can be ob-

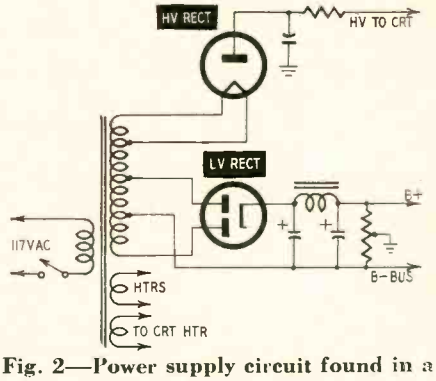


Fig. 2—Power supply circuit found in a scope.

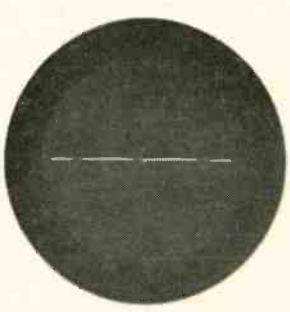


Fig. 3—A sure sign of 60- or 120-cycle hum is brightening at regular intervals on the trace.

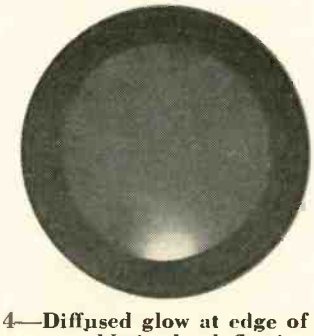


Fig. 4—Diffused glow at edge of screen indicates trouble in the deflection-amplifier system and not a defective cathode-ray tube.

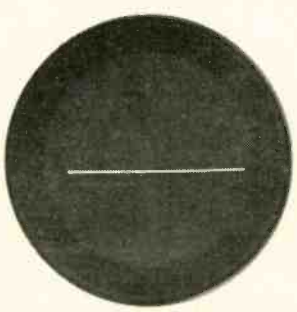


Fig. 5—Straight horizontal line indicates trouble in vertical signal or deflection sections.

* Electron Tube Div. Commercial Engineering, RCA, Harrison, N. J.

tained, rotate the intensity, focus and centering controls and note their effects. Run the vertical and horizontal amplifier controls and the sweep and sync controls through all their settings and note the effects. Because intermittent, shorted and open input leads are a major source of trouble, check all probes and cables by connecting them to a signal source and flexing them, paying particular attention to connection points.

A complete check should indicate the section in which the trouble lies. For example, if a horizontal trace can be obtained but no vertical display is evident, the trouble is probably somewhere between the test probe and the output from the last vertical amplifier stage. If vertical deflection can be obtained but the display lacks width, the trouble probably lies in the horizontal amplifier or sweep oscillator sections. Power supply defects can, of course, affect operation of all stages and sections, and inability to obtain any spot or trace may indicate trouble in the power supply.

Once the faulty stage is isolated, conventional troubleshooting procedures can be followed. Try changing tubes in the defective section, bearing in mind that tubes used in some direct-coupled circuits must be selected or aged before permanent installation. If certain tubes fail repeatedly, look for a defective component, such as a changed-value resistor or a leaky or shorted capacitor. Use your vtvm for voltage and resistance measurements. The proper operating voltages should be given on the schematic diagram in the instrument instruction book.

CAUTION: Treat the cathode-ray tube with the same respect as a TV picture tube in an operating receiver. The cathode-ray tube uses high dc operating voltages, and electrode voltages may be 1,000 or more above or below ground. The scope's high-voltage power supply, which uses a line transformer, can deliver as much as 1,000 times the current found in TV sets with flyback high-voltage systems. Do not strike the tube or subject it to more than moderate pressure.

The power supply

Low B-plus or inadequate high voltage can cause defective operation of the entire scope and can produce a variety of symptoms. Insufficient brightness, poor focus, low gain in both vertical and horizontal amplifiers, and sweep and sync difficulties are a few. Such defects are often traced to a weak rectifier tube.

Hum on the scope trace may be caused by a leaky filter capacitor in the B-plus voltage section (see Fig. 2). Hum shows up on low-frequency sweep traces as a thickening of the line and is often mistaken for a defective focusing circuit because it is impossible to obtain a sharp line with the focus control. The presence of 60- or 120-cycle hum modulation can be checked by switching the sweep oscillator to a higher frequency and noting whether the hum causes brightening at regular intervals on the trace (see Fig. 3). Hum can also be introduced by heater-to-cathode leakage in an amplifier or oscillator tube.

Blown fuses can result from a shorted filter capacitor in the B-plus or high-voltage filter sections. When checking power supply voltages, work closely with the schematic because many scopes have a B-minus bus operating between −40 and −50 volts. Do not confuse power supply hum with hum picked up by the vertical input leads. Double-check by disconnecting the scope's input lead and shorting the vertical terminal to ground.

Trace off the screen

This characteristic is normal on *direct-coupled oscilloscopes* because these instruments respond to both dc and ac components in the circuit. The action may be compared to that of a low-range dc voltmeter which is connected to a high-dc-voltage source. The voltmeter pointer deflects past the meter's full-scale point. On the scope, the pattern may be deflected either up or down. When the probe is disconnected, the trace returns to its on-screen position.

If this action occurs in a capacitively coupled scope, the input blocking capacitor is probably leaky. This capacitor has a large value (0.1–0.5 μf) and should be replaced only with a high-quality part. If the trace returns slowly to an on-screen position, the capacitor is probably good and the slow return time is due to charging of the capacitor by the dc test-circuit voltage through the series resistance of the input attenuators. When a low-capacitance probe is used, the additional probe resistance may delay return of the trace for several seconds. Trace-return time can sometimes be reduced by first setting the range control to the minimum-gain position, next connecting the direct probe to the test point and then resetting the range control to the desired attenuator position.

No spot or trace

Check to see that the C-R tube's heater is lit. Use a vtvm to check operating voltages at the cathode-ray-tube pins.

NOTE: The cathode-ray-tube voltages shown in the schematic may be measured with respect to cathode, B-minus bus or ground. Check the instructions.

If any voltages are off by more than 20%, check for a defective tube or component in the associated circuit. Look for open circuits in the associated resistance networks if the trouble is apparently in the intensity and focusing circuits. Make sure that a defect in the vertical or horizontal amplifier has not disabled the vertical or horizontal centering circuits, causing the beam to be deflected off screen. If a diffused glow is noted at any point around the edge of the screen (see Fig. 4), the cathode-ray tube is probably OK and the trouble lies in one of the amplifier stages. In push-pull amplifiers, a defective tube or component in one stage can unbalance the entire amplifier, causing permanent off-screen deflection of the beam.

No vertical deflection

If you can get a properly focused horizontal trace but the input signal cannot be displayed (see Fig. 5), check the vertical amplifier section from probe tip to the output of the vertical deflection amplifiers for a bad tube or component. Check the attenuator sections by switching to different positions and checking for vertical deflection. Use an audio or rf signal generator to inject a signal into different points in the amplifier, starting at the grid of the output amplifier stage. If the signal is reproduced on the scope screen, move the point of signal injection forward until the faulty stage is found.

NOTE: When injecting a signal into plate circuits or into direct-coupled amplifiers, use a dc blocking capacitor in

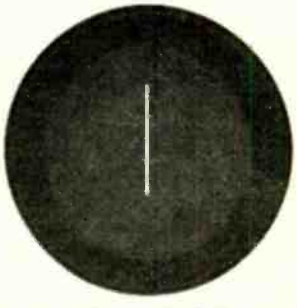


Fig. 6—Straight vertical line points toward a defect in the horizontal amplifier or sweep oscillator.

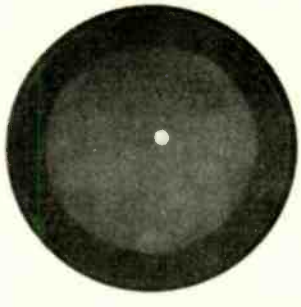


Fig. 7—Diffused spot which cannot be focused reveals defective focus circuit.

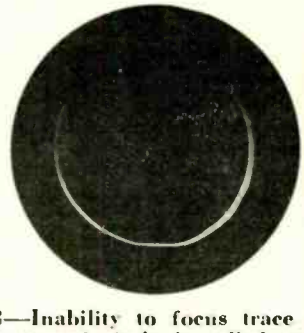


Fig. 8—Inability to focus trace at all points around circle is called astigmatism.

series with the signal lead from the generator.

No horizontal trace

This defect shows up as a single vertical line which can be adjusted in height with the vertical vernier control (see Fig. 6). Change tubes in the horizontal amplifier section, set the horizontal amplifier selector to the line position and turn up the horizonal gain control. If the horizontal trace is still defective, inject a 60-cycle signal through a 0.1-μf capacitor at the horizontal amplifier's grid. If the horizontal trace is still defective, look for faulty components or wiring between amplifier and cathode-ray tube. If the directly injected signal produces a horizontal trace, look for trouble in the sync–horizontal selector switching circuit or in the circuit proceeding the horizontal amplifier.

Low vertical gain

Insufficient vertical gain is characterized by a small amount of vertical deflection, inability to get full-screen deflection or inability to calibrate the graph screen properly. When this condition arises, first check to see that the horizontal amplifier is operating correctly, because insufficient power supply voltage may affect operation of both the vertical and horizontal amplifiers. If the horizontal amplifier appears to be working, the trouble probably lies in the vertical amplifier. Many service scopes are equipped with an internal gain adjustment, usually located in the cathode circuit of the first vertical amplifier stage. This control requires adjustment from time to time as tubes and components age. Apply a sine-wave signal to the vertical input and readjust the internal gain control. If the signal does not reach the required amplitude, install new tubes in the vertical amplifier stages, beginning with the input stage.

If installing new tubes fails to increase the gain, check voltages with a vtvm and look for a faulty component. Check cathode, screen and plate load resistors. In push-pull amplifiers, the plate load resistors do not have to be perfectly matched, but they should have approximately the same value.

Hash on trace

Tube noise and external noise show up on the trace as random spikes and hash. To determine the exact source of the noise, disconnect the input cable and ground the vertical input terminal. If the hash does not disappear, set the scope for near-maximum gain and change the input tubes, noting the effect on the trace. If hash still does not disappear, check for noisy load resistors or defective potentiometers. If grounding the vertical input terminal indicates external noise, check lead dress, grounding and shielding in the attenuator section. Check the input cable connected to the vertical terminal to see that the shield is properly grounded.

Poor focus

The focusing voltage for the cathode-ray tube is obtained from a network across the high-voltage rectifier. Inability to focus the trace or an unstable focusing condition (see Fig. 7) generally indicates trouble in the high-voltage circuit. Focusing troubles are often accompanied by lack of brightness or by varying brightness. With power removed from the scope, check the resistances in the high-voltage divider network wth a vtvm. Carefully check the potentiometers for spotty contacts. When replacing focusing or intensity controls, replace only with properly insulated types recommended by the scope's manufacturer. If the focusing circuit checks out satisfactorily, check the dc voltage on the deflection plates for abnormal values.

Instability or loss of sync

If sync is unstable, the sync-switching circuit or the horizontal sweep oscillator may be defective. In most service type scopes, the sync-switching circuit contains only a few resistors, a potentiometer and a coupling capacitor. Some scopes, however, have automatic sync-level control circuits and may use crystal diodes or a vacuum-tube sync stage in different arrangements. In any type of scope, the oscillator tube and sync-level control should be changed first. If the trouble persists, replace any crystal diodes, being careful to observe correct polarity. Look for defective resistors or open capacitors at any yoint ahead of the sweep-oscillator grid pin.

Poor intensity

The most common cause of poor intensity is a decrease in high voltage. Try changing the high-voltage rectifier tube and checking the filter capacitors and resistors in the focusing and intensity circuits. Although cathode-ray tubes cannot be expected to last forever, they usually function well for many years and are a minor source of trouble in oscilloscopes.

Poor sweep linearity

Poor sweep linearity is characterized by cramping of some of the displayed waveshapes, usually at the left- or right-hand ends of the trace, and is the result of nonlinear sawtooth output from the sweep oscillator. Sweep nonlinearity is characteristic of many scopes, and the technician should make sure that the defect is not inherent in the instrument before ripping into the wiring. Because a variety of sweep oscillator circuits are used in service type scopes, it is not practical to offer remedial suggestions by part number. Many scopes have an internal potentiometer adjustment which is factory-set to give a correctly shaped sawtooth output voltage. Tube and component aging may require resetting of this adjustment, and the procedure should be described in the instrument instruction booklet. If readjustment of this control does not correct the trouble, change the oscillator tube and check resistors and capacitors in the sweep oscillator stage with a vtvm.

Astigmatism

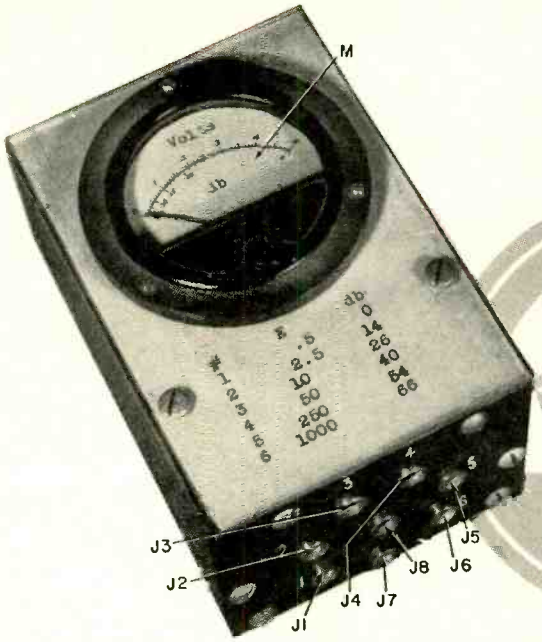
Astigmatism is the inability to obtain correct focus at all points on a displayed trace (see Fig. 8). Check by feeding a line signal to the horizontal and vertical amplifiers to produce a circle whose diameter equals about two-thirds the screen diameter. If the scope has an astigmatism adjustment, reset the control until all parts of the circle are in focus simultaneously. If adjusting the astigmatism control does not correct the difficulty, check the dc voltage on the deflection plates for improper values.

Poor frequency response

Poor frequency response is characterized by inability of the scope to provide proportional vertical deflection for any input frequency within the rated response range. For example, if the response of the scope is rated from 3 cycles to 4.5 mc, all input signals having the same voltage amplitude within this frequency range should produce exactly the same amount of vertical deflection on the screen. If response is faulty, the scope cannot be depended upon for visual voltage measurements. Response is best checked by feeding a square-wave signal into the vertical input terminals and observing the resultant shape on the screen. A good square wave contains high-amplitude harmonics up to approximately the eleventh harmonic. Therefore, if a 10-kc square wave is reproduced without tilt, the response and phase-shift characteristics of the vertical amplifier are satisfactory up to at least 100 kc.

Response may also be checked by feeding in sine-wave signals at various frequencies within the rated response range. The input signal level should be kept constant. If response is insufficient, the trouble lies in one of the amplifier stages or somewhere in the input attenuator sections.

A low-emission tube, changed-value resistor or leaky capacitor can affect response. If peaking coils are used in any of the plate circuits, check their alignment or examine them for shorted or burned windings. The input attenuators are equipped with small trimmer capacitors on each position of the vertical range switch. Because exact alignment procedure varies with different models, the procedure outlined in the instruction booklet should be followed. In general, alignment requires that a square-wave signal of proper frequency be displayed on the screen. The trimmer capacitors are adjusted on individual ranges for the best amplitude and shape. Before realigning the attenuators, however, make sure that the trouble is not in one of the amplifier stages. END



A look at the completed instrument.

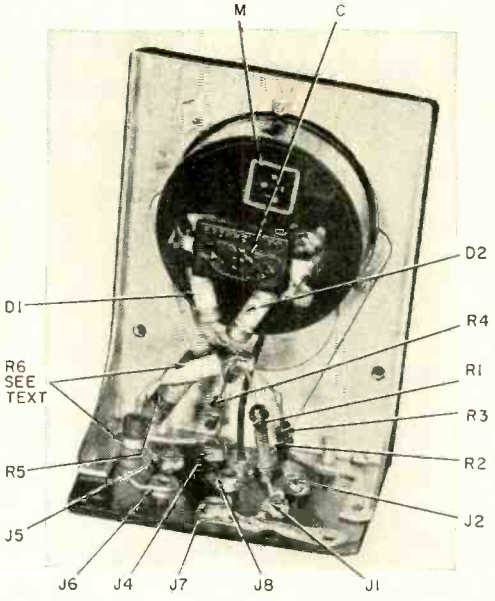
UTILITY VOLTMETER

Hand-sized unit measures ac voltages and decibels with a flat response up into radio frequencies

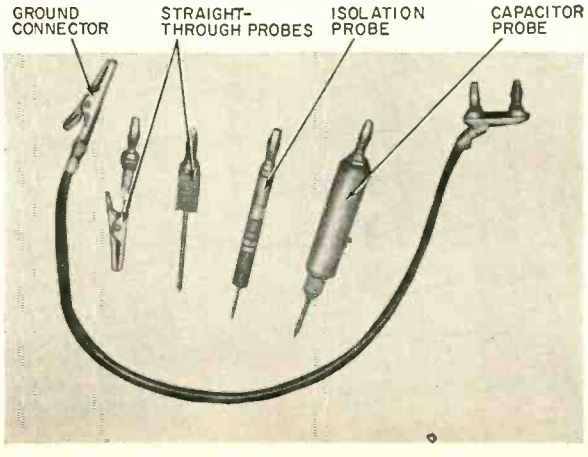
By ALBERT STRATMOEN

THIS instrument reads ac up to 1,000 volts and its response is flat up into radio frequencies. It can do the work of an rf probe—with the advantage of being able to handle much greater voltages—so it is suitable for work on transmitters as well as receivers.

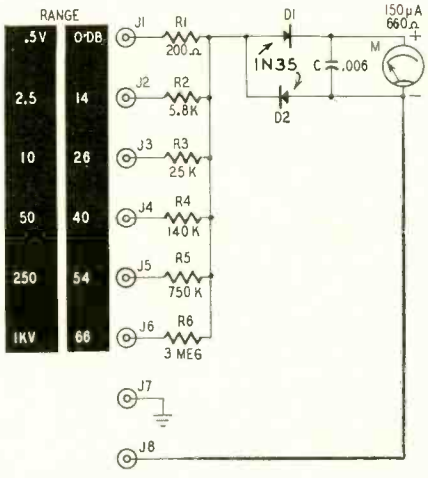
Because of its circuit, the scale is linear on all except the 0.5-volt range. It can be handled like a probe and you



Parts layout inside the meter's case.



Probes used with the meter are displayed at the right.



R1—200 ohms
R2—5,800 ohms
R3—25,000 ohms
R4—140,000 ohms
R5—750,000 ohms
R6—3 megohms
See text for how resistance values were determined
All resistors ½ watt
C—.006 μf, mica
D1, 2—1N35
J1–8—banana jacks
M—150 μa, 660-ohm internal resistance
Case
Miscellaneous hardware

Circuit of the handy meter.

do not have to shift your eyes from the work to a meter situated some distance away. It has been in use for over 5 years and has proved its value in PA work, TV–radio repair and checking transmitters. For frequencies above the broadcast band, it probably would be advisable to shield the multipliers individually.

The rectifier is half-wave but the extra diode shorts the rectifier and meter on the nonconducting half-cycle so it loads the circuit being checked almost equally on both half-cycles and therefore will not cause much distortion on sensitive circuits when used as a VU meter. The db scale uses a 6-mw reference level but, if you are going to use it on telephone work, it would be well to use a 1-mw reference.

Formulas for finding the voltage corresponding to various levels above and below zero may be found in textbooks. A more sensitive meter movement would be advantageous for this use, but for rf work it probably would be affected more by leakage from one multiplier to another.

I used a 150-μa meter which I found in a surplus store, but the easily obtained 200- and 500-μa meters can be used. Let's take a 500-μa meter as an example. To get full-scale deflection, a little more than three times the current flow needed with the 150-μa unit is required. Therefore I would start off with multipliers (R1–R6) that were about one-third the value of those shown in the diagram. For 200-μa meters, about three-fourths of the indicated value makes a good starting point.

The multipliers were determined experimentally by using a 60-cycle supply and a multimeter as a standard. The values shown were read on an ohmmeter. As neither was very accurate, the values are only approximately correct but they can be used as starting points for an accurate calibration.

It is usually best to draw a single arc when making the meter scale. By choosing a convenient voltage scale, such as 0 to 5, you only multiply or divide by 2 and add the appropriate number of zeros. The db scale is no problem as simple addition is all that is required.

Construction is simple (see photos). The banana jacks are arranged around a circle of ¾-inch radius to fit General Radio double plugs. The center jack is ungrounded except when the ground lead having the double plug is used —plugged into center jack J8 and J7 near bottom of case. This lets you work on audio circuits without danger of shorting one side of the line to ground. The four plug-in probes (from left to right) are: (1) For circuits having dc voltages as well as ac. It contains an .01-μf capacitor. (2) For circuits requiring isolation such as oscillators (it has a 30,000-ohm resistor which must be taken into consideration when reading actual values). (3) Straight through. (4) Straight through with alligator clip. END

COVER FEATURE

DIGITAL COMPUTER GUIDES JETS

FLYING an airplane these days takes a heap of complicated calculating. And when it's a combat plane, like a jet interceptor, the array of mathematical computations needed to take it through all phases of a supersonic dogfight would require—in terms of even the most advanced office calculating machines—huge roomfuls of clicking and clanking computers.

But miniaturization is the word today in airborne vehicles. Scientists are devising more and more ways to provide jet pilots with electronic senses that can note and react many times faster than the quickest human brain and muscle. And the latest development in such computers is small enough to fit into the cabinet of a 21-inch table-model television set!

It's the Digitair, developed by Hughes Aircraft Co. as the first airborne digital computer. Its existence was reported to the public only recently when the Department of Defense relaxed security restrictions. The announcement followed several months of actual production at the Hughes plant in El Segundo, Calif.

Earlier computers for aircraft were the analog type, incapable of solving the many fantastic arithmetic problems easily done by a digital computer. Digitair can make 9,600 basic arithmetic computations in 1 second and render 6,250 decisions in 1 minute. It could compute all of New York State's 6,500,000 Federal personal income tax returns in 14 hours, or could figure all New York City's gas and electric bills in 5.25 hours.

"Despite the current furor about satellites and long-range guided missiles, there are no indications that these weapons will replace jet interceptors for aerial defense in the immediate future," according to John H. Rubel, director of Hughes Aircraft Co.'s airborne systems laboratories. "The best existing weapon for delivering the the H-bomb is still the long-range jet bomber and the best defense against it is the jet interceptor. As speed, range and altitude of both increase, electronic control systems must become more and more sophisticated. Hence the need for a compact, versatile digital computer.

"Digitair can effectively perform all necessary computing functions associated with flight, navigation, search and attack in an interceptor mission. This lets the pilot concentrate almost exclusively on the vital tactical decisions involved in an Atomic Age battle in the sky."

Working with coded information flashed to it by powerful ground control stations and the airplane's own radar, the computer simultaneously takes in 61 types of information while putting out 30 types. In so doing it performs or monitors 16 navigation and flight control functions during a program cycle of 1.8 seconds, all at least once, some of them are handled several times.

These include actuating the interceptor's control surfaces to correct pitch and roll; commanding the pilot to increase or decrease his speed; maintaining a constant check on available fuel and the distance the airplane can fly on it under existing conditions; providing target-range, azimuth and elevation information for the pilot; determining the proper speed and altitude the pilot should fly to intercept the target accurately and continuously checking its own accuracy and reliability.

Digitair can solve more than one problem at a time. For example, it can be working on a navigation problem while making calculations of wind direction and speed and dead reckoning on an enemy bomber. The computer decides at what point to intercept and automatically fires the armament.

The new computer is not necessarily restricted to airborne military use but can be adapted to supersonic jet transports.

In a jet airliner it could automatically navigate and continuously compute speed and altitude for best performance, automatically program fuel consumption from takeoff to landing while considering varying flight conditions. It could automatically process and display navigation data; enable the pilot to insert alternate position, destination and altitude information, and automatically control communications between ground traffic and automatic landing control.

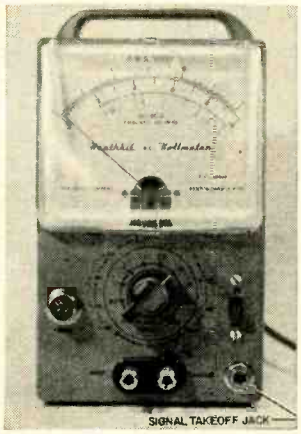
One of the prime reasons for the success of Digitair as an integral part of the most modern airborne armament control system is its extreme light weight, only 120 pounds. This was made possible through new advances in miniaturization techniques.

The computer contains 4,000 match-head-sized diodes—mostly made by Hughes—in place of various types of tubes which normally would be used, and 75% of its wiring is etched circuitry.

Besides the tremendous savings in space and weight, this miniaturization contributes greatly to the Digitair's reliability. Extensive laboratory tests have proved that its computations are performed to an accuracy of 1 part in 131,072. END

Signal Takeoff for Your Audio VTVM

By FRANK WOODS, JR.



AUDIO equipment is analyzed with several different instruments. It is desirable to observe the magnitude of the signal and listen to it or observe its waveform at various points in the equipment under analysis. Occasionally, we want to observe the signal with an audio vtvm and an oscilloscope while listening. Unfortunately, problems arise when we attempt to connect several instruments to one portion of an audio circuit.

One problem is circuit loading. If three instruments, each with an input impedence of 1 megohm, are connected to a circuit, a load of ⅓ megohm is imposed on the circuit. This will cause errors in measured values and will affect the fidelity of an amplifier under test if the instruments are connected in a high-impedance circuit.

Another problem arises when measurements are conducted in low-level circuits at the front end of an amplifier. Several pieces of equipment connected with large exposed clip surfaces provide a sensitive electrostatic pickup that feeds a 60-cycle hum to the test equipment and succeeding circuits of the amplifier.

Loading and hum problems can be reduced if only one instrument is connected to an audio circuit. They may be further reduced if the signal level is raised before introduction of additional instruments. Modification of your audio vtvm will make this possible. An amplifier is added to the voltmeter internally, and the output brought to a signal takeoff jack on the front panel. With this modification, the audio vtvm may be connected to the circuit under test and an oscilloscope to the signal takeoff. If additional equipment is used, it may be connected across the scope input terminals (see Fig. 1). Signal level at the takeoff jack will be high enough to allow less gain than required without the amplification of the modified vtvm, minimizing hum pickup. Another advantage is that the range switch of the audio vtvm controls gain for other instruments after their initial setting.

My audio vtvm is a Heathkit AV-2. A large number of these are owned by experimenters, hobbyists and service technicians. Therefore, I will describe the modification of the AV-2 step by step. Those who have other makes or models can also make use of the circuit. After considering the use of a cathode follower for the signal takeoff, I dismissed it in favor of a conventional grounded cathode amplifier with its greater voltage gain and resulting high output level.

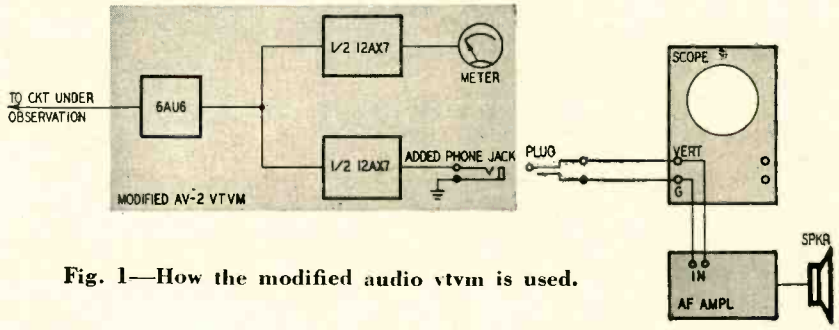
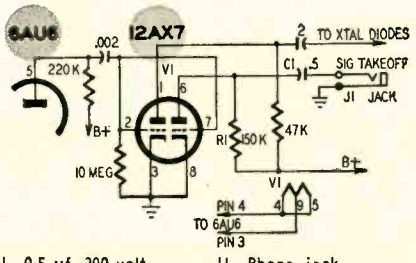


Fig. 1—How the modified audio vtvm is used.

The signal takeoff modification of the Heathkit model AV-2 audio vtvm is made easily and quickly.

1. Remove the 6AT6 output tube and disconnect the socket as follows:
   (a) Disconnect heater, pilot-light and 47-ohm resistor leads at pins 3 and 4.
   (b) Disconnect the .002-μf coupling capacitor lead at pin 1.
   (c) Disconnect the 47,000-ohm resistor and 2-μf capacitor leads at pin 7.
   (d) Disconnect lead from socket to ground at the calibration control.
   (e) Loosen the socket mounting screws and remove the socket. Salvage the 10-megohm resistor connected from pins 1 to 5 on the socket.
2. Take these precautions before drilling:
   (a) Disconnect meter leads and remove meter from instrument panel.
   (b) Remove 6AU6.
   (c) Dress parts and leads behind the panel out of the drill path.
   (d) Place the instrument in the cabinet to drill the hole.



C1—0.5 μf, 200 volt J1—Phone jack
R1—150,000 ohms V1—12AX7
9-pin miniature tube socket

Fig. 2—Modified AV-2 circuit.

3. Drill a ⅜-inch hole in the lower right-hand corner of the front panel ½ inch from bottom and side.
4. Clean drill chips off chassis and cabinet. Mount meter and phone jack and reconnect meter.
5. Mount a nine-pin tube socket in the hole vacated by the 6AT6. Pins 4 and 5 should face the 6AU6 socket.
6. Make the following connections (at nine-pin socket unless otherwise specified):
   (a) Connect a ground lead from pins 3 and 8 to the ground terminal on the calibration control.
   (b) Connect the .002-μf coupling capacitor to pin 2.
   (c) Connect the 10-megohm resistor from pin 2 to pin 8.
   (d) Connect pin 2 to pin 7.
   (e) Connect one of the 47-ohm resistor leads to pin 5.
   (f) Run a lead from pin 5 to pin 4 and to the 6AU6 socket pin 4.
   (g) Connect the pilot-light leads to pins 3 and 4 of the 6AU6.
   (h) Run a lead from pin 9 of the 12AX7 socket to pin 3 of the 6AU6 socket.
   (i) Connect the remaining 47-ohm resistor lead to pin 9.
   (j) Connect a 150,000-ohm resistor from pin 6 to the B-plus tie-down adjacent to the rectifier.
   (k) Place a 0.5-μf capacitor under the diodes and connect one lead to pin 6, the other to the ungrounded terminal of the phone jack.
   (l) Connect the 47,000-ohm resistor and 2-μf capacitor leads to pin 1.
7. Place 12AX7 and 6AU6 tubes in their sockets and recalibrate, following the procedure outlined in the AV-2 construction manual. END

servicing Oscillation and Regeneration in transistor radios

Methods of detecting and ending these troubles in the if stages

By JAMES A. McROBERTS

AMONG the common troubles a service technician must cure in transistor radios are regeneration and oscillation. He is confronted with some difficulty as he cannot always test for the symptom directly as in a tube set. There may not be a conventional and convenient test point corresponding to the detector load resistor as in a tube job. And the avc or agc may not yield a satisfactory indication, unless a comparison set is available for test.

Birdies, hiss, distortion, etc. indicate oscillation in the transistor radio just as in its tube prototype. Loss of high notes due to side-band attenuation, coupled with extreme sharpness of tuning, appears with excessive regeneration prior to actual breakthrough into the oscillatory state. A transistor radio generally has equal or greater selectivity than its tube brother due to the relatively high Q of the tuned circuits.

How to test it

We can seldom test directly for oscillation. The small changes in voltage on even the local oscillator do not permit direct measurements as in a tube set. Indirect methods must be used.

One way is to use a sweep oscillator loosely coupled to the radio's antenna coil. Use about five turns placed near the antenna coil or loopstick. Connect an oscilloscope to the audio, using a series blocking capacitor (its value may be .01 to 0.1 μf) and observe the alignment curve. (Some sweep generators do not have a small enough sweep range to operate properly on the broadcast band and cannot be used for this purpose.)

Fig. 1-a shows a normal symmetrical alignment curve. Fig. 1-b illustrates a sharpening of the curve on one side due to regeneration. Or the curve may display a spike or unnatural hump as in Fig. 1-c. The spike will change to a birdie if oscillation is present or the alignment curve may degenerate into a birdie as in tube radio and TV work.

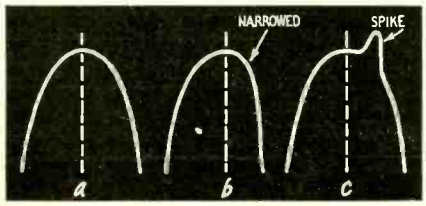


Fig. 1—Alignment curves; a—normal; b—unsymmetrical due to regeneration; c—spike or hump indicating unwanted regeneration.

A wavemeter is another way to test for oscillation. Couple it loosely to the detector input, although far more tightly than to pick up an ordinary if signal. Kill the local oscillator with a jumper or a capacitor across its tuning plates if these are hot. With no signal applied to the set (short the if plates if necessary) any indication on the wavemeter indicates oscillation.

A handy wavemeter circuit is shown in Fig. 2. It is made up of a ferrite antenna, a tuning capacitor and a trimmer capacitor in series with a switch. The switch connects the trimmer or padder in for if measurements.

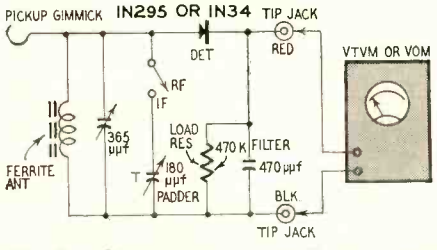


Fig. 2—Wavemeter for oscillation tests.

(The wavemeter can be used with the switch open for oscillator checking if desired.)

A voltmeter (vtvm or vom), set on its lowest dc range, is connected to the two tip jacks and acts as an indicator. The gimmick is simply a piece of flexible wire. In use, about three turns are wrapped around the lead or lug from the last if transformer to the detector (diode or transistor). With a printed circuit, hold the gimmick lead in parallel with that from the if transformer. The variable capacitor is tuned to the if with the switch closed. Any meter reading indicates oscillation. When the cause of the oscillation is found and eliminated, the meter will not indicate.

The avc or agc may be used if the fixed voltage is known. Appreciable departure indicates oscillation. In a transistor radio, the avc may go either positive or negative from some fixed value and can control the base, collector or emitter of the controlled stage. Use this test with these limitations in mind.

Sometimes, the presence of oscillation can be detected by a change in voltage at the detector after checking with the schematic or a similar radio.

Localize the trouble

Having proved that oscillation exists, the next step is to find the stage or stages involved; that is, the stages over which feedback and amplication of feedback occur. The idea is illustrated by Fig. 3. One or more stages act as an amplifier. If feedback energy to the amplifier's input has a value of more than 1/A of the amplifier's gain A and is in phase, oscillation will develop unless circuit losses are heavy enough to keep feedback below the 1/A point. This basic idea gives us a method of testing.

In the partial schematic of the if of a commercial set (Magnavox AM2) shown in Fig. 4, you can shunt the secondary of each if transformer in turn with a low resistance. Use a resistor of about 300 ohms. It may be a potentiometer with maximum value of 1,000 ohms. Start with terminals 3 and 5 of T2. If the response curve loses its bad shape or the wavemeter no longer picks up a signal, this transformer is in the feedback path.

If nothing happens, go to terminals 3 and 5 of T3 and shunt them with the test resistor. If the wavemeter now shows no signal, T3 is part of the feed-

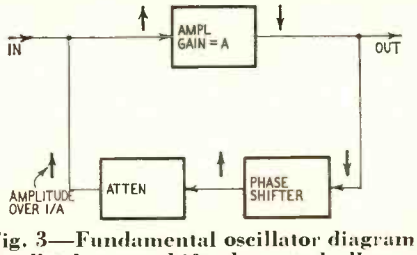


Fig. 3—Fundamental oscillator diagram. Feedback must shift phase and allow at least 1/A of amplifier output return to input. Stabilized amplifier must attenuate feedback from all sources to less than 1/A. Heavy arrows show direction of phase.

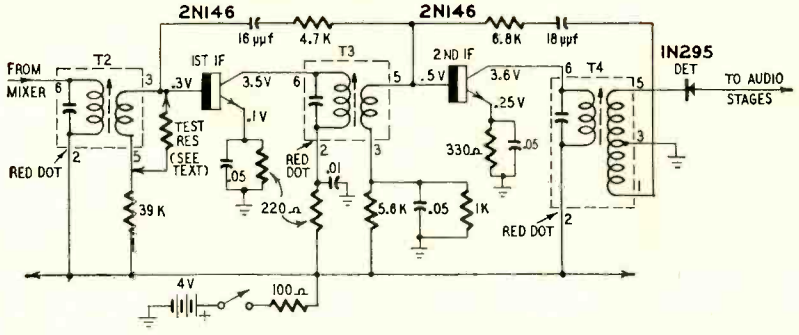


Fig. 4—Partial circuit of a Magnavox AM2, showing use of a test resistor.

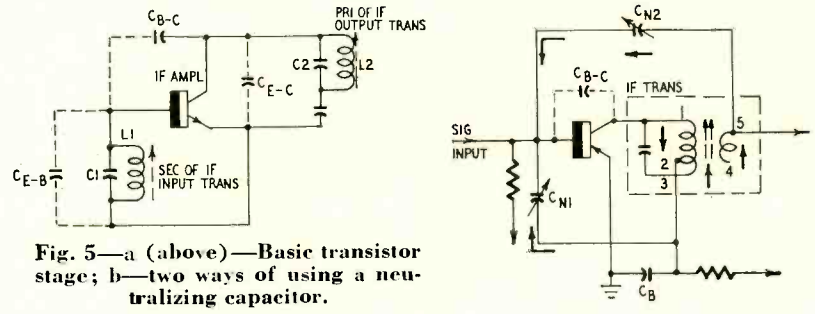


Fig. 5—a (above)—Basic transistor stage; b—two ways of using a neutralizing capacitor.

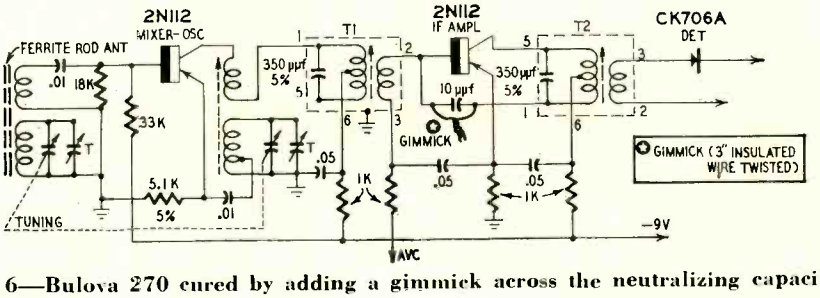


Fig. 6—Bulova 270 cured by adding a gimmick across the neutralizing capacitor.

back path. This way you isolate the feedback to a single stage or several stages.

Causes and cures

One frequent cause of oscillation or excessive regeneration in a transistor radio is excessive gain in one or more stages. This may be due to improper electrode voltages. Check them with a high-impedance voltmeter and compare with voltages on the schematic or voltage table. The voltages must be correct to closer tolerances than on tube radio sets. Often 1/10 volt is enough out of the way, particularly on a transistor base. Why the increase in gain causes oscillation is shown by Fig. 3. If the feedback is insufficient to cause oscillation with normal gain, an increase in gain can cause instability.

Be sure the proper transistors are used. Sometimes an interchangeable type isn't a direct replacement. And there is the possibility that a transistor itself has more gain than it should. Test by substitution.

All transistors currently used in portable radios are triodes. Like rf and if tubes used before the screen-grid era (long ago!), they may require neutralization unless the circuit is made stable without it. The reason for feedback is the capacitance between input and output—collector and base in almost all instances. Fig. 5-a shows the simplified circuit of a transistor if amplifier with interelectrode capacitances shown by dashed lines. Most important of these is C_{B-C}. Being small it introduces about 90° phase shift. With slight detuning, enough energy can be forced back through this capacitance to cause oscillation. Since the input and output tuned circuits cover a band of frequencies, it is easy for oscillation to occur at some frequency near resonance.

Fig. 5-b shows two schemes for counteracting the undesired effects of C_{B-C}. C_{N1} feeds back out-of-phase energy to the base of the transistor. Arrows show direction of the instantaneous current flow through the interelectrode capacitance C_{B-C} and C_{N1}, Another neutralizing scheme employs a neutralizing capacitor from the secondary. Here the phase may be inverted due change in phase in a secondary. Flow of current through the capacitor, C_{N2}, is opposite to the instantaneous flow through C_{B-C}. One scheme only is used per stage. However, both are shown in a single diagram for convenience.

A simple adjustment of the neutralizing capacitor may be all that is required if it is an adjustable type. Set it while watching the voltmeter or the scope as directed under tests for oscillation. Absence of signal or waveform distortion indicates the proper setting. Sometimes the capacitor may be fixed but is a little short of enough capacitance to neutralize. A small trimmer (20 $\mu\mu$f maximum) may be shunted across the neutralizing capacitor and adjusted for the point of neutralization. If only a little shy, a gimmick made of twisted wire shunted across the capacitor is enough.

Such a cure was effective in a midget Bulova set (see Fig. 6). The gimmick was two 3-inch lengths of wire twisted together and shunted across the 10-$\mu\mu$f neutralizing capacitor.

Additional cures

In some sets, no provision is made for neutralization. Adequate decoupling resistors and control of stage gain hold down regeneration and oscillation. There may be damping resistors across the primary or secondary of the if transformer, or both primary and secondary. These serve a purpose similar to the test resistor mentioned earlier. (See Fig. 4.)

Shunt all bypass capacitors in any set with regeneration or oscillation. Some may be electrolytics across the battery and serve as an rf bypass as well. Use .01 to .05 μf in the shunt test. Watch the test meter or scope as each is shunted. Replace any defective units. Some electrolytics may require permanent addition of a fixed capacitor (ceramics are usually used).

As seen in Figs. 4 and 6, the bypass capacitors furnish ac grounds for collector and base supply dc voltages. Some trouble is encountered from not enough filtering between stages. A decoupling capacitor can be used with a low-ohmage resistor in any line going to a transformer. Use about 470 ohms and about .01 μf as in decoupling work in ordinary radio sets and TV.

A test resistor may be used to determine the value of a losser across a transformer primary or secondary. Always use a value a trifle lower than that required to just stop oscillation. A little less reduces regeneration, but considerably less tends to short the coil and kill gain unnecessarily. Start with any such oscillation suppressor or losser already present unless testing has indicated another stage or transformer.

In some sets, adding a neutralizing capacitor is a quick solution. It will cool down a hot transistor quickly. The neutralizing capacitance is installed according to any of the schemes shown previously. Adjust while maintaining a test for oscillation. The correct point is where oscillation just stops. Do not overneutralize or gain loss will result.

Sometimes careless placement of antenna or speaker leads will result in oscillation. The mixer acts as an if amplifier while a considerable amount of unbypassed rf and if may be present on the speaker or earphone leads. And, a battery may have high impedance and still give good volume. As a final tip—try a new battery! END

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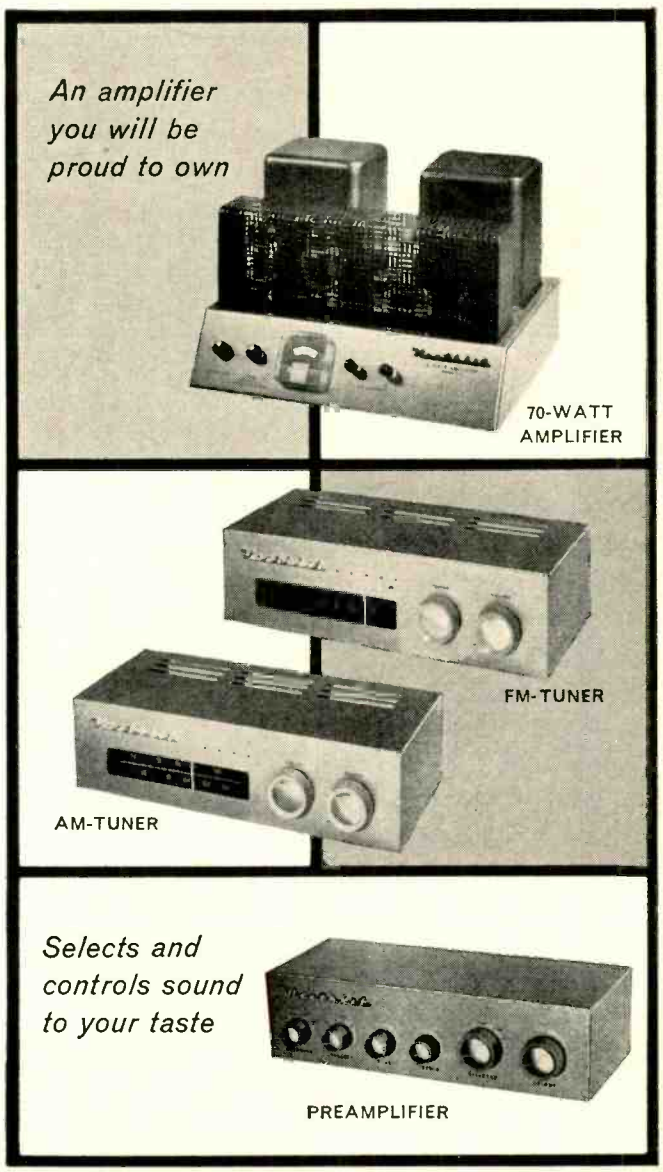
MODEL WA-P2

$19.75

(with cabinet)



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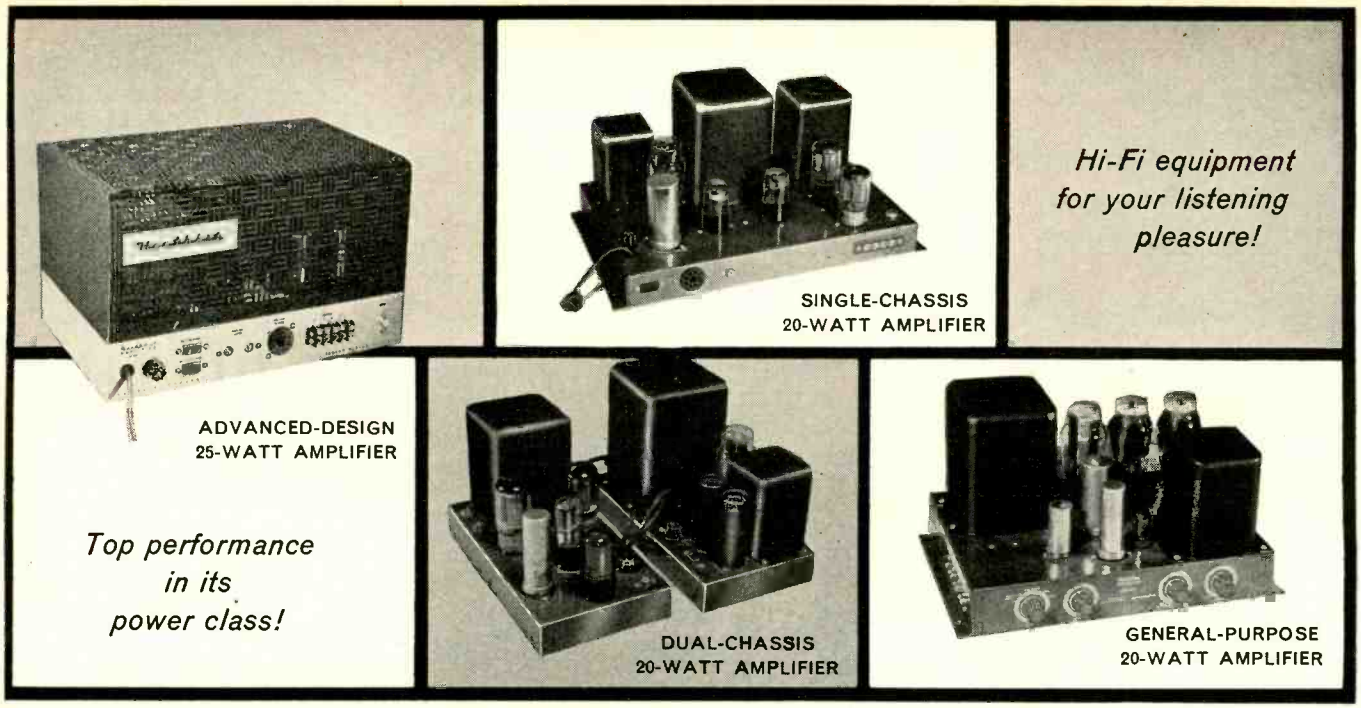

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Designed especially to satisfy critical audio requirements, the W-5M incorporates the extra features needed to compliment the finest in program sources and speaker systems. Faithful sound reproduction is assured with a frequency response of ±1 db from 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
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MODEL W4-AM
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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.

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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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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.

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MODEL AG-10

$49.95

HEATHKIT AUDIO ANALYZER KIT

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

MODEL AA-1

$49.95

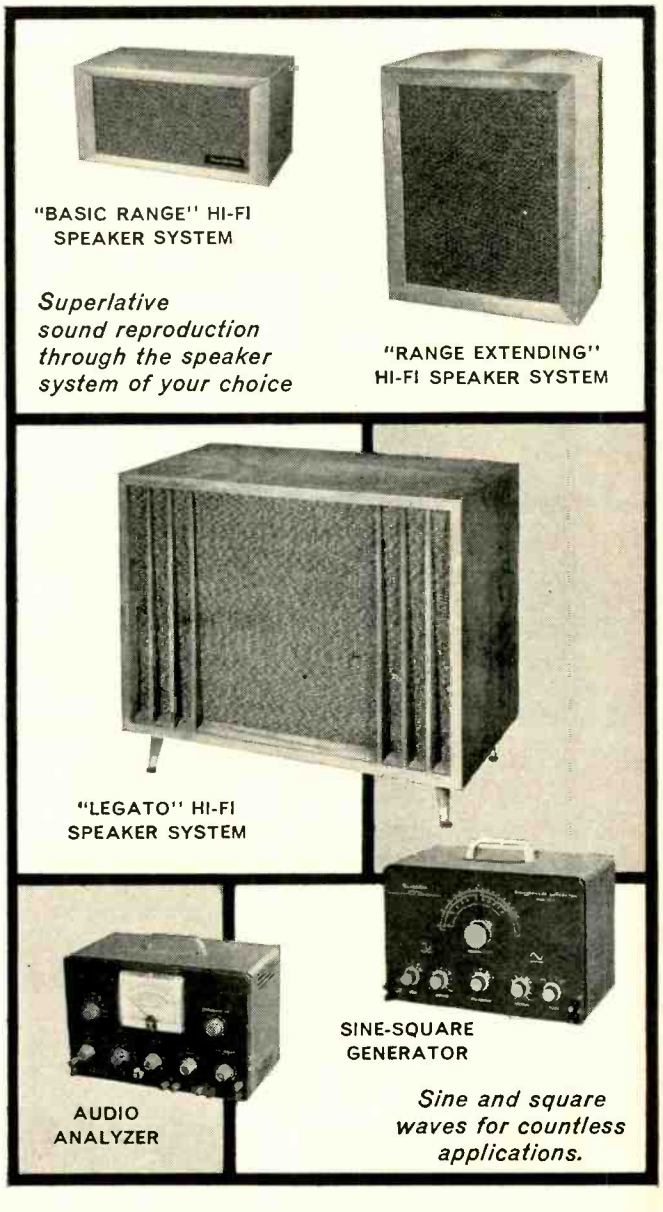
HEATHKIT "LEGATO" HIGH FIDELITY SPEAKER SYSTEM KIT

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

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

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

$299.95 EACH



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

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

Heathkits...

By DAYSTROM

are well known for their high quality and reliability.

HEATHKIT AUDIO VTVM KIT

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

MODEL AV-3

$29.95

HEATHKIT COLOR BAR AND DOT GENERATOR

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

MODEL CD-1
$59.95

Heathkits...

By DAYSTROM

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

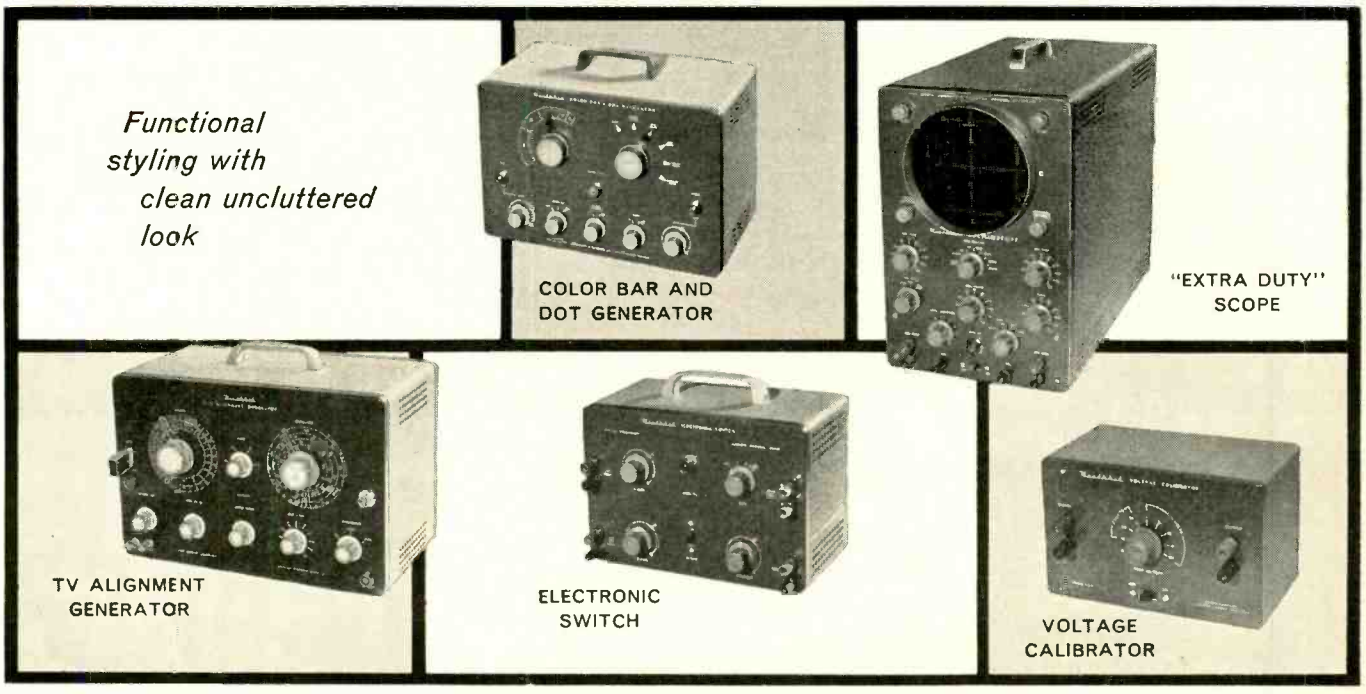
A valuable accessory for any oscilloscope owner. It allows simultaneous oscilloscope observation of two signals by producing both signals, alternately, at its output. Four switching rates. Provides gain for input signals. Frequency response ±1 db, 0 to 100 kc. A sync output is provided to control and 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



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

HEATHKIT TUBE CHECKER KIT

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

MODEL TC-2

$29.50

HEATHKIT HANDITESTER KIT

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

MODEL M-1

$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

Heathkits...

By DAYSTROM

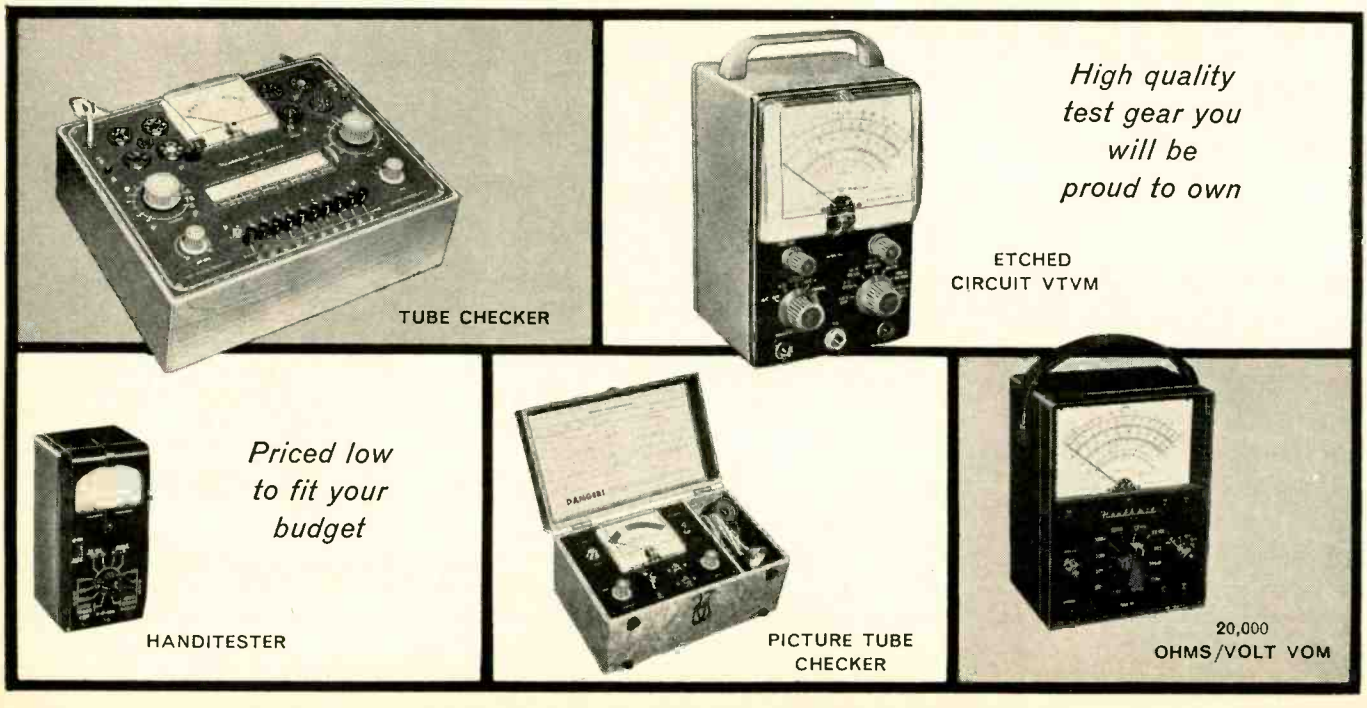
let you fill your exact needs from a wide variety of instruments

HEATHKIT 20,000 OHMS/VOLT VOM KIT

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

MODEL MM-1

$29.95



HEATHKIT RF SIGNAL GENERATOR KIT

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

MODEL SG-8

$19.50

HEATHKIT LABORATORY RF GENERATOR KIT

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

MODEL LG-1

$48.95

HEATHKIT DIRECT-READING CAPACITY METER KIT

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

MODEL CM-1

$29.50

Heathkits...

By DAYSTROM

are educational
as well as functional

HEATHKIT "IN-CIRCUIT" CAPACI-TESTER KIT

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

MODEL CT-1

$7.95

HEATHKIT CONDENSER CHECKER KIT

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

MODEL C-3

$19.50

HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT

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

MODEL T-3

$23.50

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

HEATHKIT IMPEDANCE BRIDGE KIT

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

MODEL IB-2A

$59.50

HEATHKIT "LOW RIPPLE" BATTERY ELIMINATOR KIT

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

MODEL BE-5

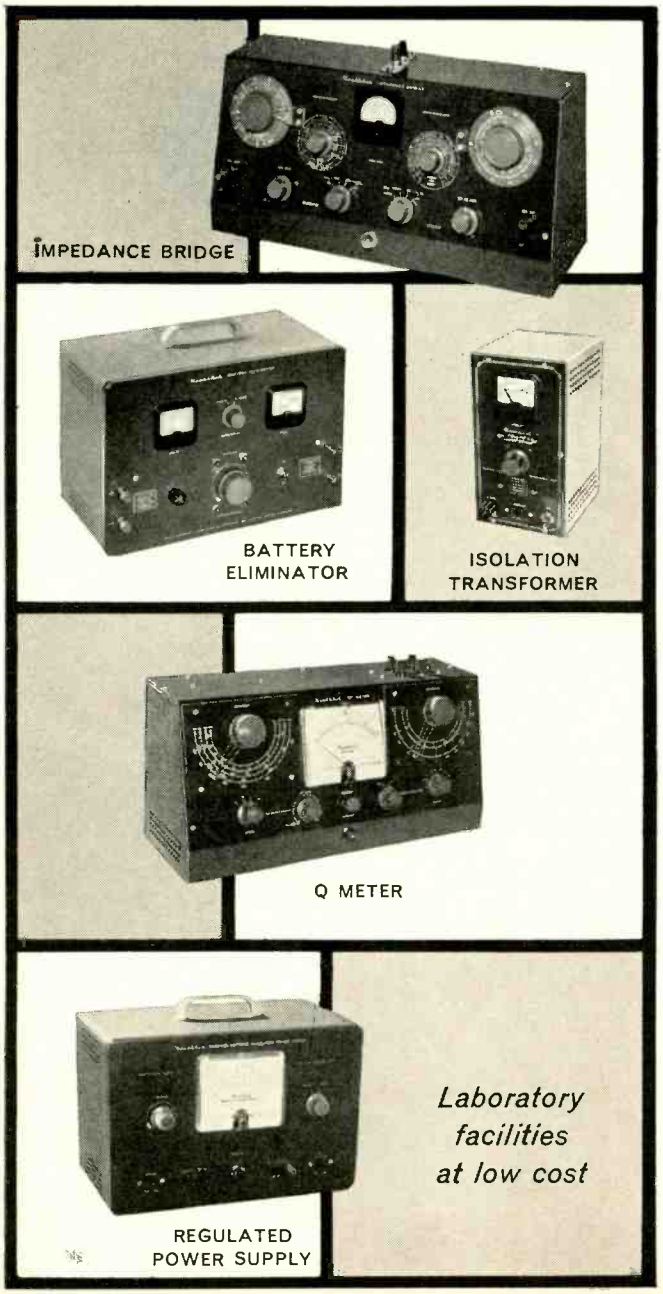
$39.95

HEATHKIT ISOLATION TRANSFORMER KIT

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

MODEL IT-1

$16.50



Heathkits...

By DAYSTROM

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

HEATHKIT "Q" METER KIT

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

MODEL QM-1

$44.50

HEATHKIT REGULATED POWER SUPPLY KIT

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

MODEL PS-3

$35.50

Terrific values in amateur equipment!

DX-100 TRANSMITTER

DX-20 TRANSMITTER

DX-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 . . .

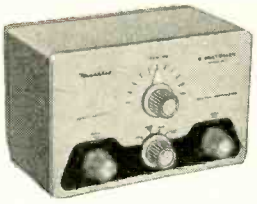
The transmitters described on this page were designed for the ham, by hams who know what features are desirable and needed. This assures you of the best possible performance and convenience, and adds much to your enjoyment in the ham shack.

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

Automatically turns off transmitter and gives visual signal

"AUTOMATIC" CONELRAD ALARM

GRID DIP METER



"Q" MULTIPLIER

COMMUNICATIONS-TYPE RECEIVER

An ideal receiver for the beginning ham or short wave listener

HEATHKIT "AUTOMATIC" CONELRAD ALARM KIT

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

MODEL CA-1
$13.95

HEATHKIT "Q" MULTIPLIER KIT

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

MODEL QF-1
$9.95

HEATHKIT GRID DIP METER KIT

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

MODEL GD-18
$21.95

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

HEATHKIT ALL-BAND COMMUNICATIONS-TYPE RECEIVER KIT

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

MODEL AR-3
$29.95
(Less cabinet)

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

Heathkits...

By DAYSTROM

are outstanding in performance and dollar value

HEATHKIT REFLECTED POWER METER KIT

The Heathkit reflected power meter, model AM-2, makes an excellent instrument for checking the match of the antenna transmission system, by measuring the forward and reflected power or standing wave ratio. The AM-2 is designed to handle a peak power of well over 1 kilowatt of energy and may be left in the antenna system feed line at all times. Band coverage is 160 meters through 2 meters. Input and output impedances for 50 or 75 ohm lines. No external power required for operation. Meter indicates percentage forward and reflected power, and standing wave ratio from 1:1 to 6:1. Another application for the AM-2 is matching impedances between exciters or $R.F_1$ 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 milliamperes and 6.3 volts AC at 0.45 amperes. Extra features include copper-plated chassis, ceramic coil forms, extensive shielding, etc. High quality parts throughout. VFO operation allows you to move out from under interference and select a portion of the band you want to use without having to be tied down to only two or three frequencies through use of crystals. "Zero in" on the other fellow's signal and return his CQ on his own frequency! Crystals are not cheap, and it takes quite a number of them to give anything even approaching comprehensive coverage of all bands. Why hesitate? The model VF-1 with its low price and high quality will add more operating enjoyment to your ham activities. Shpg. Wt. 7 lbs.

MODEL VF-1

$19.50

Heathkits...

By DAYSTROM

are the answer for your electronics hobby.

HEATHKIT BALUN COIL KIT

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

MODEL B-1

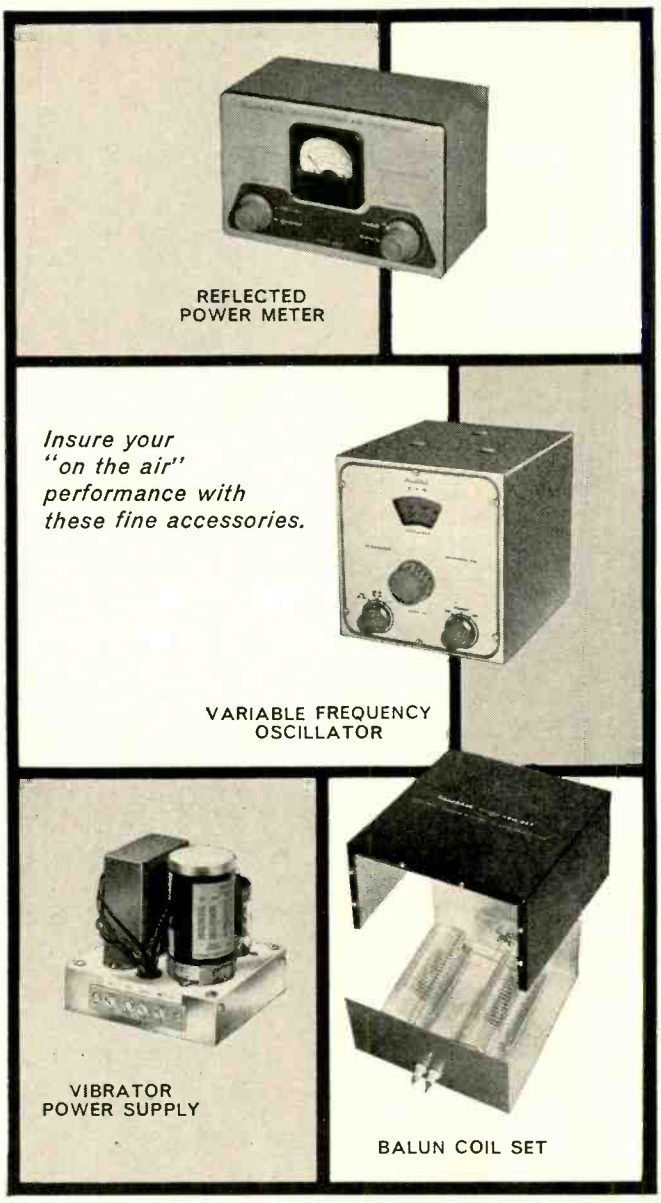
$8.95

HEATHKIT 6 OR 12 VOLT VIBRATOR POWER SUPPLY KITS

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

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

$7.95 Each



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

HEATHKIT ELECTRONIC IGNITION ANALYZER KIT

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

MODEL IA-1
$59.95

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

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

MODEL RC-1
$79.95

Heathkits...

By DAYSTROM

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

HEATHKIT ENLARGER TIMER KIT

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

MODEL ET-1
$11.50

HEATHKIT BATTERY TESTER KIT

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

MODEL BT-1
$8.50

HEATHKIT CRYSTAL RADIO KIT

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

MODEL CR-1
$7.95

Heathkits...

By DAYSTROM

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

HEATHKIT TRANSISTOR PORTABLE RADIO KIT

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

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

HEATHKIT BROADCAST BAND RADIO KIT

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

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

MODEL BR-2
$18.95
(Less cabinet)

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

protects against possible explosion and fire from undetected fuel vapor

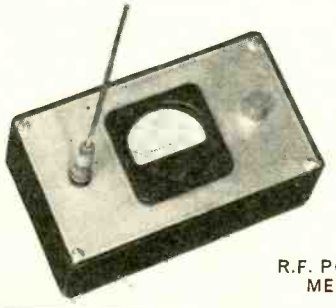
FUEL VAPOR DETECTOR

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

ELECTROLYSIS DETECTOR

indicates condition and charge of batteries for safe cruising

BATTERY CHARGE INDICATOR



R.F. POWER METER

HEATHKIT FUEL VAPOR DETECTOR KIT

Protect your boat and its passengers against fire or explosion from undetected fuel vapor by building and using one of these fine units. The Heathkit Fuel Vapor Detector indicates the presence of fumes on a three-color "safe-dangerous" meter scale and immediately shows if it is safe to start the engine. A pilot light on the front panel shows when the detector is operating, and it can be left on continuously, or just used intermittently. A panel control enables initial calibration of the detector when installed. Features a hermetically-sealed meter with chrome bezel, and a chrome-plated brass panel. It is very simple to build and install, even by one not having previous experience. Models FD-1-6 (6 volts DC) and FD-1-12 (12 volts DC) operate from your boat batteries. The kit is complete in every detail, even to the inclusion of a spare detector unit. Shpg. Wt. 4 lbs.

6 volt MODEL FD-1-6
12 volt MODEL FD-1-12
$35.95 EACH

HEATHKIT BATTERY CHARGE INDICATOR KIT

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
$9.95

HEATHKIT RF POWER METER KIT

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

MODEL PM-1
$14.95

Heathkits...

By DAYSTROM

now offer you completely modern marine equipment with outstanding design features

HEATHKIT TRANSISTOR RADIO DIRECTION FINDER KIT

The Heathkit Transistor Radio Direction Finder model DF-1 is a self-contained, self-powered, 6-transistor super heterodyne broadcast radio receiver incorporating a directional loop antenna, indicating meter, and integral speaker. It is designed to serve primarily as an aid to navigation when out of sight of familiar landmarks. It can be used not only aboard yachts, fishing craft, tugs, and other vessels which navigate either out of sight of land or at night, but also for the hunter, hiker, camper, fisherman, aviator, etc. It is powered by a 9-volt battery. (A spare battery is also included with the kit). The frequency range covers the broadcast band from 540 to 1600 kc and will double as a portable radio. A directional high-Q ferrite antenna is incorporated which is rotated from the front panel to obtain a fix on a station and a 1 ma meter serves as the null and tuning indicator. The controls consist of: tuning, volume and power (on-off), sensitivity, heading indicator (compass rose) and bearing indicator (antenna index). Overall dimensions are 7½" W x 5⅞" H x 5⅜" D. Supplied with slip-in-place mounting brackets, which allow easy removal from ship bulkheads or other similar places. Shpg. Wt. 5 lbs.

MODEL DF-1

$54.95

use it for a radio-compass or as a portable radio

TRANSISTOR RADIO DIRECTION FINDER

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By DAYSTROM

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The Heath Company maintains a technical consultation service, should you experience some sort of difficulty in construction or operation. Although only a very small percentage of our customers ever have occasion to use this service (usually only beginners in electronics) it is still reassuring to know that technical help is available when needed. A service department is also available, should you wish a complete factory check of operation and alignment or repair. After you build your first Heathkit you'll realize how easy it is.

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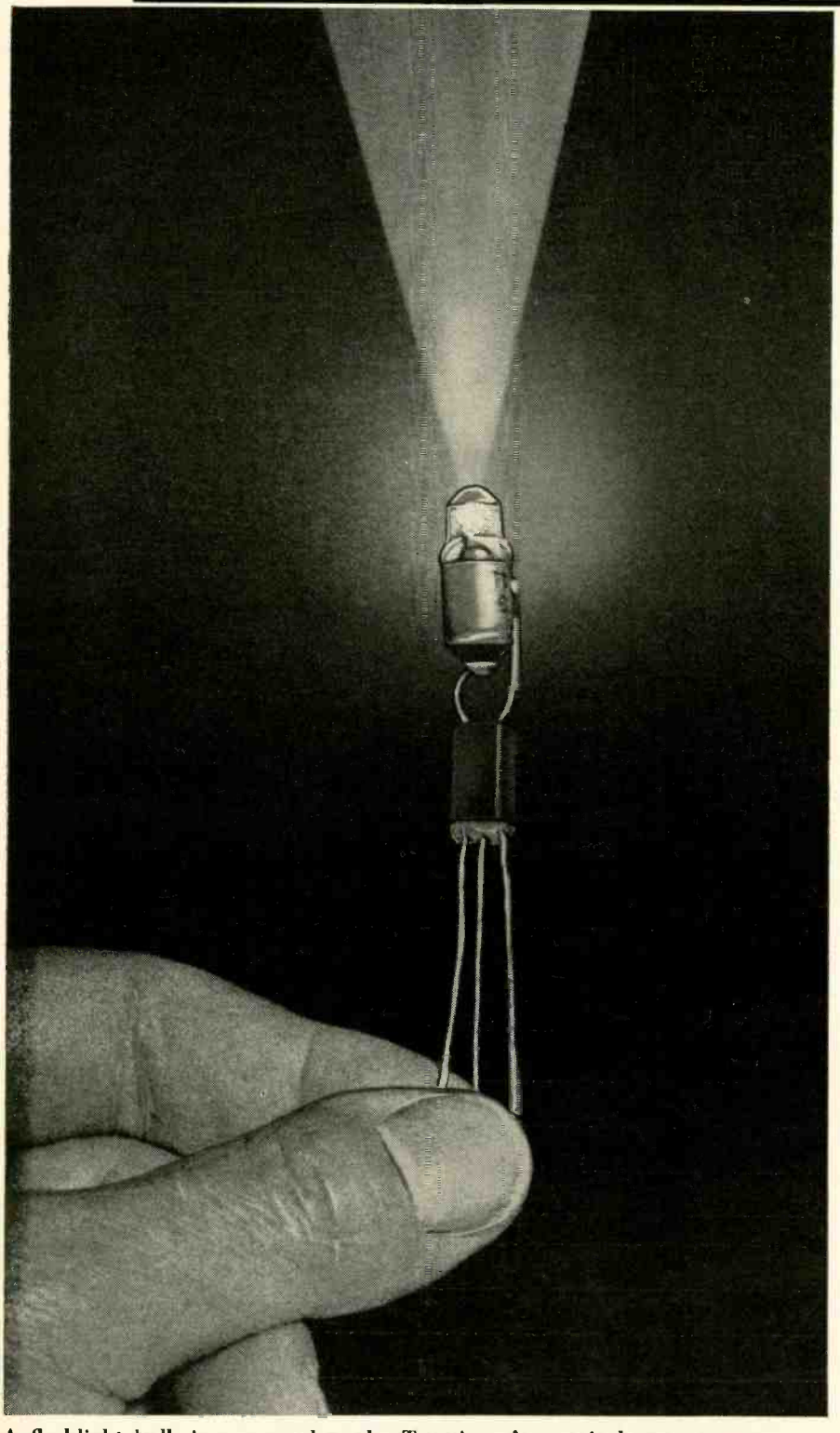
the TRANSISTOM



A flashlight bulb is connected to the Transistom's atomic battery to demonstrate its power. The battery can keep the lamp lit for 50 years.

This remarkable discovery foreshadows advances in two areas of the semiconductor field—diodes and transistors—and makes greater miniaturization possible while increasing transistor sensitivity. A radio battery with a life of 50 years is possible

By MOHAMMED ULYSSES FIPS, IRE*

FIPS, you engineers are in the stone age," scowled the Big Boss, savagely biting his 7-inch Havana. "The idea of dry-cell- or house-current-powered receivers is not only preposterous, it's insane. Prehistoric, that's what it is! You yak all day long about your glorious science, my accomplished yaketeer—now come down to earth and compose. I'll give you 90 days to produce a receiver that needs no dry cells, no outside current—or else!"

The door banged shut with final explosive emphasis and I knew that the Chief meant business. Strangely enough, for once I agreed with the antediluvian coot and found myself even elated with the difficult assignment. I immediately knew I could produce. Such is the exuberance of youth! Instanter, within minutes of Bignose's talk, I was deeply enmeshed in the problem.

I soon hit upon the solution. *Radioactivity was the answer!* I took out my dusty old handbook on *Primary and Secondary Batteries* and soon found that in Volta's and later physicists' potentials-of-the-metal series, magnesium and manganese have respective voltages of +1.628 for Mg and +1.239 for Mn, or a *theoretical* total of 2.867 volts.†

If, I reasoned, I made these two metals radioactive and used them as an atomic battery, I should get at least 2½ volts per element. I accordingly secured a small quantity of manganese and magnesium and took them to the neighboring atomic research plant on Long Island, whose director I knew. He put the metal bits into the cyclotron

*Institute Radioactive Engineering.

†A recent magnesium–carbon–manganese dry cell actually gives 2¼ volts.

and bombarded them atomically for a week.

Here I should call attention to the fact that my first experiments had quickly shown that *pure* metals alone would not work as an atomic battery. I had to use a magnesium as well as a manganese *alloy* of certain proportions, which for patent reasons I cannot divulge now. I can state, however, that the alloyed metals used were *much* heavier in each case than manganese (atomic weight 54.94) and magnesium (atomic weight 24.32).

After the samples were "cooked" atomically, I called for them. The tiny pieces had been placed in a thick lead box, although the director assured me that the quantity of the now radioactive metal was sufficiently small that all the pieces *together* were not more dangerous than a dozen radium-luminous wrist watch dials.

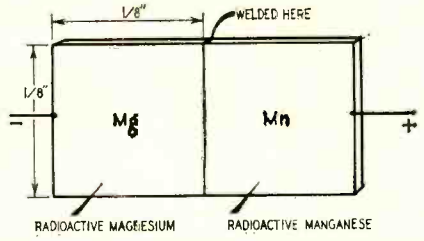


Fig. 1—The battery consists of two small squares of radioactive metals—magnesium and manganese — welded together.

I must also report that before I took the manganese and magnesium pieces to the cyclotron I had welded the thin ⅛-inch metal squares together. This was easy because they were almost paper-thin. The final atomic battery thus consists of a ⅛ x ¼-inch magnesium–manganese radioactive strip (Fig. 1). The finished battery gives a voltage of just over 2½ under a light load. As the load increases, the voltage of course drops as in an ordinary dry cell. You might wonder how the atomic battery works with its two main elements welded together. The answer is no different than in a dry cell in which the zinc can and the depolarizer (manganese dioxide) are intimately connected by the electrolyte (sal ammoniac and zinc chloride), which is highly conductive. Or take a storage battery in which the positive and negative plates are immersed in a bath of dilute sulfuric acid, which you'd think would short-circuit the plates.

Naturally, in an atomic battery, the energy is not chemical as in a dry cell nor "stored" electricity as in a storage battery. The energy in an atomic battery comes from the gamma radiation, which is then converted electronically in the two metals. A current then flows from the manganese to the magnesium.

What is the useful life of an atomic battery? My calculations show that a conservative estimate is 40 to 50 years. With future refinements, the life expectancy should be much greater.

My next step, naturally, was to hook up my atomic cell to a transistor, thus making it possible to construct a small radio in which the batteries would take up practically no extra room. Curiously, too, I soon found out that the atomic radiation had a decided influence on a transistor; *it enhanced its sensitivity surprisingly.*

The final and successful version is shown diagramatically in Fig. 2. Here we have a standard three-lead transistor to which the atomic battery has been joined. For a number of technical reasons, the battery elements should not physically contact the transistor elements, hence I use a thin ceramic separating film. (Other suitable insulators can be used.)‡

The transistor battery is now encapsuled, as is standard practice with all modern transistors. This results in a new electronic device which I call the TRANSISTOM *(transistor* plus *atom).* The transistom, as will be noted, has five leads—three transistor and two battery leads. These external battery leads can be interconnected as necessary in various circuits. In a six-transistor set we can even hook all the batteries up in series, giving us 15 working volts to drive a large speaker.

Needless to state, the coming tran-

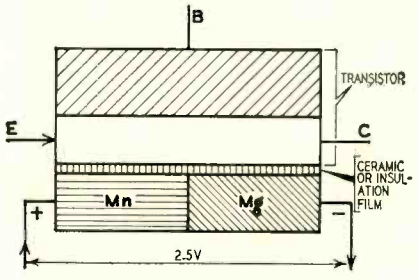


Fig. 2—When the battery is fastened to a transistor, forming a composite unit, the Transistom is completed.

sistom circuitry is endless and the nuisance of battery replacements will soon be a thing of the past.

Long before the 90-day time limit imposed upon me by the Chief, I walked into his office unannounced one morning. Out of my vest pocket I pulled a six-transistor receiver. If it hadn't been for the loudspeaker, the little set would have fitted into an ordinary matchbox—but the speaker made it 50% bigger.

I put it through its paces and, if I must say so myself, it worked—as the French would say—*formidable.* Bignose, for once, was enchanted as I opened the tiny lid, showing him the "works."

In the office with the all-highest there were also the science editor and the electronics editor. All three listened politely and interestedly to my technical description of my transistom. Then there was a long, thick silence accompanied by pointed headshaking.

Finally Bignose cleared his throat and snickered, "Fips, my boy, do you ever read the papers and do you know what goes on nowadays? Did you know that the word radiation is akin to pestilence all over the world today? What do you think would happen to us if we printed your transistom story? *A radio set that gives off deadly radiation!* Admittedly you—and we—know that it wouldn't hurt a fly, but what about the public? What about the Radiation Energy Commission (REC)? What about the National Health Service? People are hysterical today about *any* form of gamma radiation. You know that every kind of X-ray—except in doctors' hands—is taboo now. And now you want us to publicize a radio set that gives off gamma rays! Indeed!"

"Frank," this to the science editor, "bring in your Geiger counter!"

Frank returned in a minute with the Geiger and brought the probe to within a foot of my receiver. Of course it clicked furiously, as was to be expected—it would have done that with a luminous radium wristwatch dial, too.

"Look here, Fips," rasped Joe, the electronics editor, "can't you just visualize the ads of the large set manufacturers screaming 'Buy a *safe* NON-RADIATION battery set that won't endanger your or your family's health.' "

"Yes, Fips," piped in Frank, "you must know too that radiation today is the BIG political weapon of all our enemies and detractors the world over. Japan leads all Asia in bellowing at America to stop all forms of radiation and fallout to safeguard future generations. European scientists condemn us for the same reason.

"Kruschev, I am positive, would hop on your radiation radio as an excellent propaganda springboard to denounce our Western decadence and irresponsibility for foisting more misery and suffering on an already distressed world, all for the sake of our capitalistic dollar."

"No, Fips," this from the electronics editor, "I know what is in your mind—you want to encase your chassis in lead to stop all radiation. That, my boy, is no solution. Aside from the impossible added weight, think what a picnic the battery set manufacturers would have in their ads, telling service technicians to stay away from servicing *dangerous radiation* sets! Aside from this, shielded or not, your set would still be taboo—because of its *potential radioactive* danger. No, you'll have to start all over. I admit your scheme is brilliant—but with today's wholly uncalled for radiation hysteria, you must chart a new course."

Whipped and beaten down once more, I shuffled out the hallway. At the bend on the wall I glanced at the large leaf calendar and sadly noted the date:

April 1

‡My latest transistoms now use light-gauge magnesium and manganese wires welded together.

Grounding isn't always easy. Even an inch of wire can cause trouble

Uncommon Ground Difficulties

By A. R. CLAWSON

TECHNICAL workers, experimenters, hobbyists and even some engineers consider an electronic chassis a common ground. This common-ground idea often proves false. Case histories, including causes and solutions, of a few uncommon ground troubles are presented here.

Even the smallest part of a metal chassis presents some opposition to the flow of current. This is its impedance and for dc is equal to the ohmic resistance. There is no need to get involved in the calculation of impedance, but we must look into some of its effects.

To ac the impedance is a combination of ac resistance and net reactance —primarily inductive reactance. Ac resistance is not the same as dc resistance, but always greater. The skin and other effects add to the dc resistance. This may increase the resistance factor by as much as 12 times at television frequencies.

The other component of impedance, the reactance, may reach rather high values with increasing frequency for inductive circuits. A 1-inch piece of ordinary hookup wire can have 4 ohms of inductive reactance at 30 mc! Yet its ohmic (ohmmeter) resistance is too small to measure with an ordinary meter.

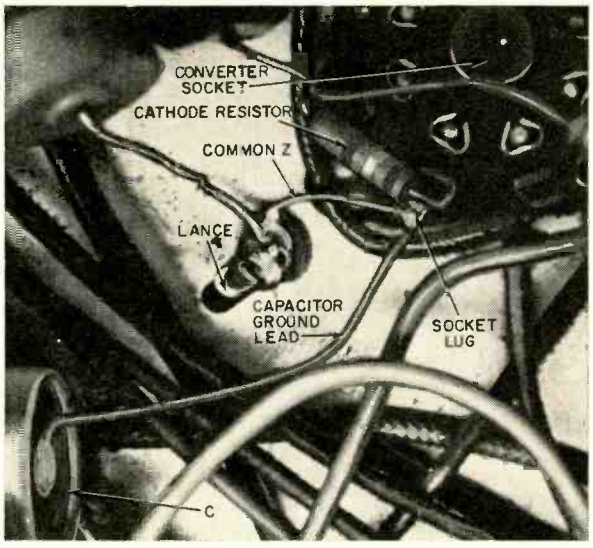


Fig. 1—Hum modulation, due to an inch of wire.

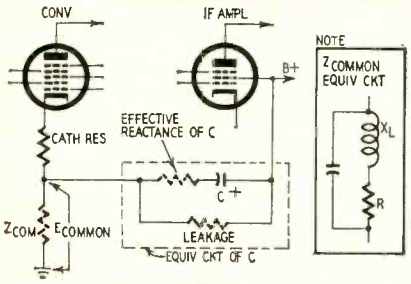


Fig. 2—Equivalent circuit showing filter capacitor return to lug and then along common impedance of converter stage.

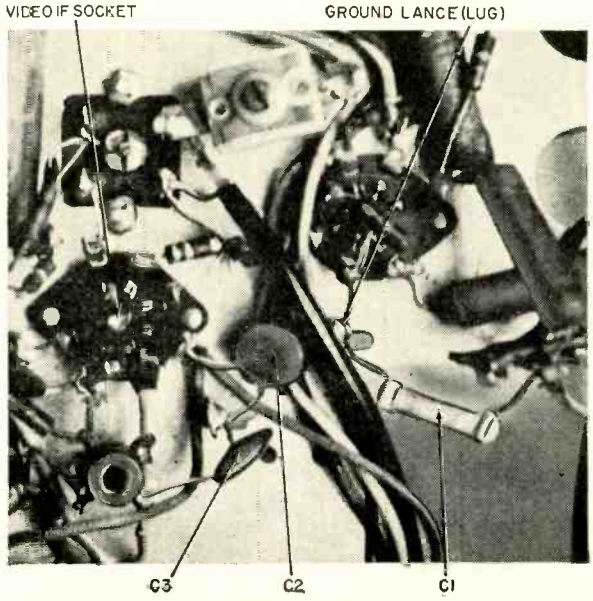


Fig. 3—Common and nearby grounding of horizontal oscillator bypass and if bypass capacitors results in jitter.

Hum modulation

An example of this type of trouble turned up in an ordinary broadcast receiver. The set had a bad case of hum modulation, indicated by no hum when the set was tuned off station.

Troubleshooting was rapid since the hum increased as the higher-frequency stations were tuned. The variation ruled out the if stages, leaving only the converter. The trouble was found to be an incorrectly grounded lead from an electrolytic capacitor.

Fig. 1 shows a wire running from a ground lance (punched-up lug) to a socket lug of the converter stage. Note the cathode resistor of the tube and the ground return of the electrolytic capacitor returning to the socket lug. Both cathode current and capacitor current

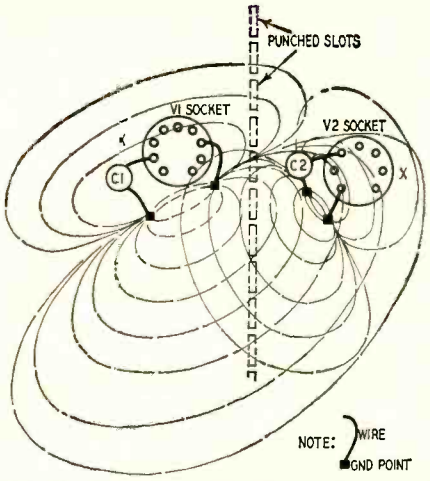


Fig. 4—Mutual interaction of ground currents from nearby ground points.

flows through the wire from socket lug to lance.

Capacitor current has two components of interest: reactance flow equals the ripple voltage divided by the capacitor's reactance; ac leakage current, equal to ripple voltage divided by the electrolytic's leakage resistance. There is also a dc component of no concern here.

The wire offers some impedance at 120 cycles—we need not worry about calculating it. But we do have to note that there is a voltage drop:

$$E = I \times Z \quad (\text{or } E = IZ)$$

where I is the combined alternating current and Z the small but definitely present impedance at 120 cycles.

Fig. 2 shows the circuit. The wire and, to a lesser extent, the lance form the common impedance, with some small contribution from the socket lug, making Z_{common}. Its equivalent circuit is shown as an insert. The leakage resistance and capacitative reactance are shown as resistances. The voltage developed, E_{common}, is applied to the cathode of the tube in series with a cathode resistor. The ripple voltage modulated the cathode of the converter in this instance.

The value of Z_{common} increased with increasing frequency, permitting more of the developed hum voltage to be effective. This follows from the formula:

$$X_L = 2\pi fL$$

Inductance L remained constant while frequency f increased 3 times from 500 to 1,500 kc, with a similar increases in X_L—the reactance—and the impedance of Z_{common} at these frequencies.

Moving the ground-return wire of the electrolytic to the lance, where it had been prior to electrolytic replacement in another shop, cured the hum. Just an inch of common ground wire caused all the trouble!

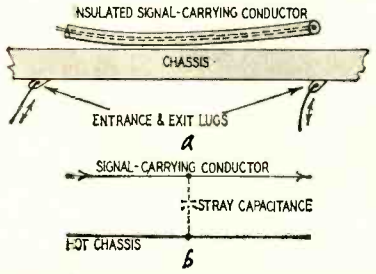


Fig. 5—Capacitive coupling between a hot chassis and a hot conductor; a—actual circuit; b—equivalent circuit.

False sync pulses

Feedback of sweep or sync into the video or pix if or front end can result in an unwanted and false sync pulse. Sweep oscillators, even though afc-protected, may try to lock on the added pulse with resultant symptoms of jump, jitter, and sometimes even vertical roll.

Typical of this class (see Fig. 3) is the case of horizontal oscillator feedback, or injection. A tubular ceramic (C1), a horizontal oscillator bypass carrying sweep currents to ground and disc capacitor (C2) were grounded to the same ground lance (lug). The lug acted as the common impedance. Feedback of horizontal oscillator pulses into the picture if resulted in jitter whenever

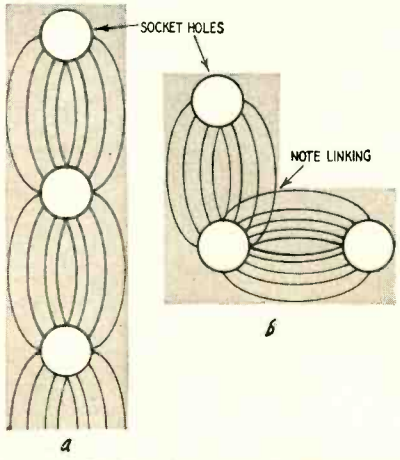


Fig. 6-a—In-line layout minimizes chassis current interaction; b—bent layout, with possible regenerative or degenerative feedback.

the horizontal frequency drifted ever so slightly. The design error was corrected in later production runs.

Not all feedback was due to the common impedance of C1 and C2's common ground lance. Some feedback was caused by the current of C1 intermingling with the chassis current of C3, a disc if bypass capacitor. The common impedance was the sheet-metal chassis proper! The solution was to move C3's ground to the same point as C1.

Fig. 4 shows what happens. Tube V1 has a bypass C1 and tube V2 has as its bypass C2. The tubes may have different functions like the sweep oscillator and if just mentioned. The bypass capacitors normally return their current through the chassis to the cathode of the tube. Heaviest current flow is between the ground point of the capacitor and the cathode or its bypass capacitor. Not all the current goes in a straight line however, but forms a sweeping motion in accordance with the low but existing chassis impedance. The lines in Fig. 4 enclose

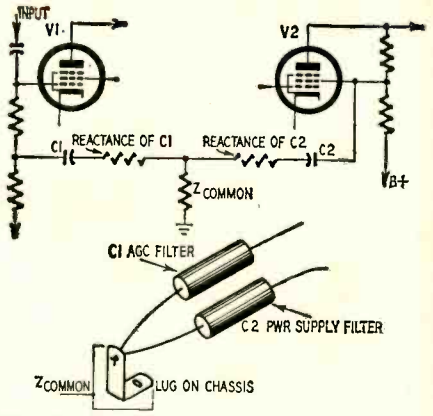


Fig. 7—Poorly soldered lug introduces a high common impedance between the common joint of two capacitors returning to ground.

approximately equal areas of current flow and equal chassis impedance.

Note that the lines of flow (flux) of capacitor C1 intermingle with those of C2. The result is a voltage, similar to that developed in the hum modulation case. This time it is in the chassis instead of a wire. The voltage is small and can be disregarded in many instances. Sometimes, this voltage may inject another voltage, a false sync pulse, for example. Degenerative or regenerative feedback may also occur.

Worthy of note is the control of chassis currents and common impedances by chassis openings. If a row of slots or holes is punched between the sockets of V1 and V2 (Fig. 4), the common impedance is interrupted to a large extent. Where rerouting the capacitor is not feasible, this might be a satisfactory solution.

Capacitive reactance

Cases occur of capacitive reactance between a wire or other conductor and a hot chassis. The chassis may be carrying a large current at a high frequency and, if a conductor is too close, a very low feedback path may exist due to the capacitance formed. The reactance will be low at high frequencies according to the capacitive reactance formula:

$$X_C = \frac{1}{2\mu fC}$$

Fig. 5 is a sketch of such a wire close to a chassis. Feedback of deflection yoke currents into tuner (front-end) shields has occurred by this method. The remedy is redressing the yoke leads. Commercial equipment does not lend itself to layout changes but such information is helpful to those that make their own. Careful layout can avoid trouble.

As an example, Fig. 6-a shows a straight-line amplifier—the tube sockets in line. Given the same components, the in-line amplifier can yield greater gain than the bent amplifier of Fig. 6-b. The reason is that the bending crowds the current flux (flow) into the corner, and input and output currents of the tube at the bend mix in the

common chassis impedance. The result may be instability.

Tube sockets are mounted in holes in the chassis. A ground point may be selected on the opposite side of the tube. For example, in Fig. 4, the common impedance between C1 and C2 can be greatly lessened by using new ground points at X. The socket holes interfere with current flow toward the other tube for each capacitor. This is more effective than the slot method.

Another way to keep ground currents in line is to increase the conductivity of the chassis or ground in the desired direction, thereby diverting current from undesired paths. A strip of braid may do the job very nicely. In Fig. 1, paralleling the inch of wire with braid would probably reduce the common impedance to where the hum modulation would not be objectionable. However, moving the capacitor lead was the easy way.

A sheet of metal, riveted, soldered, or bolted to the chassis, can serve to divert currents by lowering the impedance.

Fig. 7 shows the circuit formed by a poorly soldered connection between a ground lug and two capacitors making a return at that point. Fig. 8 shows the actual parts after resoldering.

The impedance Z_{common} should have been nearly zero ohms in this case, but actually was about 0.5 megohm. The large electrolytic and an age filter capacitor in Fig. 8 were grounded at the lance. Due to the common imped-

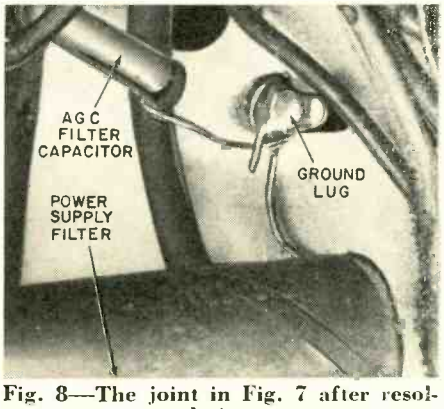


Fig. 8—The joint in Fig. 7 after resoldering.

ance, the power supply ripple fed into the age line practically without hindrance—the only opposition was the reactances of the capacitors themselves.

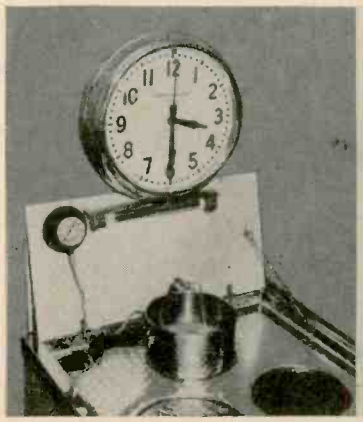
Heater grounds

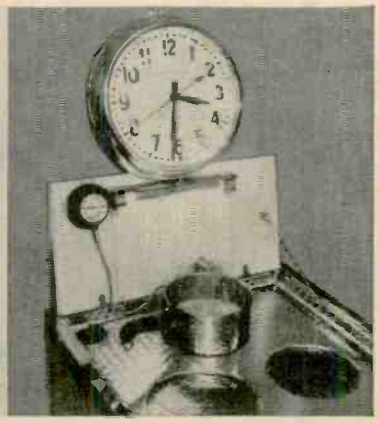
Common practice uses the chassis as one return leg for the heaters of all tubes. These can intermingle with signal currents to produce unwanted effects. Heaters should be connected directly to their own ground rather than to another socket lug because the common impedance may become a trouble spot that will be difficult to localize. Assume the wire in Fig. 1 is the common return of a heater and a cathode—the effect might resemble cathode-to-heater leakage and no amount of tube substitution will remedy such a situation.

Happy grounding! END

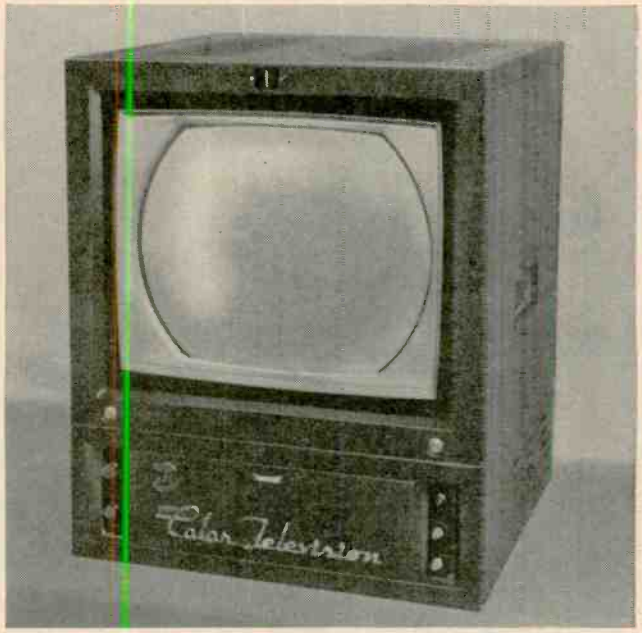
what's new?

MAGNETIC EDDY-CURRENT STOVE puts an old electrical trick to practical use. Powerful electromagnets induce heavy currents in a stationary conductor, heating pan and food. A pint of water can be brought to a boil in 100 seconds. Virtually all heat is concentrated in the cooking vessel. The stove's top does not heat up and as all moving parts are sealed off it can be easily rinsed off and cleaned with water. Varying the intensity of the magnetic field by raising or lowering the pot controls the heat. The stove was introduced by Tuttle & Kift, Chicago, Ill.

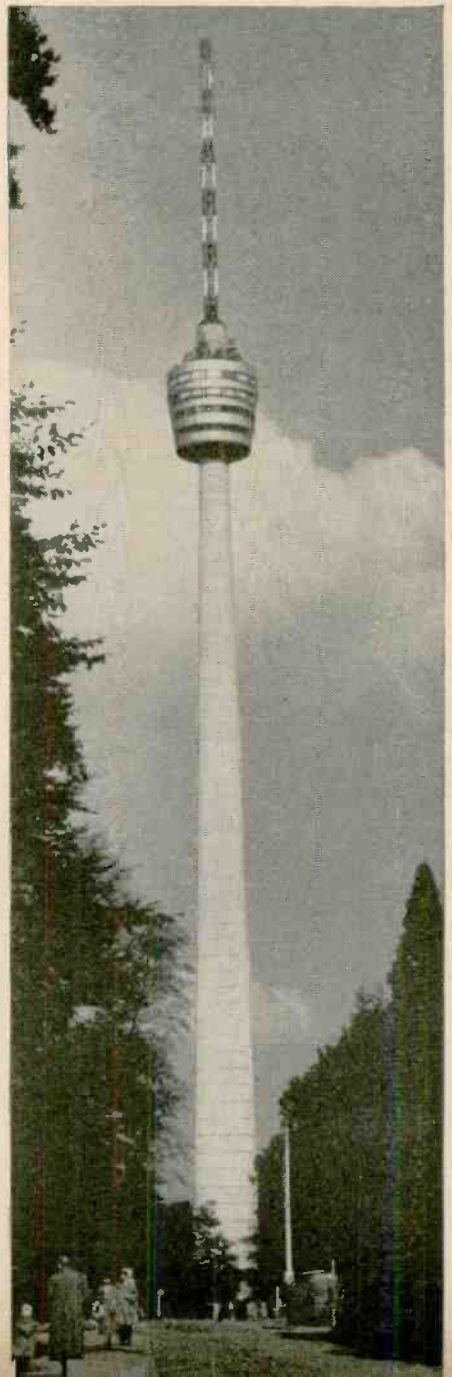




LONG-LIFE COLOR TV MONITOR might be the answer to that customer who asks "Why can't they build 'em so they'll run right and won't break down all the time?" They can. Engineered for the ultra high quality, stability and uniformity required in color broadcast and closed-circuit TV, this 21-inch RCA unit incorporates feedback stabilization throughout, kinescope protected from loss of horizontal deflection or video overdrive, regulated voltages for stability, automatic brightness tracking for color balance, and noninteracting convergence circuits. It should run for years without needing repairs. However, there is one catch—the set costs $3,650.



WANT TO LUNCH IN A TV TOWER? In Stuttgart, Germany, you can. This 695-foot tower has a public restaurant atop its tapered concrete base. There are studios under the restaurant and an observation tower above. It's one way of getting a TV tower to do two jobs.



DOWN THE HATCH goes the German opposite number of the radio pill described in Radio-Electronics in June, 1957, page 45. The German version is called a ***verschluckbaren Intestinal Sender.*** Via radio waves, the ***kleine Kapsel*** transmits the pressures present in the subject's digestive system. The unit, developed by Prof. Manfred Von Ardenne, is 26 mm long and between 8 and 10 mm wide.

Von Ardenne is one of the founders of modern television. It is said that he was the one who convinced Baird and Zworykin to use the cathode-ray tube for television.

TAMING THE HORIZONTAL OSCILLATOR

An experienced service technician shows how to troubleshoot the multivibrator type of horizontal oscillator

By WAYNE E. LEMONS

HORIZONTAL oscillator problems seem to give technicians more trouble than any other portion of the TV receiver. Through experience with a good many brands of sets, I have developed a routine for servicing bad oscillators that has paid off in faster and easier repairs.

This article is limited to the multivibrator type of oscillator, leaving the other most popular type, the Synchroguide, to a later effort.

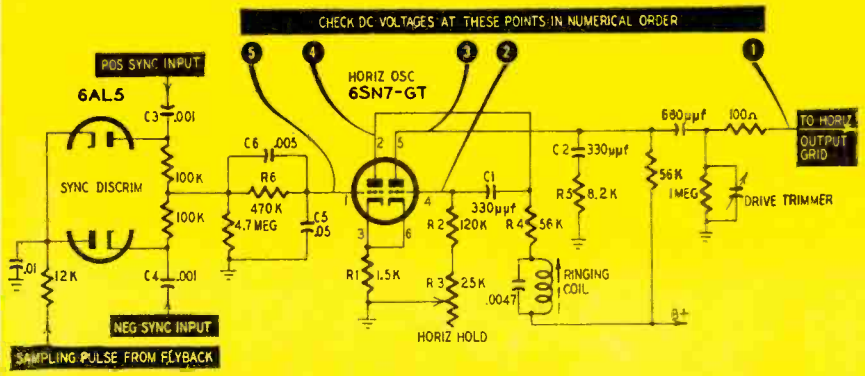
Fig. 1 is a typical multivibrator circuit which has been used in millions of TV sets. Tube types may vary, but the 6SN7 has been the most popular and perhaps still is the most stable of all tubes used in this circuit.

This is a cathode-coupled multivibrator—feedback to sustain oscillation is obtained from the common cathode-coupling resistor R1. The resistor may be anywhere between 820 and 2,200 ohms, depending on circuit design and how many surplus resistors of a given size the factory had on hand.

Cathode coupling is used so that grid pin 1 may be left floating and a dc voltage applied to it may be used to control the speed of the oscillator. This grid is at ground potential at all times as far as the oscillator is concerned, unless there is a malfunction.

Resistor R2 is the oscillator grid resistor and is often in series with the horizontal hold control (R3). A number of sets have come out without a resistance to control horizontal frequency, while others have used two. The horizontal hold potentiometer controls the speed of the oscillator by varying the time constant of the circuit. More resistance slows down the oscillator while less resistance speeds it up.

The ringing coil is to the horizontal oscillator what a flywheel is to an engine. It keeps the oscillator running at a steady pace through momentary changes in line voltage, etc. It is always tuned with an adjustable slug. Sets having no resistance type controls for horizontal frequency adjustment rely on the setting of this slug to set the frequency. Resistor R4 in series with the ringing coil and the plate is used to keep the coil from having too much influence over the frequency of the oscillator. R4 also affects the wave shape to some degree.



Circuit of typical horizontal oscillator and sync discriminator.

Coupling capacitor C1 is also part of the time-constant circuit of the multivibrator and at least one manufacturer used a trimmer across this capacitor to set the oscillator frequency. A shaping network made up of C2 and R5 is primarily for forming the pulse into the proper shape for application to the horizontal amplifier grid. If either is defective, the horizontal-oscillator is affected.

Servicing tips

How do you check for horizontal oscillations in this type of circuit? I have heard of a number of ways and there are probably many more of which I haven't heard. My young technician employe says he can hear the horizontal oscillator kick in, even when the horizontal amplifier tube is out of its socket. I don't believe him sometimes, but I've never been able to prove him altogether wrong. Anyone with lo-fi hearing must rely entirely upon instruments rather than nature's benevolence.

A good place to start—if all the tubes are in place and check OK—is at the grid of the horizontal amplifier tube. If the horizontal oscillator is working, some sort of negative voltage will be present. This does not mean that the oscillator is working at the correct frequency, but it does mean we have horizontal oscillations. If there isn't any negative voltage at the horizontal amplifier's grid, check for negative voltage at pin 4 of the 6SN7—the oscillator grid. Finding none here, check for plate voltages. These voltages may vary widely from what the schematic lists, due to other factors, but there must be *some* positive voltage on the plates of both sides of the 6SN7 or there is no oscillation.

If you have not yet found the trouble, the next step is to check the voltage of the dc-controlled grid (pin 1, 6SN7). This can be measured, of course, but, depending on whether the oscillator is running high or low, the voltage may be either positive or negative. Here I believe the dynamic approach of grounding this grid to the chassis is the quickest way to determine if the sync discriminator is affecting the horizontal oscillator. If, when the grid is shorted to chassis, the horizontal oscillator starts functioning and a raster appears on the screen, you know that the trouble is ahead of the horizontal oscillator stage and you can start looking at the sync discriminator.

This usually turns out to be either a defective 6AL5 *(which should already have been checked!)* or one or both of the sync feed capacitors C3 and C4 leaky or shorted (see Fig. 2). In later-model triode discriminators, the coupling capacitator feeding the sample pulse from the horizontal output transformer is often the offender.

If, after shorting the oscillator grid, you still do not have horizontal oscillations, you can assume that circuits before the horizontal oscillator are not affecting its operation. *Shorting this grid is a very important step in hori-*

zontal oscillator servicing because it quickly isolates trouble to either the sync or the oscillator section. A technician usually makes quick work of a repair, once he has isolated the proper stage, because it then becomes a simple matter of checking, either by instrument or substitution, to find the defective component. More time is spent by technicians in getting into the proper stage than in locating the defective part after the proper stage has been isolated.

Off-frequency oscillator

A number of troubles, other than complete loss of oscillation, can develop in horizontal oscillators. The most difficult for a technician is when the oscillator is off frequency, especially when it is off so far that not enough high voltage is developed to light the picture tube.

When it is off only a few cycles, the raster will be bright and clear and adjustments may be made. And it is easy to tell if they are made in the right direction but, when there is no raster,

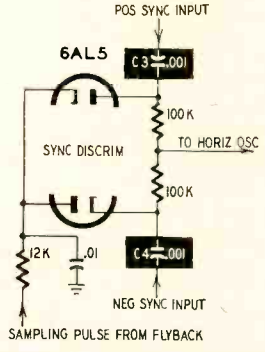


Fig. 2—Partial circuit of sync discriminator, showing sync input capacitors which often become defective.

the resourcefulness of the most ingenious technician is taxed.

An oscilloscope is about the only instrument in the average service shop that can accurately determine the frequency of whatever oscillation is present. Perhaps the most accurate way is to apply sync pulses from the station signal to the scope's horizontal input while applying the oscillator pulses to its vertical input. With care, the frequency can be determined very precisely in this manner. I, being a proponent of keeping servicing simple, choose grounding the controlled grid as being the quickest and most productive technique. After all, we are not interested in how bad the trouble is, but in how to correct the difficulty as quickly as possible.

The horizontal oscillator will operate at its natural resonant frequency with the controlled grid grounded and more often than not the cause of off-frequency operation is in the sync discriminator circuit.

If you determine that the fault is in the horizontal oscillator, a check of the component parts is next.

The best way I have ever found to check a ringing coil (see Fig. 3), short of substitution, is to short it with a jumper. Where a resistance type of horizontal hold control is used, the oscillator can often be made to lock in horizontally with the ringing coil shorted. If the oscillator can be made to lock in with the ringing coil shorted and not when the ringing coil is in the circuit, at any position of the slug, then either the coil or its associated capacitor is defective. Sometimes when the ringing coil is shorted with a jumper, the oscillator will cease functioning. If this happens, series resistor R4 is probably too small to supply sufficient

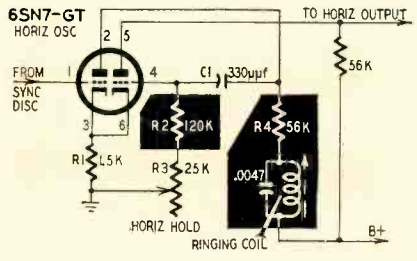


Fig. 3—Ringing coil and grid resistor in the multivibrator circuit rate careful attention.

feedback. Temporarily shunt R4 with a resistor that will bring its value down to about 10,000 ohms while this test is being made.

Frequency jumping

Many sets, especially those not having a resistance type control for horizontal frequency adjustment, are noted for taking off. (They may, during a sudden change in line voltage or in the presence of noise or even during a station break, jump to a much higher or lower frequency than 15,750.) Numerous diagonal lines appear on the screen, and the oscillator is so far off frequency that it is impossible for the sync discriminator to pull it back in. The customer usually cures this trouble temporarily by turning the set off and then turning it on again.

The cure here is to short the ringing coil with a jumper as before and, using either a resistance substitution box or a 250,000-ohm potentiometer in place of the oscillator grid resistor (R2) (see Fig. 3), vary this resistance until a picture is locked in. Remove the jumper from the ringing coil, lock the picture in with the ringing coil slug and check the value of the substituted resistance. Use this value for the permanent grid resistor. Although some engineers claim that the natural resonant frequency of the oscillator should not be exactly 15,750 cycles without the ringing coil, I have never had an oscillator take off after making the grid resistor adjustment this way.

At least two companies (Emerson and Philco) at one time or another used two potentiometers in the grid circuit for just this purpose. The ringing coil was shorted during adjustment, the main horizontal hold set to mid-range

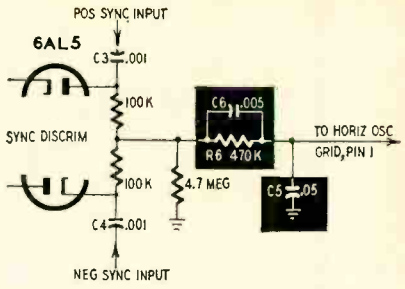


Fig. 4—The coupling network between the sync discriminator and horizontal oscillator can cause a jump in oscillator frequency.

and the auxiliary control set until the picture locked in. This in reality set the natural resonant frequency of the multivibrator. The circuit always worked well when properly adjusted. The circuit did not remain in production too long, no doubt for reasons of economy.

On occasion a piecrust or cogwheel effect is noted in the picture—vertical lines in the picture look like permanent waves. The waves may vary from a very few cycles to several hundred, depending upon the nature of the defect. This condition is often called hunting because in reality that is what the oscillator is doing—hunting for the proper frequency to lock in on according to the information of an improperly filtered sync discriminator circuit.

The condition is almost always caused by insufficient filtering at the controlled grid of the horizontal oscillator (pin 1). In the schematic (see Fig. 4) a .05-μf capacitor (C5) is used from this grid to ground. Often the filter consists of an .01-μf capacitor from grid to ground, with a 0.1- to 0.25-μf unit in series with a resistor across it. In the latter case all *three* components should be checked carefully. These filter units along with the .005-μf capacitor (C6) and 470,000-ohm resistor (R6) in parallel, tend to prevent sudden changes of sync information from controlling the oscillator instantaneously. This, among other things, improves the noise immunity of the circuit.

Numerous other troubles can occur in the horizontal oscillator circuit. Always remember that the horizontal amplifier is a direct load on the oscillator, and defects in it may cause the oscillator to stop or change frequency. I shall never forget a set in which an open cathode bypass in the horizontal amplifier caused the horizontal oscillator to operate off frequency. In another instance an out-of-town technician friend worked two days on a set only to find a partially shorted drive trimmer. Horizontal oscillators are like any other circuit—it sometimes pays to sit down and think about the problem for ten minutes instead of diving in with the side cutters. Action may speak louder than words, but does not speak louder than good common sense.

END

TV Service CLINIC

conducted by

By ROBERT G. MIDDLETON
TELEVISION CONSULTANT

I HAVE received many queries about picture-tube reactivators. The possibility of repairing an open cathode, for example, is a question in some of our readers' minds. Let's take a once-lightly-over on this subject.

An open cathode cannot be repaired unless, by tapping the tube's neck, the metal parts can be made to vibrate and contact each other, at least momentarily. However, with the heater glowing at high heat, and approximately 1,000 volts applied by the CRT reactivator (between cathode and grid), momentarily closing the circuit causes a heavy surge current. This current often "welds" the break, and restores operation of the picture tube.

Surge current from a reactivator is also used to burn out leakage resistances between tube elements. It does this just as a resistor burns out when excessive current is passed through it. A dead short, of course, cannot be burned out in this manner.

Service reactivators generally have test circuits for localizing shorts and leaks to particular elements in the picture tube. Heater–cathode shorts, both of the intermittent and permanent variety, can be easily localized with such a tester. Installing a heater isolation transformer for the picture tube permits it to remain in service.

Reactivating and curing voltages from the unit often give added life to a picture tube with failing emission. It is worth stressing that the reactivation job is more efficient when enough time is taken to cure the cathode. Electrode voltages and running periods for both reactivation and curing are given in instruction books for these units.

Finally, the unit's usefulness as a sales tool must not be overlooked. Just as the tube tester is a profitable tube merchandiser and builder of customer confidence, the CRT reactivator remove doubts from the minds of set owners and helps sell new picture tubes.

21-inch conversion?

Can a Philco model 50T1403, code 123 TV receiver be converted to use a 21FP4-A picture tube. I have a Merit HVO-7 horizontal output transformer and an MDF-70 yoke that I would like to use.—L. P. M. Somerville, Mass.

Conversion to a 21FP4-A picture tube is not impossible, but it requires such extensive electrical and mechanical changes that we cannot recommend it. Your flyback and yoke are not matching units and would not operate together satisfactorily. The vertical output transformer in the chassis will not sweep a 21FP4-A. Possibly you could sell the owner on trading the receiver in on a 21-inch set, instead of trying to convert it?

70° to 90°

We have a Techmaster 2430 chassis with a 24AP4 picture tube in the shop. The job calls for converting the chassis to operate a 90° picture tube. I will appreciate any help on this project.—R. P. C., Jr., Akron, Ohio

While a *simple* conversion from the 70° 24AP4 picture tube to a 90° 24CP4-A in a Techmaster 2430 chassis is somewhat out of the question, this is a job that can be done. Use any standard conversion units for this chassis, with a matched yoke and flyback for the 24-inch 90° tube. You will also need a new vertical output transformer to sweep the 24CP4-A tube. The necessary connections for the new flyback and yoke will be given in the conversion package. Some mechanical work will be required, but the conversion is practical.

Raster compression

An Admiral 19B1 had compression at the bottom of the raster. I repaired this by replacing C410 (see Fig. 1). Two weeks later the receiver was returned for an open CRT heater. The voltage at pin 10 of the CRT is 520 volts. The voltage called for is 470. I cannot find anything wrong in the circuits. What do you suggest?—F. J. V., New York, N. Y.

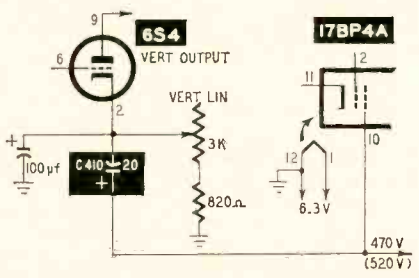


Fig. 1—A fault in capacitor C410 caused vertical compression at bottom of raster. Picture tube's heater later failed and voltage at pin 10 was high.

Compression of the raster at the bottom is often caused by cathode bypass capacitor failure, as you note. This failure would not have been connected with either the open CRT heater or the high voltage reading at pin 10 of CRT. This voltage is actually within production tolerances. We can always expect to find a variation of ±20% from the published value of a voltage in most circuits. This is because resistors, capacitors and transformers do not have exact values. They have tolerances of ±20% or ±10% in most cases. If we multiply 470 volts by 20%, we get 94 volts tolerance. Adding 470 and 94, we find that 564 volts would still be in tolerance. Thus, we can accept 520 volts as OK. As long as this higher voltage does not interfere with satisfactory CRT operation, there would be no reason to change it.

Surge current

In an Emerson 120292-P the heater of the 12BY7 video output tube lights up very bright when the set is turned on. This seems to shorten the life of the tube. I will appreciate any data on this situation.—F. P., Westfield, Mass.

There are eight heaters in series in this string. Return to the line is made through eight heaters on the other side of the heater circuit. This is a common arrangement which always results in a starting surge of current, because the cold resistance of the tubes is less than their hot resistance. Depending upon warmup times of the other heaters, any one heater may glow too bright when the receiver is warming up. High line voltage aggravates the situation. The value of the series heater dropping resistor (43 ohms, 20 watts) should be sufficient, when hot, to make the heater voltages normal. This should be checked. Always use a Globar type resistor. Better control can be obtained by using a Surgistor type of limiter. This is more expensive, but it holds the surge current to a lower value than other resistor arrangements.

Shattered safety glass

On a Du Mont RA-350, the protective glass shattered into a mass of fragments. This happened early in the morning when the set had not been in use for some time. Is there a definite explanation for this?—J. F., New York, N. Y.

While the report does not state the exact circumstances of the shattering, this sounds like one of the rare failures resulting from excessive internal stresses in the glass. It is quite easy to produce glass which has high internal stresses and which will shatter itself due to a minor fault such as a scratch in a critical place. Of course, in manufacturing protective glass, this

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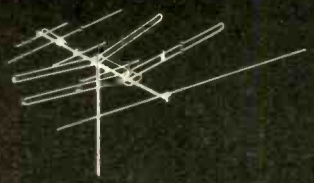

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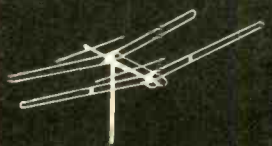

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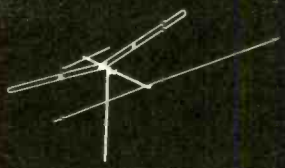

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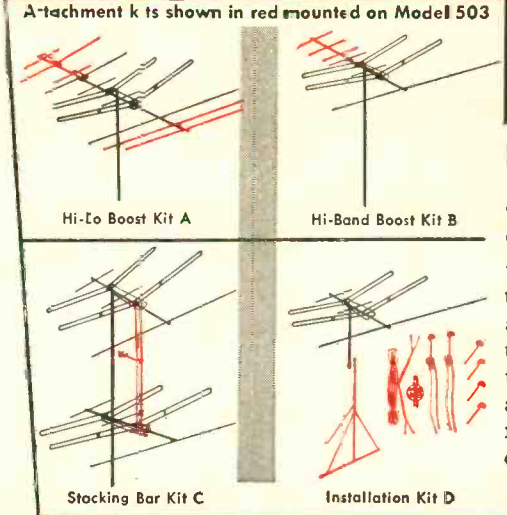

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TELEVISION

situation is avoided and internal stresses are reduced to the practical minimum. If something goes wrong in the control processes, we can end up with a sheet which has stresses higher than normal. Sometimes a very small crack will start growing and eventually spread very rapidly, resulting in shattering. It is unlikely that you will run into a fault of this kind again, as it is quite rare.

FM tuner from RA-103

We have a Du Mont RA-103 and would like to eliminate the video section and use the FM tuner only. The problem is that the chassis does not have the usual 4.5-mc sound takeoff. (See Fig. 2.) Where can the sound signal be obtained?—J. P., New York, N. Y.

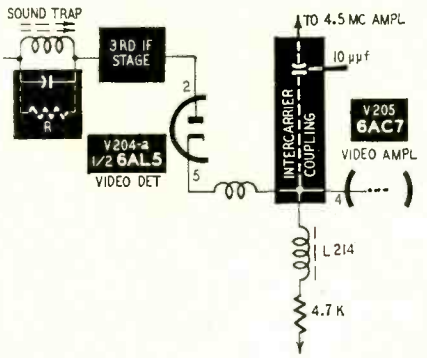

Fig. 2—Intercarrier sound can be obtained at pin 4 of V205. Resistor R can be added to lessen sound trapping.

The Du Mont RA-103 is a split-sound receiver. That is, the sound is taken off at the end of the 23-mc if passband. This type of receiver is becoming quite rare. However, a 4.5-mc sound signal is present at the output of the picture detector. You can couple into the picture detector output circuit at pin 4 of V205 with a small capacitor, about 10 μf. This will drive a 4.5-mc amplifier and a ratio detector followed by an audio amplifier. If the sound signal is a little weak, you may wish to reduce the Q of the sound trap by shunting it with a resistor. Select a value that places the dip of the sound trap about 10% up on the if response curve. If it is placed too high, you will get intercarrier buzz in the sound.

Reduced width

A Westinghouse No. 2171C lacks about 1 inch width on the right-hand side of the screen. Everything checked out, so I resorted to the standard width-producing procedures such as shunting the width coil with a capacitor, removing the width coil, raising the screen voltage to the horizontal output tube or the plate voltage to the horizontal oscillator tube. The changes cause less width, instead of more.—H. L. W., Fort Worth, Tex.

Use a wide-band scope to check for high-frequency oscillation in the damper or horizontal output circuit. If present, the oscillation has been set up by

a component failure. We suggest that you check for leaky capacitors, especially the coupling capacitor to the grid of the horizontal output tube. Also check the grid resistor. If you need to go farther, check the yoke and flyback transformer for leakage between windings.

Vertical roll

A short while after a G-E 12C101 is turned on, the picture rolls slowly upward. The hold control will stop the rolling for a while, after which the picture starts rolling again. Finally, the hold control is no longer able to stop the rolling.—P. Z., Wallingford, Conn.

Because the picture rolls upward, it indicates that the vertical sync pulse is not arriving (or arrives very weak) at the control grid of the vertical sweep oscillator. This is a rather easy job for a scope and low-capacitance probe. Check back from the grid of the sweep oscillator toward the sync takeoff point. You will be able to localize the faulty component quickly. Be sure that you do not confuse the kickback waveform from the vertical oscillator with the vertical sync pulse. If in doubt, disable the oscillator while you are signal tracing. Unless a scope is used, it can be a tedious job to locate the fault in a case like this.

No grid voltage

I find the Clinic very helpful, and would like to ask about a Sparton 5272. The horizontal oscillator is working, and supplies correct drive. But there is no grid voltage on the horizontal output stage. There should be —9 volts according to the service notes. There is grid voltage for a few seconds when the receiver is first turned on, but it soon falls to zero.—E. F., Santa Barbara, Calif.

With drive present, lack of dc bias at the grid of the output stage shows that grid current cannot flow. This is probably caused by an open cathode circuit. The brief appearance of grid voltage is due to capacitor charge-up when the receiver is turned on. Check the cathode return for an open circuit, and you will have the set working in a very short time.

Dark picture

In a Hallicrafter 820 the screen goes dark on the right side when the brilliance or contrast control is backed off. Where do I start looking for the source of the trouble?—W. E. B., Atlanta, Ga.

This is one of those jobs which calls for a scope. Check at the input of the picture tube and you will find a sawtooth wave along with the video signal. This is a spurious voltage which is getting to the picture-tube input because of failing decoupling action. The scope will lead you to the point of entry of the sawtooth voltage. Repair the decoupling circuit and you will be back in business. END

Superior's New Model TW-11 STANDARD PROFESSIONAL

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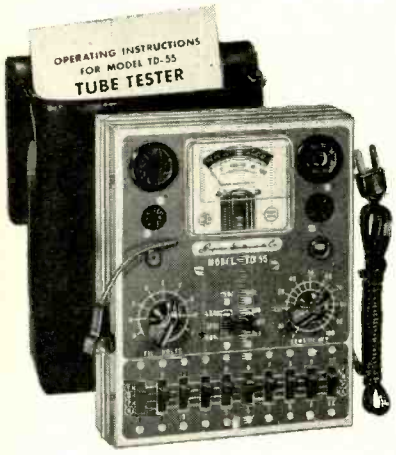

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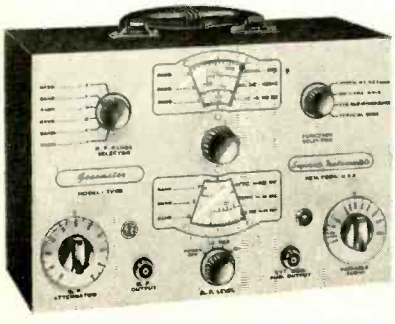

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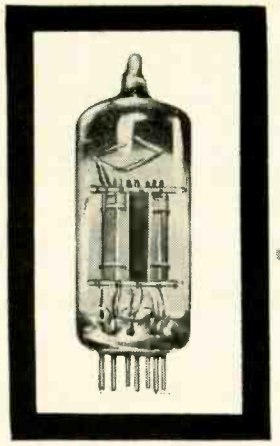


The '6BU8 can be used as agc amplifier, sync separator and noise gate simultaneously

By FRANK HADRICK *

NEW TV TUBE DOES 3 JOBS

UNDOUBTEDLY, many service technicians have noticed a new tube acting as agc amplifier, sync separator and noise gate in some TV receivers. The tube is the 3, 4, or 6BU8, designed specifically for these combined operations. The 3 and 4BU8's are used in series-string heater sets and the 6BU8 in parallel strings. Except for heater ratings, the tubes are identical.

The '6BU8 is a sharp-cutoff dual pentode with separate plates and suppressor grids. The cathode, control grid and screen grid are common to both sections. Fig. 1 is a cross-section view of the tube, showing its internal construction.

A simplified circuit diagram using this new tube is shown in Fig. 2. For easy explanation we will consider the tube as having two separate sections, with one section (V1) acting as the agc amplifier and the other (V2) as the sync separator and noise gate.

Agc circuit

V1's circuit in Fig. 2 is that of a gated agc system, where a positive pulse of approximately 400–600 volts is coupled to its plate. However, the tube is also used in nongated agc systems.

V1's suppressor grid is supplied with a composite video signal (with positive-going sync) from the output of the video amplifier through an isolating network. The pulsed plate voltage is developed during the horizontal retrace interval and is taken from a winding on the horizontal flyback transformer. It is coupled to V1's plate through capacitor C1 in Fig. 2.

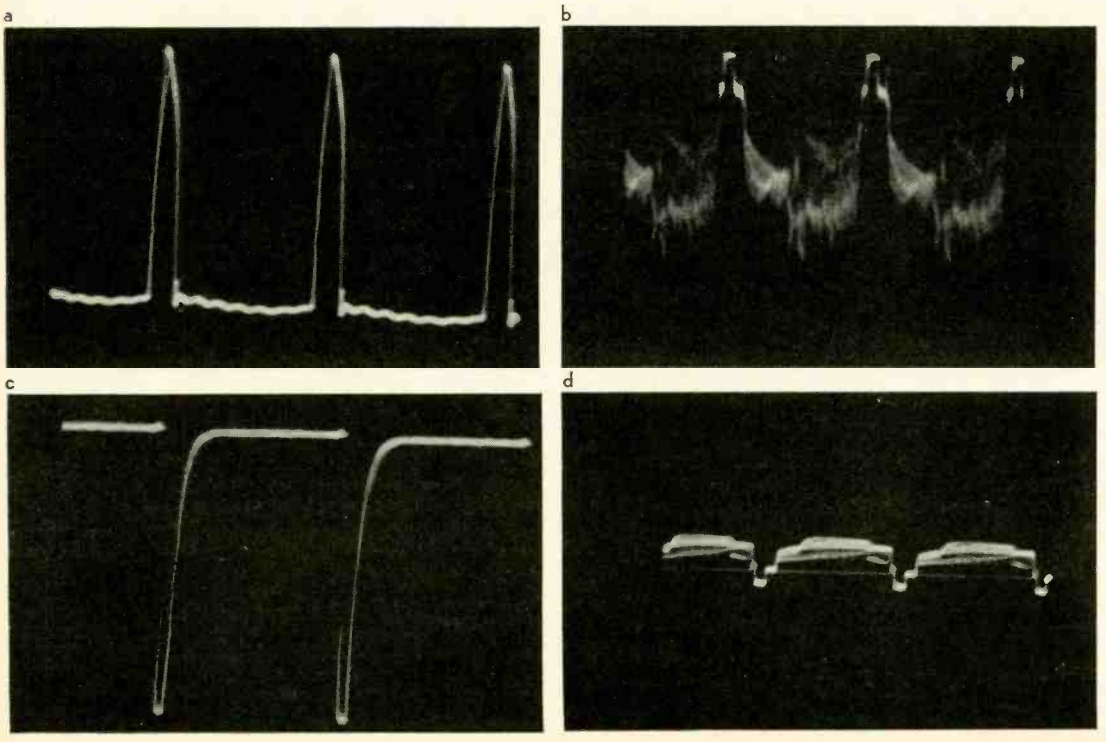
Since the plate voltage is pulsed, V1 conducts only during the horizontal sync-pulse interval. The magnitude of plate-current conduction during this period is determined by the transmitted sync-pulse level. Thus, this level determines the agc voltage. Since the transmitted sync pulse is at a constant level with respect to the transmitted carrier, it is always used to determine the amount of agc bias voltage in gated systems. (If agc bias were determined by the average level of the composite video signal, it would vary with changes in the average picture brightness.)

The automatic operating point of the gated agc system is determined by a control (R5) in the control-grid circuit. Bias voltage applied to this grid also influences plate-current flow. The control acts as an agc threshold adjustment, applying a delay voltage to the control grid.

When V1 conducts, capacitor C1 charges in accordance with the polarities indicated. The amount of negative charge on C1 determines the maximum agc bias available. The capacitor discharges between pulses, through components in V1's plate circuit. The dividing networks supply a delayed agc bias to the rf amplifier. The if amplifier agc bias is applied to all but the last if stage. If this stage were agc-biased, excessive signal attenuation and possibly if distortion could result.

The amount of delayed agc voltage is partially determined by resistor R1. It is connected to B-plus and applies a small positive voltage (1 or 2 volts) to the rf agc bus. This voltage cancels

* Chief field engineer, Simpson Electric Co.



Waveforms at various points in Fig. 2: a—At the agc winding on the flyback transformer; b—Signal from the video amplifier's plate applied to the suppressors of the '6BU8; c—'6BU8 output to horizontal afc and vertical intergrator circuits; d—Output from video amplifier grid applied to the '6BU8 control grid.

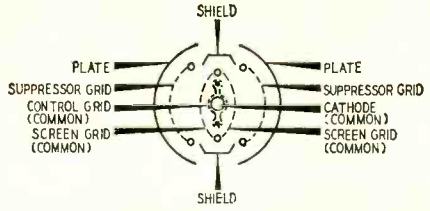


Fig. 1—Cross-section view of the tube's internal construction.

part of the normal age voltage, resulting in less age bias for the rf amplifier than for the if amplifiers. This delay lessens picture snow in weak-signal areas and effectively optimizes the rf amplifier's noise factor for all signal strengths.

Sync separation

V2 takes care of sync separation in the usual manner. However, the composite video signal (positive-going) from the video amplifier is coupled to the suppressor grid of this tube rather than the control grid. As the suppressor is acting as a control grid, in this instance, it can be treated as such.

Suppressor bias is determined by resistor R4 and capacitor C3. Only the positive sync pulses (above cutoff level) cause V2 to conduct. Only negative sync pulses appear at V2's plate, which is coupled to the sweep circuits. Typical voltage waveforms, appearing at the tube elements, are shown in the photos.

Noise limiting

The noise gate prevents transient pulses (noise) from entering the sync circuits and triggering the vertical and horizontal oscillators. This is done by coupling the low-level composite video signal (negative-going) from the video detector (or video amplifier grid) to the control grid. Since the control grid is common to both sections, any voltage change on this grid influences current flow through both sections.

This signal is smaller than and 180° out of phase with the signals on the suppressor grids. The signal on the control grid and the voltage applied or controlled by resistor R5 determines the bias voltage. Normal adjustment of control R5 is such that the sync pulse tips are near the tube's cutoff level. Thus, any pulse greater than the amplitude of the sync pulses cuts the tube off. If a noise pulse is superimposed on the sync pulse, circuit action eliminates the sync pulse and one charge cycle of capacitor C1. When sync pulses are lost in this manner, the flywheel effect of the oscillators holds them synchronized until the next noise-free pulse arrives. Noise pulses are usually at random frequencies and, therefore, never appear on more than a few sync pulses during any brief time interval.

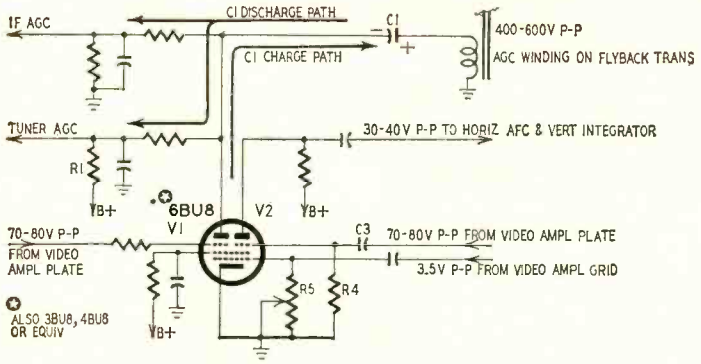


Fig. 2—Typical circuit using the multipurpose 'BU8.

Troubleshooting

The use of an oscilloscope is apparent from the number of different waveforms appearing at this tube. Peak-to-peak signal voltage measurements become very important, but are not exceptionally critical under strong signal conditions. The pulse on V1's plate, for example, can be lower than required by as much as 100 volts or more and would cause only a negligible change in the amount of charge on capacitor C1. However, a 20% or 25% decrease in amplitude of the sync pulse could easily cause erratic or weak synchronization.

A fault in the age filtering circuit (open filter capacitor, for example) could cause a high-amplitude sawtooth voltage to appear in the video circuits. This is easily detected by checking the age bus for this waveform. If a threshold control (such as resistor R5) is in the circuit, it is usually (if not always) adjusted for a satisfactory picture rather than by a voltage check. Since signal and noise levels have almost infinite variations, the control is often set at a compromise adjustment for the particular area by the service technician. Misadjustment can often cause snowy, washed-out or distorted pictures as well as excessive contrast or sync instability. In any event, the set manufacturer's instructions should be followed.

END

APOSTROPHE TO AN INTERMITTENT

By JACK DARR

OH, THOU innocuous-seeming TV receiver, with thy shining screen and crisp picture. Thou playest beautifully whilst in my shop, with never a sign of trouble or defect. Yet, when returned to the bosom of thy family, thou cuttest out immediately I leave the premises.

Yea, though thy picture is clear and thy sound pure hi-fi whilst I check upon thee, let me but turn my back and thou breakest into oscillation, or cuttest off thy sound, or thy picture vanishest without trace.

Thus thy owner waxeth exceeding wroth, and heapeth abuse upon mine innocent head.

Loudly doth he claim to have been bilked in the moneys he hath expended with me.

Exceeding doubt doth he cast upon both mine integrity and technical skill: he voweth to blacken my name and reputation among his clan and all his associates from this day henceforward.

If perchance I am granted another trial of wits with thee, both loudly and clear doth thou operate, when returned to mine bench amongst mine instruments. For hours on end dost thou play, and never a jitter or smear beclouds thy shining screen. Yet am I a-certain that art thou taken home again, thou wilt play no more, but fizz and sputter like unto a demented tom-cat, while imitation lightning flashest across thy screen.

Yea, though I test thy voltage and resistance with all my skill, thou hidest thy defect from me. Familiar unto me like the hairs on the back of mine own hand are the convolutions of thy schematic: thy parts layout is like unto mine own backyard. Thy circuits and components are engraved deep into my brain from my constant study. Thy tubes have I tested often; thy parts values measured daily. Thy switch contacts I have burnished with loving care, as they were a King's Jewels.

Thou makest me to toss and turn upon my pillow at night while sweet sleep eludeth me. Thy circuitry flasheth before my closed eyes. Each dawn I rise with furrowed brow and steely ey'n, full certain that thy basic fault hath been mystic revealed to me in my dreams. Each day I test thee, only to find that the idea is true dream-stuff: gossamer and ectoplasm, holding true only until the sleeper waketh.

Verily, the time I have wasted upon thee, if gainfully used, would cause me to rise another bracket in the estimates of the Internal Revenue Service.

Mine hair groweth white and falleth out in thy service: mine eyes grow bloodshot and my brow developeth a permanent wrinkle. Full many a gallon of coffee and carton of cigarettes have I consumed in my fruitless labours upon thee. Lo, mine ulcers grow apace, and my digestion hath long since ceased its appointed function.

I say unto thee, goodness and mercy are not in thee, nor in the adamant heart of thy designer, upon whom the curse of Eblis; may djinns and afreets fly away with him.

I have beat upon thee with hammers; smote thee sore with rubber mallets. Thy chassis have I jarred and jolted, even unto the ultimate 'drop-test', so that I blenched and trembled, for fear thy C-R tube would shatter. Through this ordeal thou didst play on calmly and perfectly, with never a crack or sputter to mar the polished perfection of thy performance.

Thy line voltage have I altered: from the lowest to the highest have I ranged thee, with never a fault. With my wife's filched hair dryer, with warmed air have I bathed thee; even unto the deep-freeze have I thought of stuffing thee. Thy printed circuits have I resoldered amain; thy transformers have I checked and thy capacitors and resistors pecked. Thy wiring has been pulled and twisted, and thy plugs abused most untowardly.

Full quarts of contact cleaner have I lavished upon thee, so that thou didst smell like unto nothing on this Earth. Thou hast caused even me to doubt mine own hard-won technical skill, so that I did meditate apace upon the advantages of raising rhubarb.

Yea, though thou sittest upon the end of my bench and playest up a storm, deep in my heart I knew that thou art not yet healed: and dare I to return thee to thy importunate owner, thou wilst promptly fail again, certes in the midst of his favorite program. Thou hast caused me to walk through doubt and bewilderment: trouble and sorrow shall follow me all the days of my life, and thou shalt sit on the end of my bench forever! SELAH

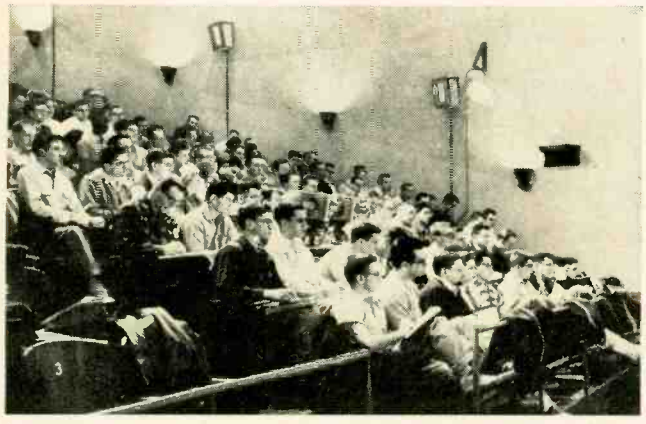
"Looks to me like either a bad short or a capacitor on the blink!"

Closed Circuit TV...at Penn State

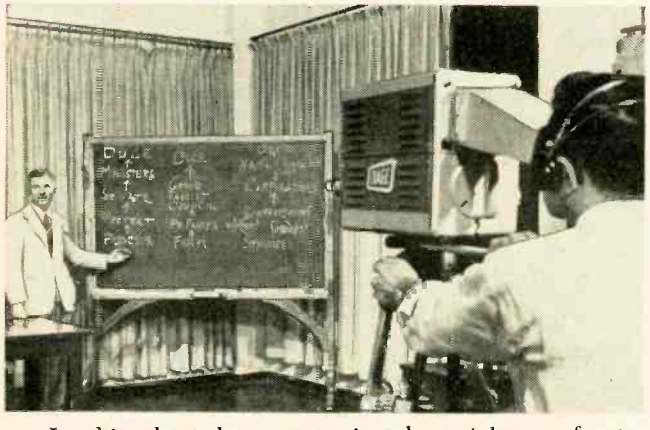
Institutions of higher education have been confronted with the problems of large enrollment and a shortage of instructors. They have been experimenting with closed circuit television as one method of solving these problems. Here is the result of this experimentation at Pennsylvania State University.

Thirty-nine Westinghouse 24-inch classroom receivers and two 21-inch monitors are in use. This makes it possible for one teacher to instruct a group of 1,000 students.

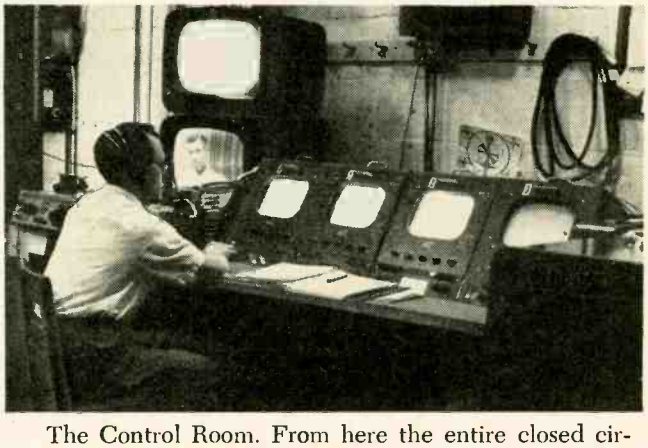
Photographs courtesy TV-Radio Division, Westinghouse Electric Corp.



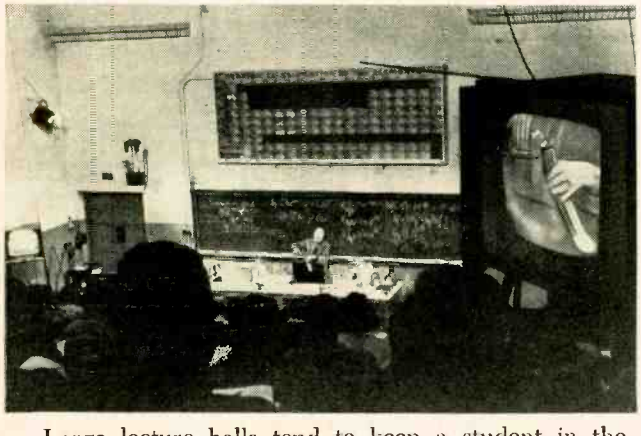
Here is a television equipped lecture room. The two TV cameras are located in the center of the class. There are approximately 150 students present with an equal number distributed among five smaller rooms equipped with television receivers.



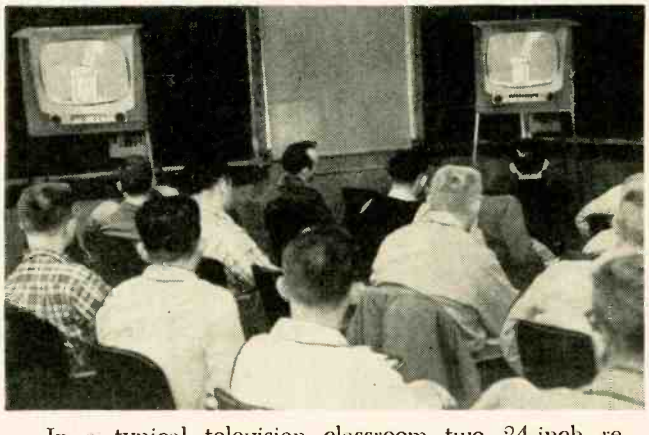
In this class the camera is taken right up front, enabling students in other classrooms to see and hear everything that occurs. With this system the only limit on the size of a class is the number of rooms equipped with television receivers.



The Control Room. From here the entire closed circuit is operated. The strength of the signal is regulated and the program is monitored and distributed to receivers in classrooms throughout the university. One man operates the control room.



Large lecture halls tend to keep a student in the back rows from getting a clear picture of the activity. Here TV receivers mounted in various parts of the hall gives every member of the class in any part of the room a front-row seat.



In a typical television classroom two 24-inch receivers are used for a group of 50 students. The sets are placed on metal stands so everyone in the room has a clear view. Above the screens are hinged flaps to exclude extraneous light.

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- Latest Time-Saving Printed Circuit Design
- Flywheel Tuning
- Automatic Frequency Control
- 2.5 μv FM Sensitivity
- True High Fidelity Response
- Beautiful Custom-Styled "Space Saver" Case

The best-looking, best-performing FM-AM tuner kit your money can buy! Carefully designed for quick, easy construction—a tuner you'll enjoy assembling and be proud to own, both for its amazing musical performance and outstanding beauty. Covers the full AM broadcast band and 88 to 108 mc FM. On FM, *sensitivity is a remarkable 2.5 microvolts for 20 db of quieting;* hum and noise, —60 db; IF bandwidth, 200 kc at 50% down on curve; response, ± 0.5 db, 20-20,000 cps. On AM, *sensitivity is 3 microvolts for 10 db signal-to-noise ratio;* IF bandwidth, 8 kc at 50% down on curve; response, 20-8000 cps. Outstanding features include: Inertia Flywheel Tuning for effortless, accurate tuning; Automatic Frequency Control (plus AFC disabling) to "lock-in" FM stations; printed circuit board (with most of the kit wiring already done for you) assures time-saving, error-free assembly; pre-aligned RF and IF coils; tuned RF stage on FM; drift-compensated oscillator; neon glow tuning pointer; cathode follower output; two output jacks—one for recorder, one for amplifier; rotatable built-in ferrite antenna for AM. Includes beautiful French-gray case with chrome-finished tapered feet, 4 x 13 x 8". Ideal for use with 18, 20 or 30 watt KNIGHT-KIT amplifiers. Ready for easy assembly. Shpg. wt., 12 lbs.

Model Y-787. FM-AM Tuner Kit. Net only..... **$49.95**

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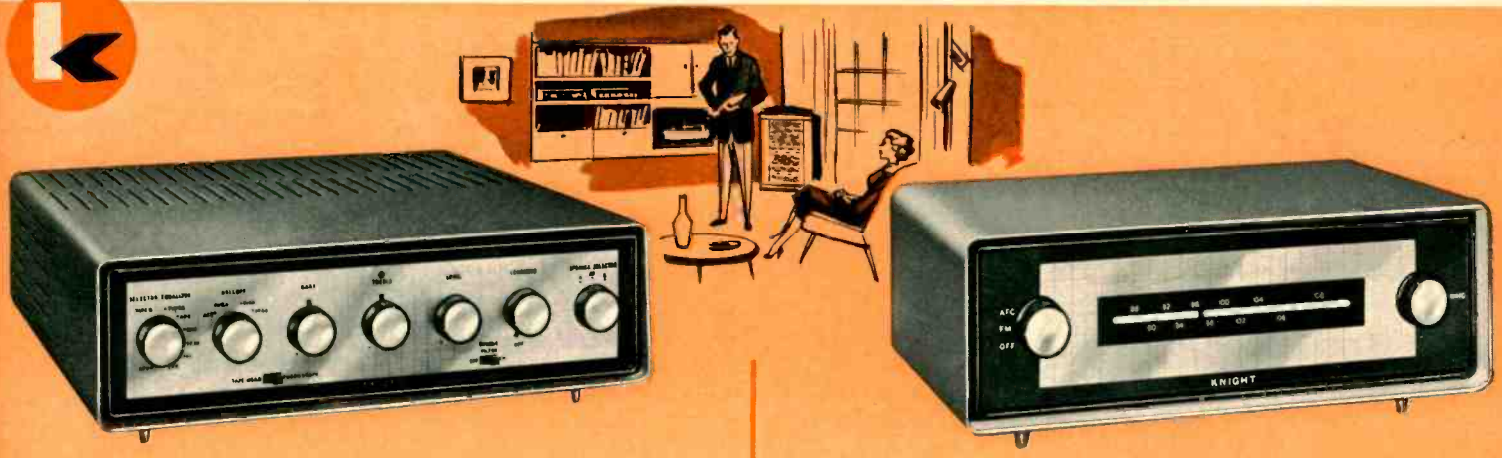

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Here is top value in creative engineering, impressive hi-fi performance and distinctive design—a tuner you'll be proud to build and own. Covers the full FM band, 88 to 108 mc. Features Automatic Frequency Control (with disabling feature) to "lock-in" 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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- Easy to Assemble—Top Hi-Fi Quality
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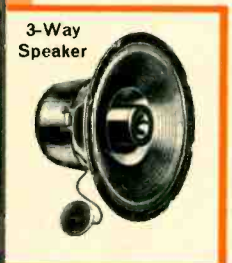
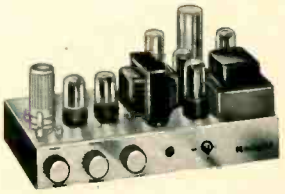


Deluxe quality high fidelity speaker system at a money-saving low price. Easy to assemble—all you need is a screwdriver. System includes KNIGHT "Quik-Craft" corner-type folded-horn enclosure kit, and the famous-value KNIGHT 3-Way 12-inch speaker. Just assemble the enclosure—*no finishing required*—all surfaces are finished in hand-rubbed Korina blonde, mahogany or walnut. The speaker is the new 3-way type: 12" woofer cone for bass (full 1¾ pound woofer magnet), conical radiator for mid-frequencies, built-in compression-type tweeter (with wired level control and calibrated dial) for highest frequencies. Unexcelled enclosure efficiency and superb speaker performance combine to cover the whole spectrum of audible sound for true hi-fi response from 35 to 15,000 cps, ± 3 db. Kit includes 12" 3-Way speaker, prefinished enclosure panels, grille cloth, hardware and instructions. *Specify Korina blonde, mahogany or walnut when ordering.* Shpg. wt., 44 lbs.

Model Y-937. 3-Way Speaker System Kit. Net only.....**$89.50**



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Y-753

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$2.35 down

Low-cost, authentic hi-fi amplifier. Response, ± 1 db, 30-20,000 cps. Input for crystal phono or tuner; chrome-plated chassis is punched for preamp kit below, to permit use of magnetic phono. Only 0.5 volt drives amplifier to full output. Separate bass and treble controls. Only 1% harmonic distortion. Matches 8-ohm speaker. 7 x 13 x 6". With all parts, tubes and instructions. Shpg. wt., 13 lbs.

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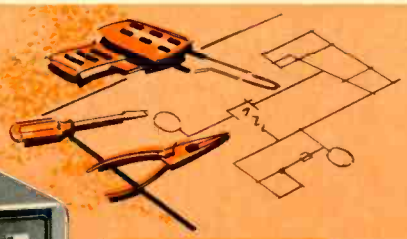

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Sensational Hi-Fi design at amazing low cost. Provides precise record equalization guaranteed within ½ db of recommended accuracy!—more accurate than all but the most expensive factory-built preamps. Includes exclusive new KNIGHT-KIT printed circuit switches for easy, error-free assembly; 2 printed circuit boards eliminate all other wiring, except for power supply and control leads—so easy to build. Has built-in power supply, includes premium 12AY7 and ECC82 tubes. Frequency response, ± 0.5 db, 10-50,000 cps. Has 8 inputs: Tape Head; G.E. Phono; Pickering Phono; Ceramic; Microphone; Auxiliary; Tape Preamp; Tuner. Level adjustment for tuner input. Includes separate Bass and Treble controls; separate Level and Loudness controls; Rumble Filter switch; DC on all tube filaments; cathode follower output; 2 extra AC outlets. You get every advanced hi-fi feature in this easy-to-build preamplifier at the lowest possible cost. Includes beautiful custom-styled French-gray case, with tapered chrome-finished legs, 4 x 13 x 8". With all parts, tubes, step-by-step instructions; ready for easy assembly. Shpg. wt., 12½ lbs.

Model Y-754. Hi-Fi Preamp Kit. Net only..... **$39.95**

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- Printed Circuit Wiring Board
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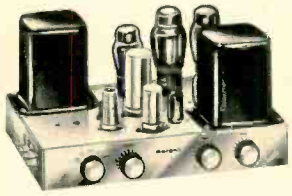
- Williamson-Type Circuit with Over 25 Watts Output

Here's superb Hi-Fi performance at less than half the cost of a comparable commercially-assembled unit. Williamson-type linear-deluxe circuit delivers over 25 watts of virtually undistorted reproduction. Ideal for use with the KNIGHT-KIT preamp at left. Includes printed circuit board for simplified, error-free assembly. Remarkable hi-fi response, ± 0.5 db, 10-120,000 cps at 20 watts. Harmonic distortion, 0.15% at 30 watts; IM, 0.4% at 20 watts. Hum level, 85 db below 25 watts output. Output impedances, 4, 8 and 16 ohms; output tubes, 2-5881. Includes balance control for precise matching of the output tubes; variable damping control for maximum performance with any speaker system—prevents low-frequency distortion from overdamping or underdamping. Very attractive black and chrome styling, 6¼ x 14 x 9". An outstanding engineering achievement in a basic hi-fi amplifier, delivering performance equal to the finest commercially assembled units. Includes all parts and tubes; with step-by-step instructions, ready for easy assembly. Shpg wt., 25 lbs.

Model Y-755. 25-Watt Amplifier Kit. Net only..... **$44.50**
Y-759. Metal Cover for above; black finish. 5 lbs. Net..... **$4.25**



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Y-750
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- With 16 Filament Voltages
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Chromatic single-gun color TV tube which has 1,000 fine color lines on its screen is pointed out by Paul Raibourn, chairman of Chromatic Television Labs.

COLOR SELECTION with the CHROMOTRON TUBE

Recent information on the principles and circuitry of the one-gun three-color Lawrence tube.

By LLOYD W. ALLEN*

THE color selection, or chrominance system, is the heart of the color television receiver. Many systems are in use at present and it is safe to predict that many more will be developed in the not-too-distant future, each resulting in savings in cost or space, or in an improved picture.

One of the promising developments in color television is the Chromatron picture tube which is the basis of color TV sets now being developed by Du Mont. The Chromatron (also called the Lawrence tube after its inventor) uses only a single electron gun but, because it also contains special beam-deflecting grids, it produces either color or monochrome pictures from the compatible NTSC color signal. Since some of the color decoding is done by the Chromatron tube itself the circuitry is simpler than in other types of color TV systems. For example, a complete color receiver containing only 22 tubes has been built around the Chromatron tube. This represents a reduction of about 20% in the number of tubes, as compared to other types of color receivers.

Simpler circuitry is one of the advantages of the Chromatron tube; a second is increased color brightness. The increased brightness is due to the relatively low interception of beam electrons by the deflection grid. Most of the beam (85%) passes through the deflection grid wires and reaches the phosphor screen anode. In some types of picture tubes as little as 13% of the beam current arrives at the anode.

What gives the Chromatron its important characteristics? Two factors must be examined for the answer to this question: the structures within the tube, and the color-selection circuit used with it. Let us first examine the tube structure.

Inside the tube

The tube uses many conventional parts: the single electron gun, the control grid or grids and the focusing and deflection means are all standard. The unique structures within the tube are close to the tube face. Fig. 1 shows a small section of the phosphor screen. It is composed of horizontal phosphor strips, .012 inch wide. The sequence of phosphor colors is red, green, blue, green, red, green, blue, etc.; a green strip is placed between each alternate red and blue strip. The deflection grids are placed about ⅞ inch behind and parallel to the phosphor screen. The grid wires are spaced so that a wire is aligned over each of the red strips, and similarly a wire is aligned over each of the blue strips. There are no wires over the green strips. Adjacent wires are spaced about 0.36 inch apart, on the average.

All the wires over the red strips are connected to a feedthrough electrode on the tube envelope. The grid formed in this manner is known as the red deflection grid. Similarly, the wires over the blue strips are connected to another feedthrough electrode; these wires form the blue deflection grid.

* Consulting engineer. Associated with Heald's Engineering College, San Francisco, Calif.

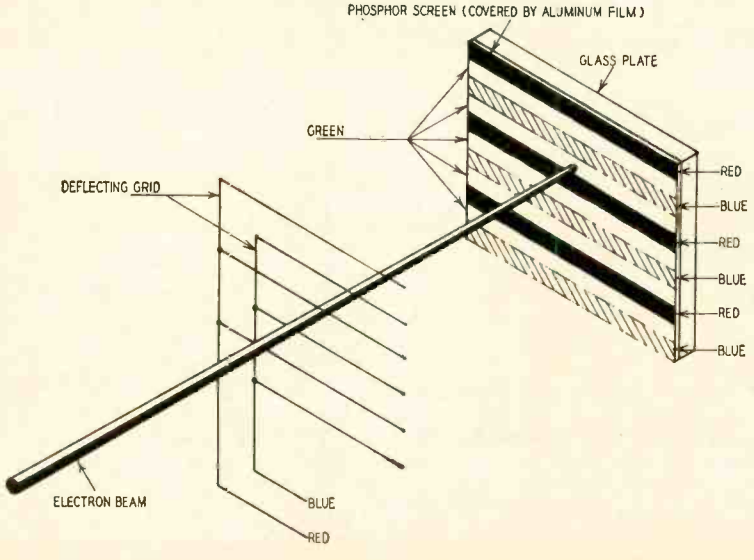

Fig. 1—Section of phosphor screen. Phosphors are narrow, horizontal strips.

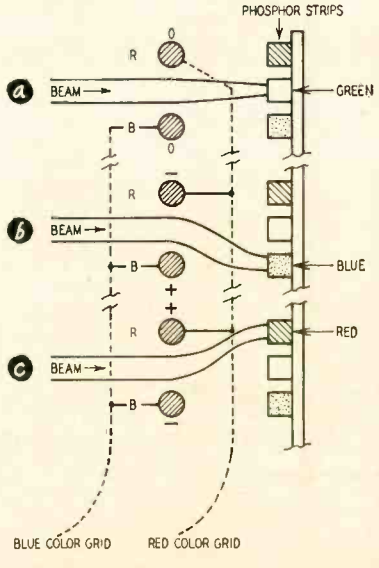

Fig. 2—How color strips are energized: a—green; b—blue; c—red.

TELEVISION

The electron beam is directed between adjacent wires of the two deflection grids and is swept horizontally the length of the wires, in the same direction that the phosphor strips and grid wires run. The red and blue deflection grids have a positive bias with 7,000 volts dc. The phosphor screen anode operates at 25,000 volts dc. When the red and blue grids are at the same potential, the electron beam passes between the two grids and strikes the screen phosphor strip (see Fig. 2-a).

The beam is focused into a wedge shape by the electrostatic field formed between the wires operating at 7,000 and the anode screen at 25,000 volts, and is therefore smaller in cross-section and elongated at the point where it impinges on the screen than at the point where it passes through the grid wires. If the blue grid is now made 300 volts more positive than the red grid (by making the total voltage on the blue grid 7,150 while making the total voltage on the red grid 6,850), the electrostatic fields between the grids will be changed so that the electron beam will be deflected to strike the blue phosphor strip. This condition is shown in Fig. 2-b. If the red grid is made 300 volts more positive than the blue grid, so that the total voltages on the two grids are reversed, the electron beam is deflected to the red phosphor strip, as shown in Fig. 2-c. In present practice, a 300-volt peak-value sine wave is applied between the red and blue grids. This is the color-selector signal. How it is formed is explained later.

The result of the combination of the color-selector and sweep signals can be readily visualized. The beam sweeps steadily along a horizontal path between a red and a blue grid wire, while the tip of the beam (remember that the red and blue grids are only ⅞ inch from the anode) oscillates vertically at high speed across the red, green and blue phosphor strips. The tip of the beam traces the color-scan path along the phosphor strips. Fig. 3 shows a view of the color-scan path. The shape of the path is approximately sinusoidal because the color-selector signal which generated the path is also sinusoidal. The action of the electron beam is similar to the action generated by extending your arm and sweeping it horizontally while wiggling the tip of the index finger rapidly up and down.

Since the joint action of the sweep and color-selector signals would cause all colors on the screen to be excited, it is necessary to regulate the magnitude of the beam current to control color selection. Current practice with the Chromatron uses two separate controls for the beam current. One regulates current magnitude and therefore controls color saturation. The other gates current magnitude and controls color sequence. Beam-current magnitude is controlled by applying the composite video signal to the first grid of the Chromatron. Color saturation is thus made proportional to the amplitude of the composite video signal.

Gating is the second way to control the beam and can be explained by reference to Fig. 3 and to the nature of the NTSC color signal. If the second grid of the Chromatron tube (or alternately the cathode) has a separate gating signal applied to allow electrons to flow in the beam only when the beam is directly over each of the three color phosphor strips, then one or more colors may be cut off at will by cutting off the gate at the time the electron beam would be focused on the corresponding strip.

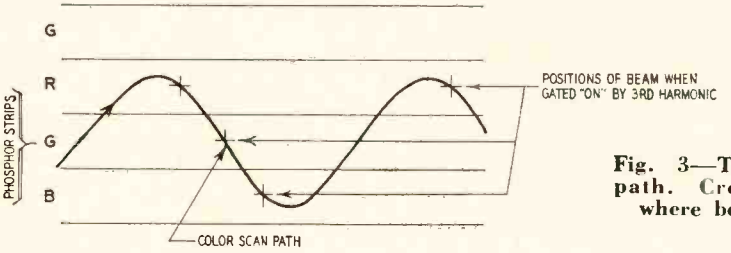

Fig. 3—The color scan path. Crosses indicate where beam is gated.

Why gating?

The beam must be gated in this manner because the sequence of colors produced by an ungated beam is different from the sequence of color information in the NTSC signal. From Fig. 3, it is clear that the ungated sequence of colors on the tube screen is RGBGRG. . . while in the NTSC signal the sequence of color information is RGBRGB. . .

The color sequence appearing on the tube screen can be changed to match the NTSC sequence by eliminating every other green signal in the tube sequence—RGB(G)RGB(G)R . . . The gate signal is used to eliminate the alternate green signals (shown in parentheses) but another problem is created —how to make the tube color sequence occur at the same time as the corresponding sequence of color information in the NTSC signal.

A neat solution to this problem has been worked out by the engineers of Chromatic Television Laboratories, designers of the Chromatron. If a single cycle of the sine wave is divided into thirds, the one-third points can be made to occur at 0°, 120°, 240° and again at 360°, which is also 0° of the following cycle. Fig. 3 shows crosses superimposed on the sine wave that the beam describes on the phosphor strips; the crosses correspond to the one-third points described above. The third points occur at the locations on the strips necessary to form the desired color sequence of RGBRGB . . . and are also spaced equally in time, which syn-

chronizes the tube color approximately with the NTSC color information.

It is necessary to gate the beam on at the one-third points and off at other points. This is done by using the third harmonic of the 3.58-mc color subcarrier as the gating signal.

The color subcarrier is in phase with the color-scan signal to which we have already referred. The desired relation of the color-scan signal, its third harmonic and the resultant gated-beam signal is shown in Fig. 4. Fig. 4-a shows a cycle of the color-scan (color subcarrier) signal, with the one-third points indicated by vertical lines. Fig. 4-b shows the third harmonic of the color-scan signal, synchronized so that a maximum point of the third harmonic corresponds to the zero point of the color-scan signal. Successive maxima of the third harmonic occur at 0°, 120°, 240° and 360°, which are the points at which the beam must be gated on.

By applying the third harmonic to the second grid of the Chromatron and by biasing the signal so that current in the beam flows only during a short time on each side of the maximum points of the signal, the desired gating can be achieved; the resultant gated-beam current is shown in Fig. 4-c. The gated-beam current causes color to be synchronized with the NTSC color information. The sync is not perfect since the NTSC signal does not have equal phase intervals between color signals, but has phase intervals of 116° between red and blue and 137° between green and red. The agreement with the 120° phase interval of the gated beam is close enough, however, to allow compensation for the disagreement by any of a number of ways, such as distorting the color-scan signal and using unequal spacing of the phosphor strips. The gating signal is not used to determine color saturation since this is determined by the composite video signal which is applied to grid 1. The gating signal determines which of the three primary colors the composite video signal applies at any given instant.

Switcher and tripler

The circuit used for generating the color-scan and gating signals is shown in Fig. 5. It is called the color switcher and tripler circuit. The input signal,

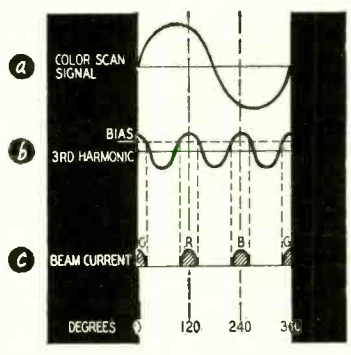

Fig. 4—The relationship between the color scan signal: (*a*), its third harmonic (*b*) and the resultant gated-beam signal (*c*).

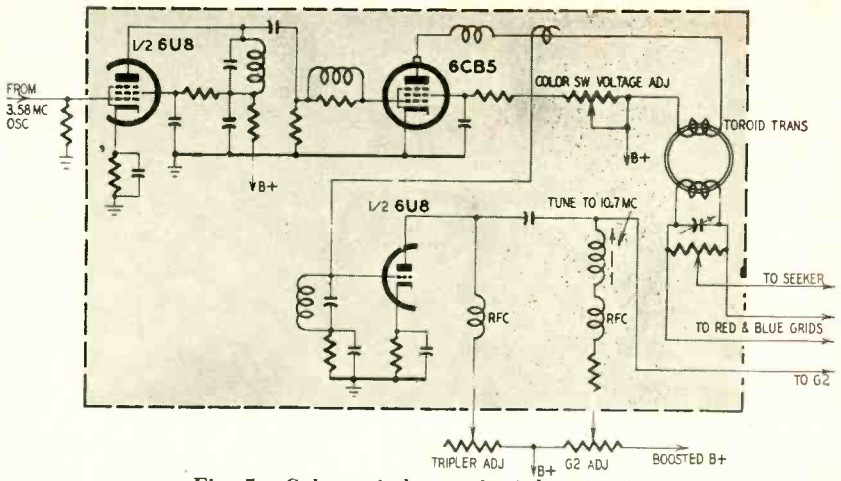

Fig. 5—Color switcher and tripler circuit.

which is the NTSC color subcarrier of 3.58 mc, is applied to the grid of the 6U8's pentode section. This tube drives a 6CB5 as a class-C amplifier. The amplified 3.58-mc signal is coupled to the red and the blue deflection grids through a toroid transformer.

The toroidal transformer has three functions. It couples the 6CB5 to the load; it isolates the 7,000-volt bias to the red and blue grids from the 6CB5, and its inductance resonates with the capacitance of the red and blue grids. The 7,000-volt bias is connected to the grid circuit via the lead marked TO SEEKER. The high Q of the grid resonant circuit is desirable because of the considerable capacitance (about 1,200 $\mu\mu$f) of the red and blue grids—drive power is economized by the high-Q circuit.

The lower half of Fig. 5 shows the method used for generating the triple-frequency (third-harmonic) gating signal. An oscillator tuned to 10.7 mc (three times the 3.58-mc color-scan signal) is driven in synchronism with the color-scan signal. The output of the tripler circuit goes directly to grid 2 via the lead marked G2. The bias voltage on grid 2 is adjusted to cut off beam current except during the desired positive portion of the gating signal. The particular advantage of this circuit is that the gating signal never gets out of sync with the color-scan signal because the triple-frequency circuit is driven by the color-scan circuit. Correct color sequence and phasing are thus assured.

A block diagram of the color TV receiver using the Chromatron tube is shown in Fig. 6. It shows the relation of the color-selection circuit to the remainder of the receiver. The incoming signal is fed to the RF section. After frequency conversion to a 40-mc if, detection and video amplification, the video signal is used as input to (from top to bottom) sound, second video, sync and subcarrier regenerator circuits.

The color-selector circuits which are the subject of this article are contained in the 2ND VIDEO and COLOR SWITCHER AND TRIPLER blocks. The 2ND-VIDEO circuits deliver the composite video signal that determines selection of beam magnitude and thereby determines color saturation. The COLOR SWITCHER AND TRIPLER block, shown in detail in Fig. 5, produces the color-scan signal that deflects the beam to the proper phosphor strip on the tube face, and the gating signal that determines the proper color sequencing.

The ingenious color selection system of the Chromatron tube, resulting in simpler circuitry and space economy, is of more than academic interest. After additional development work now in progress is completed, you can expect to see a new type of color TV set on the market. END

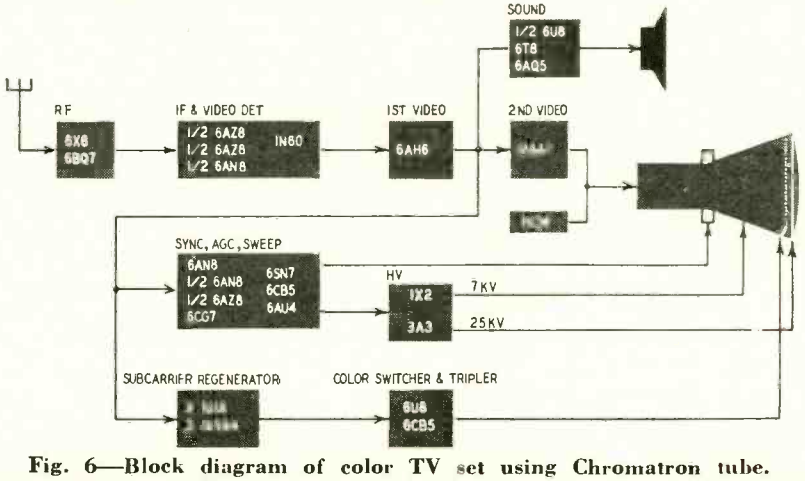

Fig. 6—Block diagram of color TV set using Chromatron tube.

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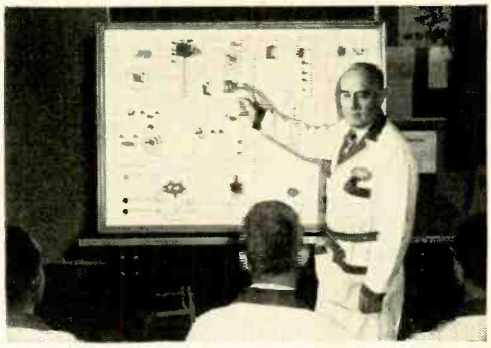

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THE INDUSTRIAL SERVO AMPLIFIER

The heart of any servo system is simpler than a TV receiver's circuitry

By FORREST H. FRANTZ, Sr.*

AUTOMATION is the big word in industry today. It conjures up visions of automatic factories manufacturing products with a small staff of master-control operators or no staff at all. The rapid trend toward the automatic factory is bringing industrial electronics into new prominence. To make automatic factories possible—to conceive, plan and build them, and keep them running—a host of men with electronic backgrounds and a knowledge of industrial electronics is needed. The basic principles these men must understand are those of the closed-loop servo system. The heart of this system is the servo amplifier.

A servo system is somewhat human in performance. To understand its principles, consider keeping a molten mixture in an oven at a constant temperature, in a critical manufacturing process. If a human operator controls the operation, he has a temperature indicator and fuel valve control before him. Assume that the temperature is to be maintained at 1,000°F. If it rises to 1,050°F, the operator's eyes sense the change and a message is transmitted to his brain. In the brain, comparison of this temperature with the standard temperature of 1,000° causes a correction signal to be transmitted to the operator's hand. His hand turns the fuel valve and decreases fuel input. The human operator's job is boring and fatiguing and his precise.

Electronic control

An electronic system can perform this task more competently and release the human operator for another job. Fig. 1 illustrates the arrangement. The pickup element or transducer is a resistance thermometer R1 (mounted in the oven) which is one leg of a Wheatstone bridge. R2 is a similar thermometer kept at a constant reference temperature. R3 and R4 are selected so that the bridge is balanced when the oven temperature is 1,000°. Any change in temperature causes the bridge to become unbalanced and a voltage is transmitted to the servo amplifier. The servo amplifier amplifies this voltage and drives an electrical - to - mechanical energy transducer—in this case, a motor—which actuates the fuel valve. The fuel injection rate continues to change until the oven reaches standard temperature, balancing the bridge and reducing the amplifier input signal to zero.

Numerous other applications are apparent. Quantity of material entering a mixing process, the thickness or length of metal strips, the positioning of parts in critical mechanical assemblies, the maintenance of a ship or aircraft course and many other possibilities exist for servo systems. The input transducer can take numerous forms, depending on the application. Now, let's take a look at the servo-amplifier circuit.

Electronic circuits used in industry are, in general, not much more complex than those found in radio receivers, and in most cases simpler than those in a television receiver. Fig. 2 is the circuit of the Brown ElectroniK 354574 servo amplifier. Fig. 3 shows the top and bottom views of an amplifier and the balancing motor. Its operation is: The input signal is dc, and the chopper converts it to an ac signal. The chopper operates like an automobile power supply vibrator. However, it must be constructed to very exact standards since the input voltage may be as low as 0.5 μv. The chopper is employed because it allows an ac amplifier to be used in preference to a dc amplifier, which is subject to drift and other difficulties. The chopper's frequency is 60 cycles. If an ac signal input is used, the chopper is unnecessary. The input is coupled to the amplifier through a medium-impedance (7,000-ohm) input transformer. The use of a medium-impedance transformer minimizes attenuation of the input signal if an ac signal is to be transmitted over a long distance.

The amplifier is a three-stage R-C-

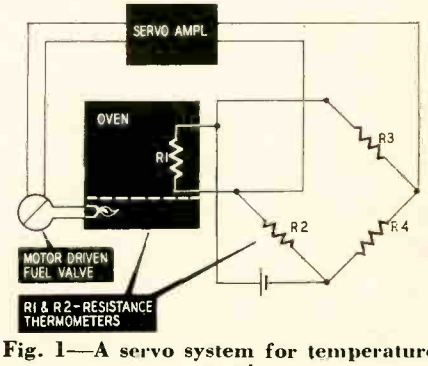


Fig. 1—A servo system for temperature control.

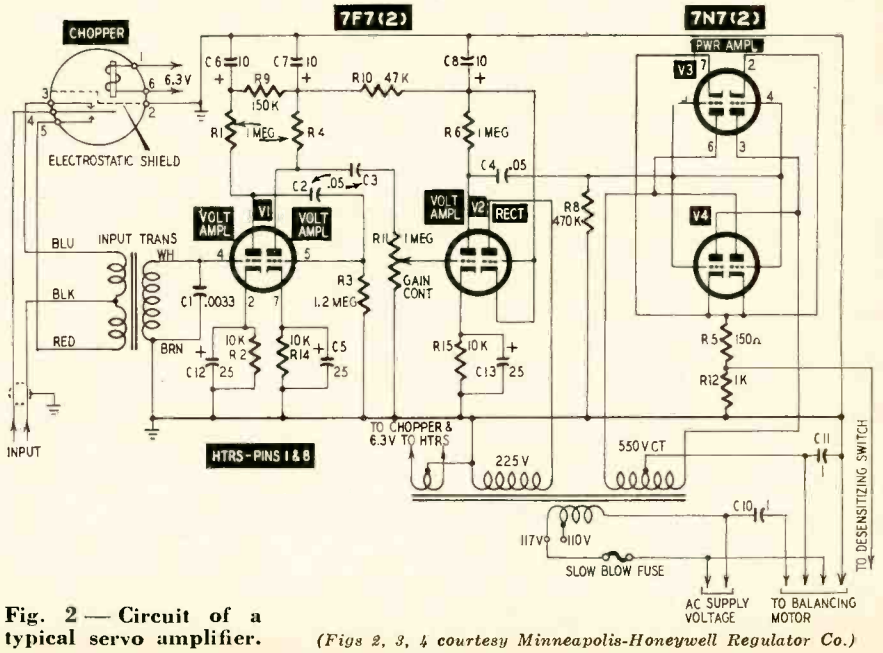


Fig. 2 — Circuit of a typical servo amplifier.

(Figs 2, 3, 4 courtesy Minneapolis-Honeywell Regulator Co.)

* Physics Department, Mississippi State College.

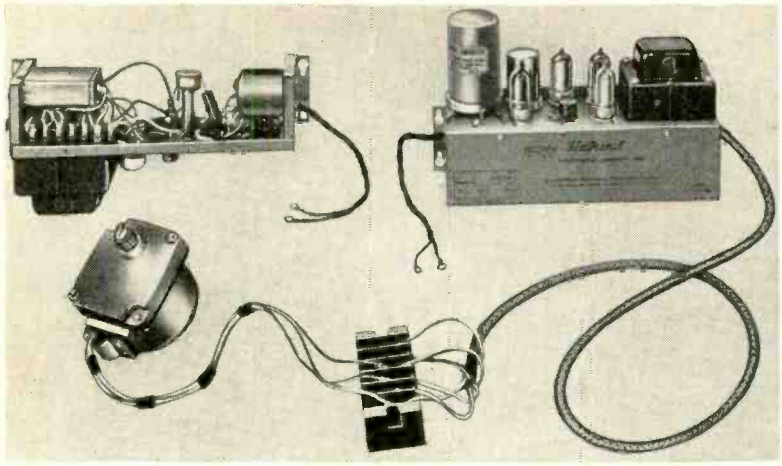


Fig. 3—Brown servo amplifier and motor (Model 356358-1.)

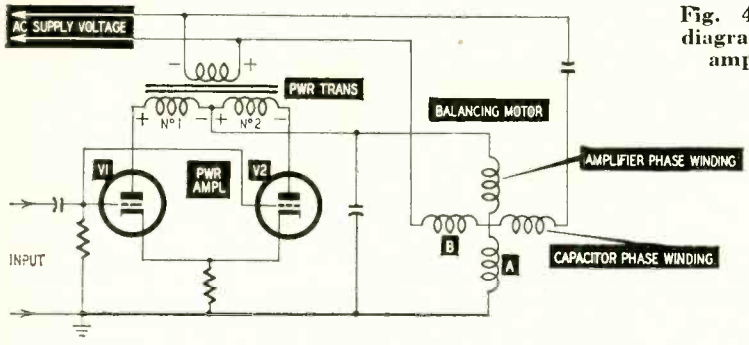


Fig. 4 — Simplified diagram of power-amplifier stage.

coupled voltage amplifier followed by a power amplifier which contains two duotriodes connected in parallel. It would appear that the plate circuits are not connected in parallel. In the physical sense they are not; however, note that the transformer, which in an audio amplifier would be an output transformer, is a power transformer. Fig. 4 will make this and subsequent operation description clearer.

The push-pull stage (V1 and V2) actually acts as a *discriminator* since its job is to distinguish between signals calling for a clockwise rotation of the motor and those calling for counter-clockwise rotation. The tube's plates are fed with ac, so the tubes conduct alternately, on successive half-cycles. Since the plates and chopper are fed by the same ac source, plate voltage on one of the push-pull tubes is in phase with input voltage on its grid. This means that, as the input signal drives the grids positive, one tube's plate current increases and decreases on alternate half-cycles while the other tube is cut off.

For example, if a positive signal is applied to the grids while V1's plate is positive, plate current in the tube increases. It flows through winding No. 1 on the transformer to amplifier phase winding A on the motor. The phase of this current in relation to the phase of the current through phase winding B (energized through a capacitor from the ac line) makes the motor turn in one direction. On the next half-cycle the tube does not conduct as plate and grid voltages are negative. Meanwhile, though V2's plate is positive, its grid is negative and it cannot conduct.

If the phase of the input signal is reversed, the action is reversed with V1 cut off and V2 conducting through winding No. 2 of the transformer and amplifier phase winding A of the motor. This changes the phase relationship of motor winding A to motor winding B, reversing the direction of the motor.

When the signal at the amplifier input is zero, the motor is at rest. When a signal is applied to the amplifier input, the motor rotates; the greater the signal, the faster it rotates.

If the motor shaft is coupled by gears to a machine control, it can cause a change in some machine characteristic. Then, if the transducer which provides amplifier input is connected so that it supplies less voltage as the machine characteristic approaches the desired value, the motor gradually decreases speed. When the error correction is complete, the input transducer is supplying zero voltage to the amplifier, and the motor comes to rest until some external influence causes the input transducer to receive an error signal again. In most industrial operations, changes are gradual and correction is almost instantaneous. The method of servo control discussed here is known as closed-loop or closed-sequence operation. It is analogous to inverse feedback in an audio amplifier.

With the exception of the output circuit and application to process control, the system discussed employs circuits commonly found in radios and audio amplifiers. The transition from radio servicing to industrial electronics is easy for the man willing to study a few new principles and circuits. END

TONE MODULATOR FOR R-C

Simple circuit has stable oscillator for tone-operated radio-control systems

By E. L. SAFFORD, JR.

ONE of the most perplexing problems facing the R-C enthusiast when he turns to a tone-operated system is the construction of an oscillator that will provide the various frequencies accurately and with long time stability. The tone modulator described in this article is an answer to the problem. It not only provides the tones but also a method of modulating the radio-frequency oscillator.

The circuit is a modified Hartley oscillator using a standard (push-pull plates to voice coil) audio output transformer as its tapped inductor. The size or type of this transformer is not critical and its wattage may vary from 2 for a battery-operated system to 10 for a system using a 6V6 as the oscillator–modulator tube. The latter will modulate a 5-watt carrier adequately. One end of the primary winding is connected to the plate, the center tap to B-plus and the other end to the stabilizing element which is a series-resonant circuit. The screen is connected to B-plus and the cathode is grounded.

The theory of operation is simple. The transformer provides feedback necessary for oscillation, but the series-resonant circuit prevents all frequencies from being impressed on the grid except the resonant frequency of the tuned circuit. In practical operation, it is possible to vary the frequency slightly by changing the value of the grid resistor, but this should be adjusted for the *best*, purest and cleanest note. Changes in frequency should be obtained by changing the value of the coil or capacitor or by using entirely different tuned circuits.

Fig. 1 shows the circuit as actually used. A four-channel tone section which modulates an oscillator generating a radio-frequency carrier of 50–54 mc was required. The unit was to be battery-operated, using not more than 135 volts for B-plus and has a power output of approximately 1 watt.

To meet these requirements, two 3Q4's were used. The audio oscillator–modulator section uses one as a pentode while the rf section uses the other triode-connected. The value of the grid resistance was varied from 5,000 to 50,000 ohms and the frequencies generated range from 600 cycles to 3,200 cycles.

A separate tuned circuit is used for each tone. The keying switches are placed between the grid and the ends of the coils. A 47,000-ohm grid resistor gave the best operation over the whole range with voltage variations from 75 to 135.

The rf section is modulated by connecting the plate of the rf oscillator through a radio-frequency choke and small bypass to the plate of the modulator tube. B-plus connects only to the center tap of the transformer and the screen of the audio oscillator–modulator tube.

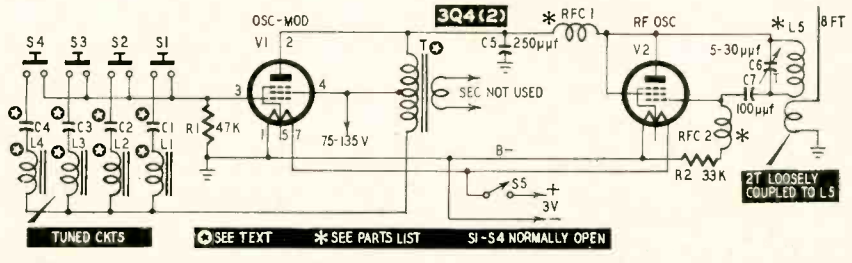
Tuned-circuit calculations

The tuned circuits are built around Chicago NSI-1 0.8-h and NSI-2 2.4-h coils. It is possible to use one inductance and switch various series capacitances into the circuit to obtain the required tones. The sharpness of the resonance, however, is a function of the choke's reactance. Thus, the use of one choke for the entire range means that the Q varies and the accuracy of the tone along with it.

The Chicago chokes are listed as they have a minimum Q of 20. However, less expensive units, such as the Stancor C2328 (0.8 h) and the Stancor C2334 (2.8 h) may be used.

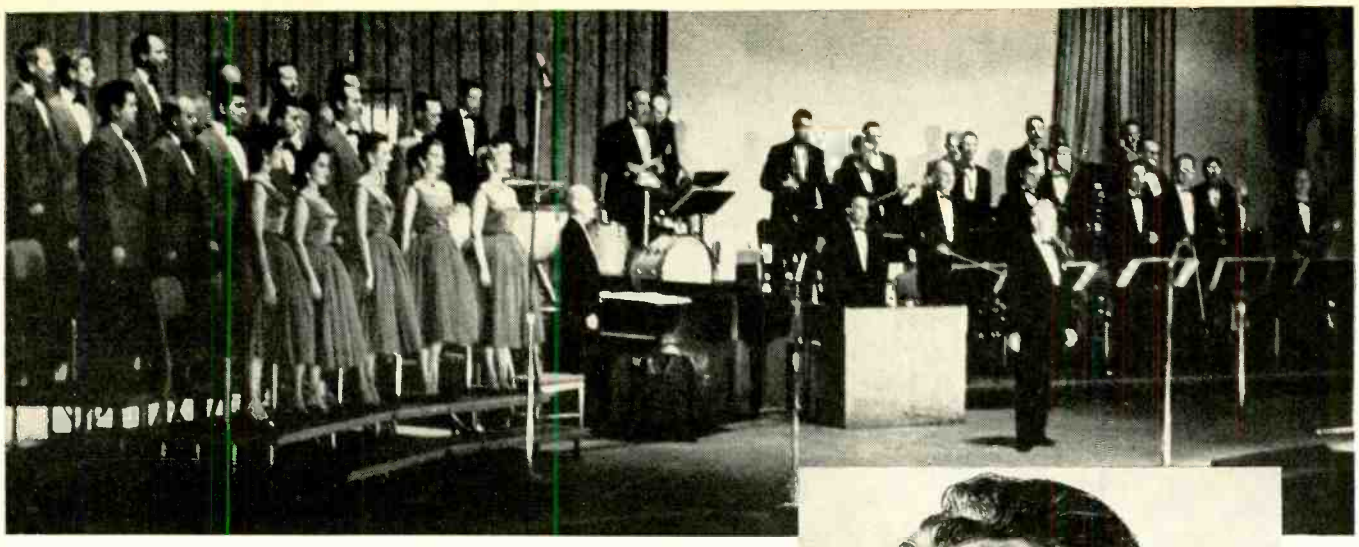
Using either a single choke or the less costly chokes will result in some degradation in the frequency stability. This will be small when applied to tuned-circuit receivers, but important with tuned-reed units.

The *best* stability and ease of adjustment would be with variable-inductance



R1—47,000 ohms, ½ watt
R2—33,000 ohms, ½ watt
C1, 2, 3, 4—see text
C5—250 μμf, ceramic
C6—5–30 μμf, trimmer
C7—100 μμf, ceramic
L1, 2, 3, 4—see text
L5—14 turns No. 18 enameled wire spaced width of wire on a ¾-inch-diameter form
RFC1, 2—1¼-inch winding of No. 32 enameled wire on ¼-inch form
S1, 2, 3, 4—spst pushbutton
S5—spst toggle
T—see text
V1, 2—3Q4

Fig. 1—Four-channel two-tube 6-meter R-C rig.



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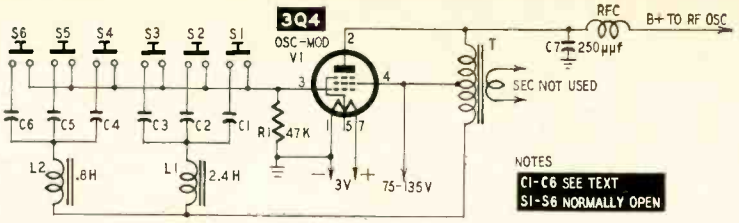

R1—47,000 ohms
C1, 2, 3, 4, 5, 6—see text
C7—250 μμf, ceramic
L1—2.4 h (Chicago NSI-2 or equivalent)
L2—0.8 h (Chicago NSI-1 or equivalent)
RFC—1¼-inch winding of No. 32 enameled wire on ¼-inch form
S1, 2, 3, 4, 5, 6—spst, pushbutton
T—see text
V1—3Q4

Fig. 2—Another way of arranging tuned circuits in oscillator–modulator.

chokes, like UTC's VIC types, using a separate unit for each frequency. A simple adjustment of the core would set up the proper tone for transmission. Of course, this is the most expensive method.

The values of the series capacitors can be calculated by the standard formula:

$$\text{Resonant frequency} = \frac{1}{2\pi\sqrt{LC}}$$

where C is capacitance in farads, L is inductance in henries and the frequency is in cycles per second.

This can be rearranged to solve for the capacitor as:

$$C = \frac{1{,}000{,}000}{(39)\,(L)\,(\text{frequency desired})^2}$$

where C is capacitance in microfarads, L is inductance and frequency is in cycles per second.

For example, if you wanted a 1,000-cycle tone using the 0.8-h coil:

$$C\,\mu f = \frac{1{,}000{,}000}{(39)\,(0.8)\,(1{,}000)\,(1{,}000)} = .033\,\mu f$$

Shunt this capacitor with a small variable padder, say 100 to 750 μμf, to allow some adjustment of the frequency. If you come up with odd values for the capacitor, remember if you parallel values, say .01 and .001 μf, the total capacitance will be .011 μf. If you use two *series* capacitors, the resultant value can be found from:

$$C = \frac{(C1)\,(C2)}{C1 + C2}$$

Therefore, you might use a single coil and several values of capacitors to obtain the different frequencies or use two coils, one 2.4 and one 0.8 h, the smaller for frequencies above 1,000 cycles and the larger for frequencies below that. Fig. 2 illustrates this arrangement. END

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The 1.5-volt cell and R1 are connected in series with the photocell, which then acts as a variable resistance in the penlight-cell circuit. It is important to observe the polarities of all components. The value of R1 will depend upon the photocell used. If the International Rectifier B10 photocell is used, R1 should be between 2,500 and 3,000 ohms. If the smaller and less expensive B2M is used, R1 may be eliminated but the unit will not be as sensitive as when using the B10.

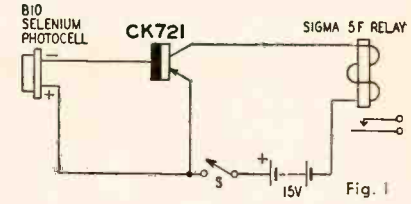

Fig. 1

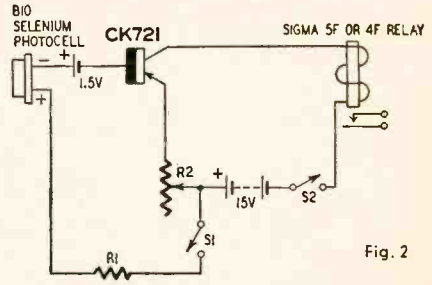

Fig. 2

Resistor R2 controls the emitter voltage, allowing the circuit to be adapted to various light intensities without readjusting the tension spring on the relay armature. The reason for this is that the force that will close a relay is expressed in watts. Watts = amps × volts and if we vary the voltage in the circuit we can vary the force acting on the relay armature for any given light intensity on the photocell. R2 should be variable and have a maximum value of 1,000 ohms. The transistor used (Raytheon CK721) yields a current gain of about 40 in the grounded-emitter circuit. The relay should be a Sigma 5F or 4F. Both are dependable and easy to adjust, the 5F (8,000-ohm coils in parallel) yielding slightly greater sensitivity than the 4F.

With the photocell receiving about 8 candlepower and the relay closed, the 1.5-volt cell has a drain of about 65 μa and the 15-volt battery a drain of about 1.7 ma. Under these conditions battery life is long but may be increased by substituting larger-capacity batteries of the same voltage. With the unit completed and the S1 closed, R2 should be adjusted so that the relay will just hold in the closed position when exposed to a source of light. — *D. H. Gucker.*

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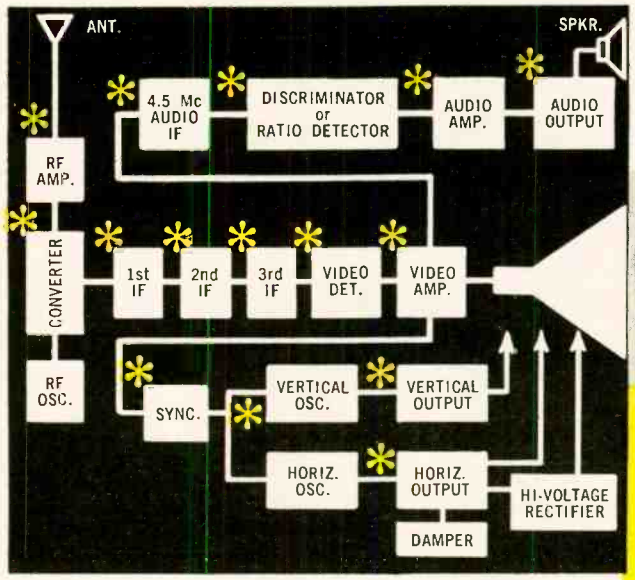
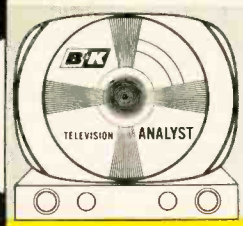
test each stage SEPARATELY





and watch the ← result on the TV set itself

UNIQUE NEW SIGNAL-INJECTION TECHNIQUE
Saves TV Trouble-Shooting Time and Work

R.F. I.F. Supplies complete r.f. and i.f. signals with video and audio modulation to quickly trouble-shoot each stage in each of the sections of the TV receiver. Enables you to check the r.f. sensitivity and AGC settings of TV receivers.

VIDEO Reproduces a complete test pattern on the screen of the TV picture tube and injects signals into each video stage of the TV receiver for fast, visual trouble-shooting and correction—anywhere, anytime, Makes it easy to check bandwidth, resolution, shading and contrast capabilities of the TV set.

SYNC Provides composite signal, sync positive and negative.

SWEEP CIRCUIT DRIVING PULSES Provides separate vertical and horizontal driving pulses for trouble-shooting deflection circuits.

INTERMITTENTS Test signal injection also aids in locating intermittent troubles.

AUDIO Provides a 4.5 mc sound channel, FM modulated with approximately 25 kc deviation. (This audio carrier is modulated either from a built-in 400 cycle tone generator, or from your own external audio source.) Injection of the 400 cycle tone signal simplifies trouble-shooting of the audio section.

COLOR Enables you to trouble-shoot and signal trace color circuits in color TV sets.

Generates white dot and crosshatch patterns on the TV screen for color TV convergence adjustments.

Generates full color rainbow pattern of orange, red, magenta, blue, cyan, green to test color sync circuits, check range of hue control, align color demodulators, etc.

SET ADJUSTMENT Enables you to check and adjust the vertical and horizontal linearity, size and aspect ratio of television receivers.

NEW
B&K
MODEL 1075

QUICK, DIRECT, COMPLETE TV TROUBLE-SHOOTING

Now, by point-to-point signal injection and test pattern reproduction, you can easily trouble-shoot and signal trace *any stage throughout the video, audio and sweep sections* of black & white and color TV receivers. With the remarkable new Model 1075 B&K TELEVISION ANALYST, you can quickly isolate and diagnose TV troubles (including intermittents). By use of the generated test pattern, you can *actually see* the condition directly on the picture tube of the television set itself. No external scope is needed. The TELEVISION ANALYST is practically a *complete* TV service shop *in one instrument!* Net, $259.95

See your B&K Distributor or write for Bulletin 1075-RE

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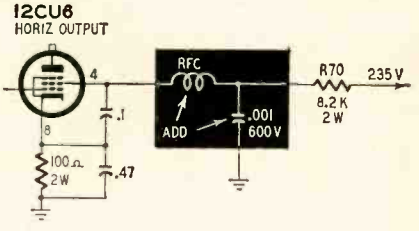
Technotes

EMERSON 120258-D

The customer let us pull his 24-inch set to the shop for removal of thin salt-and-pepper lines on the left-hand side of the raster and the picture. Trouble was readily pinned down to excessive radiation of pseudo-BK oscillation at the screen grid of the 12CU6 horizontal output tube.



Rather than reroute and shield the screen lead, a filter was inserted between socket pin 4 and the dropping resistor R70, 8,200 ohms. The filter was made up of a small rfc choke and a .001-μf capacitor (600 volts). It was installed as shown in the partial schematic.—*James A. McRoberts*

RCA KCS-96 CHASSIS

The video becomes progressively poor over a period of days, and can be temporarily compensated for by adjustment of the agc control. If allowed to progress, video becomes almost completely lost with raster brightness remaining normal.

Cause of the defect is a leaky capacitor C-167, a 330-$\mu\mu$f pulse coupling unit to the plate of the agc tube.—*Harry C. Keller*

MOTOROLA 55A RADIO

Several of these ac–dc radios have been inoperative due to failure of the printed circuit from pin No. 2 of the 12BA6 to ground. This can quickly be repaired by running a piece of hookup wire from the pin connector to the output transformer case rather than trying to locate and repair the actual fault in the printed circuit.—*Paul Falk*

HOFFMAN 703A

The receiver provided good color reception except that the setting of the fine-tuning control was critical. Alignment was suspected, but it turned out that there were no abnormal peaks in the response curves and bandwidths were OK.

Then is was surmised that the color killer might be operating close to threshold, since all color dropped out promptly when a small pad was inserted in the lead-in. (This was done

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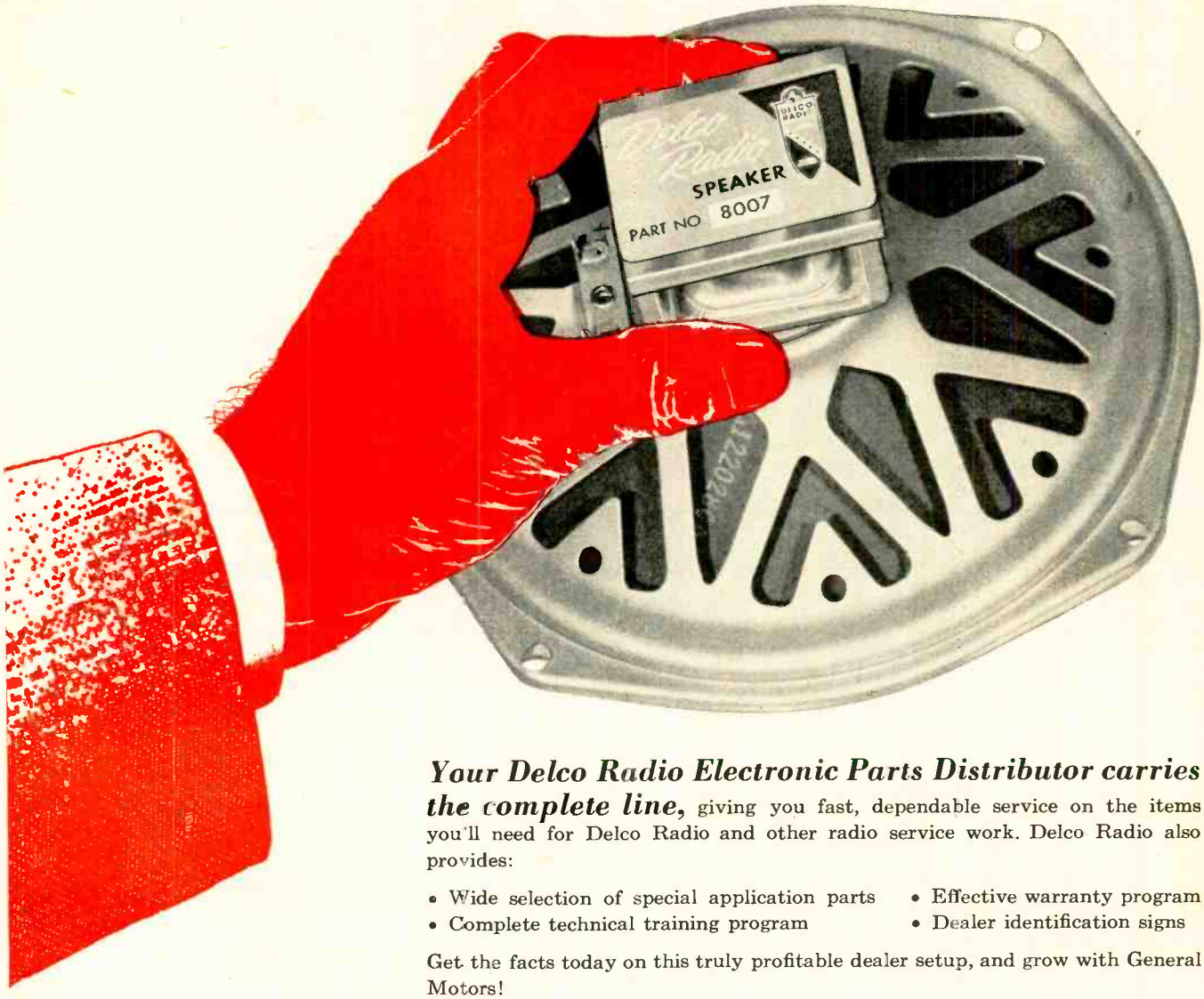

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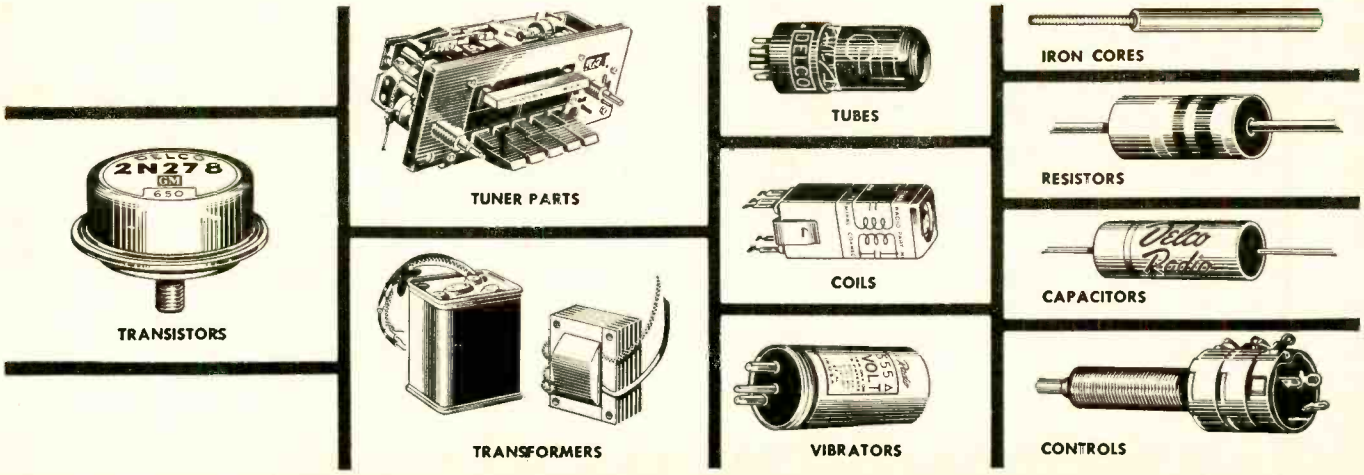
DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA



Technicians' News

SKIATRON TALKS TO SERVICE TECHS

More than 70 service dealers and technicians met in San Francisco to hear Alan Lane, vice president of Skiatron TV Inc., tell of his company's plans to handle service for pay TV.

The meeting was called by the San Francisco Television Service Guild and representatives from San Mateo, Santa Clara, Alameda and Contra Costa counties were invited to attend.

In a 20-minute talk, followed by an hour and a half of questions and answers, Mr. Lane emphasized that it was the definite plan of Skiatron to use independent service technicians to bring pay-TV lines from the street to the customer's set. They plan to appoint independent dealers to cover a given number of square blocks in their immediate vicinity, making installations on a contract fee basis to all subscribers to pay TV within their zone. The price to be paid for the installation is under negotiation. Lane pointed out that the technician would have no responsibility for the sealed pay-TV box which would sit on top of the customer's set.

From the NATESA Scope

ELECTION IN CHICAGO

The Television & Electronic Service Association (TESA)–Chicago, Ill., voted the following members into office for 1958:

John Cahill, president; Elmer Frohardt, first vice president; Walter Schafer, second vice president; Clarence Wilhelm, third vice president; Angelo Chrysogelos, secretary; Joseph Issak, treasurer, and Harry Miklasz, sergeant-at-arms. Joseph Bink was elected NATESA director and Joseph Issak his alternate. Frank Moch is chairman of the board.

TECHNICIANS' ANSWERS

In November, 1957, 635 technicians were sent a questionnaire by the conference of Manufacturers, Representatives, Jobbers and Service Dealers (CMRJSD), Kansas City, Mo. The survey, which drew 142 replies, came up with some interesting results. Take the question "List the three most important things the manufacturer can do to help you." The answers were headed by "make factory service information more readily available." "Use standard components" was next and third was "design sets for ease of service."

The next question was "List the

three most important things parts distributors can do to help you." The most common answer was "fast service—complete stocks." Second came "give full wholesale price only to dealers with sales-tax number." Third was "do not sell retail."

The last question was "What would help you most to improve your business?" The overwhelming majority said, "A favorable publicity program to the public about service."

The conference comment was that "this survey plainly shows that great opportunity and necessity exist for the manufacturers, representatives and distributors to help the service industry in many ways. This assistance will be beneficial to all segments of our industry, as well as the public who purchase the products and services of the electronic industry."

GUILD ELECTION

The Radio & Television Guild of Long Island (RTGLI) has installed its new officers for this year. Robert Larsen (left) (Windsor TV, Laurelton) is president. Robert Barasch (right) (Bell TV, Lindenhurst) is vice president. Other officers are Robert Henderson (I & R TV, Baldwin), recording secretary; John Holland (Holland TV, Lyndenhurst), corresponding secretary; Emanual Greene (National TV, Elmont), treasurer; Fred Strickland

(Strickland Radio & TV, Huntington Station), sergeant-at-arms.

The trustees of the guild are: Art Cyr (Port Electric, Port Washington); Robert Bloom (B & H TV, Hicksville); Murray Barlowe (Barlowe TV, Bethpage); Ralph Milne (Mid Island TV, Rockville Center); George Volkens (Volkens Refrigeration, Richmond Hill), and Jack Wheaton (M & W Radio Corp., East Williston).

TOO MANY TUBE TYPES

Addressing the Joint Electron Tube Engineering Council in Philadelphia, Pa., Donald W. Gunn, general manager of Sylvania's Electronic Product Sales Dept., said that new variations of existing tube types, often "dreamed up" by design engineers, are continually appearing on the market.

"This factor," Mr. Gunn declared, "plus countless requests on the part of customers, for new types and variations has flooded the market and distribution channels with a galaxy of

tube duplications representing endless loss of time and money.

"Only 95 of the 735 types (currently handled on the replacement market) represent 80% of total sales. The remaining 640 slow-moving tubes are carried all through the distribution system to the dealer's shelf at considerable inconvenience and cost.

"The sensible solution to this situation would be for tube manufacturers to adopt the best design and eliminate others in instances where several tubes represent solutions to the same problem."

ETA ELECTS

The Electronic Technicians Association of Lancaster County, Pa. Inc. (ETA), formerly the Northern Lancaster County Electronic Servicemen's Association, elected the following officers for 1958: Harold Snader, president; Thomas Horst, vice president; George Styer, secretary; Ralph Strickler, recording secretary, and A. J. Yundt, treasurer.

GUILD GETS NATESA CHARTER

The San Francisco Service Guild became a member of the National Alliance of Television & Electronic Service Associations (NATESA) when Ned Gramlich, Guild president, accepted the NATESA charter from Winston Haines, NATESA's Western vice president.

The San Francisco group is expected to become the largest association in California. There are about 280 service shops in the city.

SERVICE CONVENTION

Minnesota Television Service Engineers Inc., (MINTSE) is planning an Upper Midwest Electronic Service Convention for April 24–27, 1958. Details will be announced by MINTSE as they are formulated.

RTA–PASADENA MEETS

At a recent meeting of the Radio Television Association (RTA) of Pasadena, Calif., Mr. B. J. Castro, Sylvania sales and service representative, gave a talk on "Transistors—Theory and Application." The talk was preceded by coffee and doughnuts and followed the awarding of door prizes (three were given). END

"Let's see—didn't you put three picture tubes in my set last year?"

Patents

LOUDNESS CONTROL

Patent No. 2,812,498

Cecil T. Hall, Mount Lebanon, Pa.

At weak sound levels, human hearing is lo-fi. This is shown by Fletcher-Munson curves (Fig 1) which relate apparent loudness to frequency at various sound levels. Loudness curve A shows that at a loud signal level (0-db) ear response may be taken as uniform throughout the band. Now if the signal is lowered only 10 db at 30 cycles, curve B shows that the apparent loud-

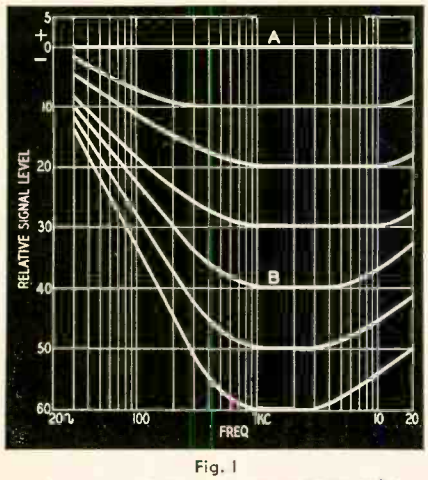


Fig. 1

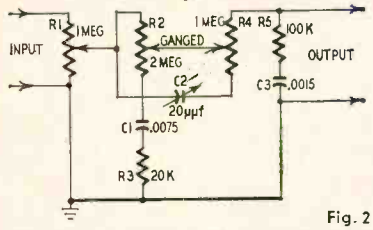


Fig. 2

ness will drop as much as if a 2-kc signal were attenuated 40 db. Briefly, this means that program material must be reproduced at the same level at which it was originally played. Otherwise, it will seem deficient in high frequencies and (especially) in low frequencies.

This control is designed to boost bass and treble automatically as it attenuates signal. It comprises four separate networks (see Fig. 2). R1 is a linear potentiometer which adjusts various inputs for nearly equal signal strength. R2, C1, R3 provide bass boost of about 6 db per octave. Network R4, R5, C3 functions in a similar way, so at low frequencies the total bass boost is about 12 db per octave, as required.

Another network comprises the upper portion of R2, the lower portion of R4, and C2. At nearly maximum attenuation, C2 shunts nearly all of R2 to supply the treble boost. This capacitor is adjustable for optimum boost.

Potentiometers R2 and R4 are ganged and have linear tapers.

RADAR

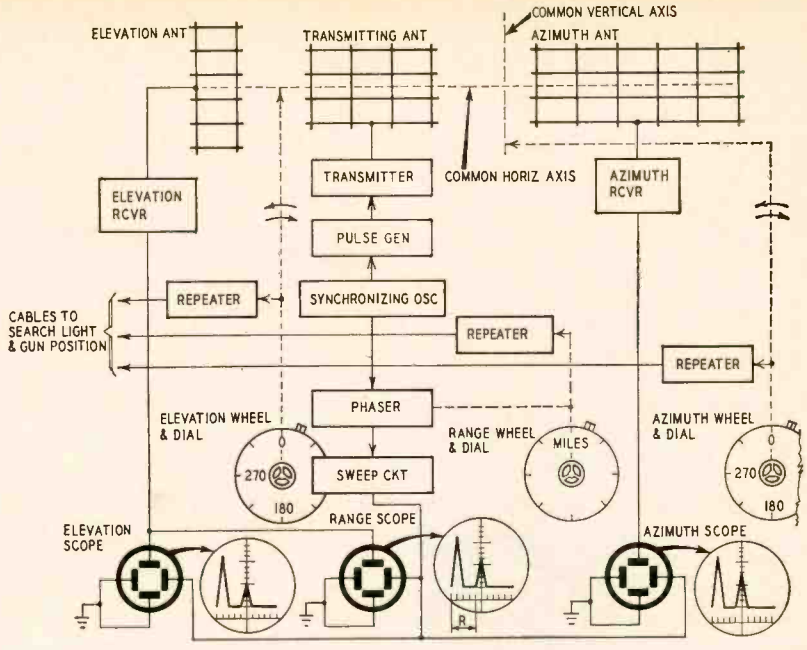
Patent No. 2,803,819

William R. Blair, Washington, D. C.
(May be used by U.S. Government without payment of royalties)

This patent took a long time going through the Patent Office. Application was made back in 1945, after several years of work, but due to the need for military secrecy, it has only recently been disclosed. See RADIO-ELECTRONICS, November, 1957, page 12. It is the fundamental patent covering modern radar. Utilizing three oscilloscopes, it instantly shows elevation, range and azimuth of a moving target, relaying the data automatically to a nearby gun position.

The diagram shows a trio of antennas mounted on common horizontal and vertical axes. The central unit transmits pulses at uhf for reflection

PATENTS *(Continued)*



from the target. Echoes are picked up by the other two antennas, one for elevation and the other for azimuth. The echo pulse, along with the larger original pulse, is displayed on each scope.

An operator controls the horizontal rotation of the antenna system by an elevation wheel. When set for maximum amplitude of echo (on the scope), the calibrated elevation dial shows angular elevation of the target. The data is sent to the gun position by a repeater or selsyn motor. Likewise, the azimuth operator sets his wheel for correct azimuth angle by noting maximum echo pulse, and this information is also relayed by a repeater.

The range dial operates a delay circuit which varies the phase of the sawtooth sweep to all scopes. Thus the range operator can move the pattern on all scopes. When set so that the echo pulse appears at the vertical hairline (see diagram), his calibrated dial indicates actual range in miles for the gun crew. This range is shown as R on the range scope.

Besides this basic information, the patent contains data for pulse generation, transmitting circuits, etc.

It is interesting to note here that a much earlier patent (No. 1,585,591) issued May 18, 1926, to H. Lowy of Vienna, disclosed the basic idea of using radio to determine the distance of an object. Of course, his apparatus was very crude judged by modern practice. END

radio-electronic Circuits

P-N-P AND N-P-N TRANSISTORS ON COMMON BATTERY

Sometimes it is desirable to have p-n-p and n-p-n transistors on the same chassis—either because of circuit requirements or because the experimenter has some of both types with similar characteristics and wants to use them. By proper circuit arrangement, *both* types can be powered by the *same*

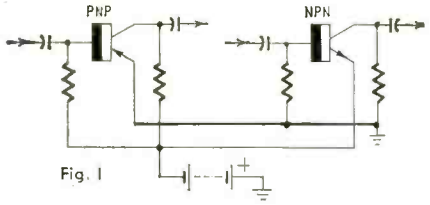


Fig. 1

battery without any increase in circuit complications. Further, this arrangement is possible for either a grounded-positive (Fig. 1) or a grounded-negative (Fig. 2) battery connection as shown in the diagrams.

Both circuits are shown as simple R-C-coupled amplifiers for ease of illustration, but the same basic connection applies regardless of the circuit

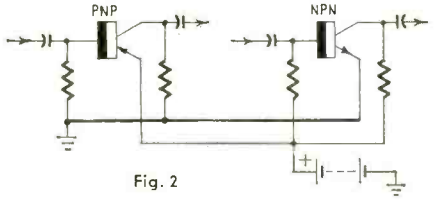


Fig. 2

used. Simply remember that p-n-p and n-p-n transistors can be connected in either of two ways—*emitter returned to ground with the base and collector returned to the hot side of the battery*, and *base and collector returned to ground with the emitter returned to the hot side of the battery*. If one type transistor is connected the first way, simply connect the other one the second way.

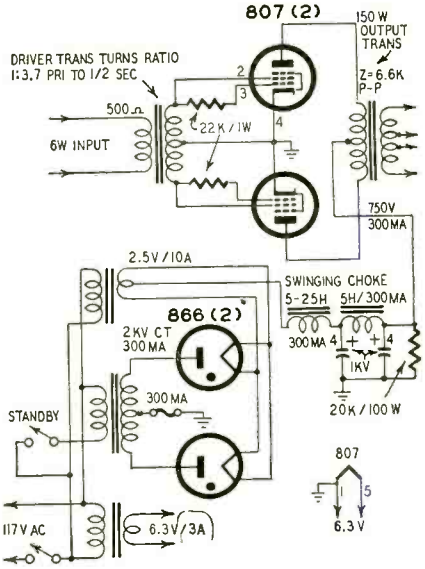
Because of the slightly different connections required for the two types of transistors, check each carefully before connecting the battery.—*J. E. Pugh, Jr.*

BOOSTER AMPLIFIER

The diagram shows the circuit of a 120-watt booster amplifier that I use to replace four 30-watt PA amplifiers formerly used for large outdoor affairs. Setting up is faster and more trouble-free than formerly. I use a little 10-

watt amplifier as a driver and the 30-watters are now free for use on other jobs.

The amplifier uses zero-bias 807's operating in class B. The tubes operate as triodes with the signal applied directly to the screen grids and to the control grids through series resistors. A 6-watt amplifier with a 500-ohm output winding supplies sufficient driving power.



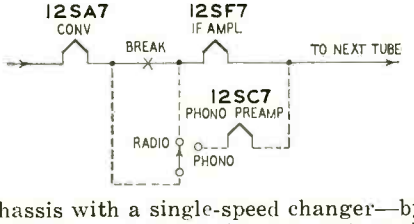
This circuit was employed by W2RYI in a modulator that was described in the May-June, 1947, issue of *RCA Ham Tips*.

The driver transformer should have a power rating of at least 8 watts and should be designed for matching a 500-ohm line to push-pull class-B grids. The turns ratio of primary to one-half secondary should be approximately 1 to 3.7. You can use a Stancor A-4765 or equivalent universal line-to-grids driver transformer or a universal audio output transformer with its primary feeding the grids. The Stancor transformer is rated at 15 watts.

The power supply should use a high-grade power transformer and chokes for good regulation and long trouble-free performance. Always allow the 866 filaments to warm-up for 30 seconds or more before closing the standby switch and applying plate voltage. Applying plate voltage before the filament heats up is a good way to ruin a lot of 866's.—*E. Wilhelm*

ADDING PREAMP TO AC–DC SET

A customer asked us to modernize his radio-phono console — an RCA ac-dc



chassis with a single-speed changer—by installing a 4-speed changer with variable reluctance cartridge and preamp.

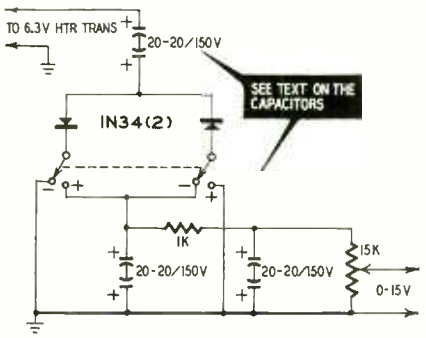
The tubes in the set had the full line voltage distributed across their series-connected heaters so my problem was the heater supply for the 6SC7 preamplifier tube. Short of adding a 6.3-volt heater transformer to the set what could be done?

After some study, I replaced the 6SC7 with a 12SC7 and solved the problem by connecting a RADIO-PHONO switch as shown. In the PHONO position, the 12SC7 heater is inserted in the line in place of the 12SF7 if amplifier.—*Gerald Kirby*

REVERSIBLE DC SOURCE

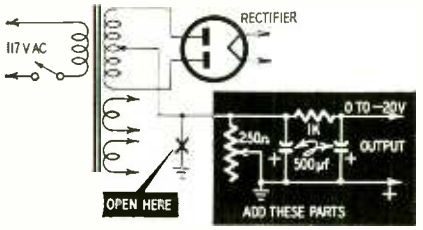
In designing a piece of test equipment, I needed a source of low-voltage dc for test and calibration purposes. This voltage had to be variable and reversible in polarity. After a while I came up with an inexpensive but practical solution.

The only voltage available was the 6.3-volt heater line with one side grounded. I made a voltage-doubler circuit, using 1N34 diodes as rectifiers, and used nonpolarized electrolytic capacitors. The finished circuit is shown in the diagram. This gave me 15 volts at either polarity. The nonpolarized capacitors were made by clipping off and taping the common negative lead from a 20–20-μf 150-volt electrolytic. Of course, two large paper capacitors could be used but they would raise the price of the power supply.—*L. M. Dilley*



DC FOR TRANSISTOR PREAMPS

The power amplifier's power supply can be used to provide the necessary operating voltages for a transistor preamp by making a simple modification. Lift the center tap of the high-voltage winding on the power transformer from ground and connect a resistor in series to ground as in the diagram. A 250-ohm 10-watt variable resistor for this purpose gives a convenient adjustment of the voltage. The voltage rating of the filter capacitors should exceed the highest desired output voltage.—*Joseph A. Fiederer*



END

try This one

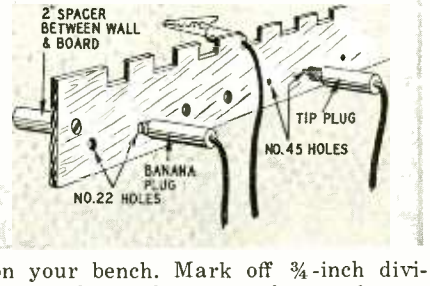
RE: POWER-FAILURE ALARM

In the "Power-Failure Alarm" described on page 116 of the January, 1958, issue, a slight simplification might be made. The original design calls for a pushbutton to reset the relay by pressing in on the armature. This might be difficult to make. A better idea would be to wire a normally open pushbutton switch in parallel with the normally open contact on the relay. This would have the same effect. When using the pushbutton, change R2's value so the relay can draw enough current to pull the armature up.—*Charles E. Cohn*

TEST-LEAD STORAGE

In most shops the problem of where to keep test leads not in use is not satisfactorily solved. Leads are usually left in a drawer or on the bench, resulting in time-consuming untangling before they can be hooked to an instrument and used again.

A few minutes' work can end this problem. Take a piece of wood or metal about 2 inches wide and long enough to accommodate the number of leads



on your bench. Mark off ¾-inch divisions along the top edge and saw notches ½ inch deep (see diagram). These notches accommodate leads with alligator clips, meter probes and coaxial fittings. Below these slots drill a series of No. 22 and No. 45 holes—the No. 22 holes for banana plugs and No. 45 holes for tip plugs.

Mount the board or metal strip on the wall behind your bench, about 5 feet above the floor, on 2-inch spacers. —*Ray L. Allen*

CABINET PANELS

While building some plywood speaker enclosures, I discovered that prefinished plastic-coated hardboard ceiling and wall covering makes ideal veneerlike panels for radio-electronic cabinets. Available at most lumber yards under the trade name of *Marlite*, it comes in a variety of finishes, design patterns and colors. It's easily attached

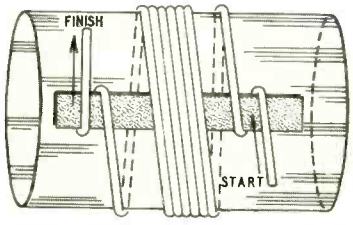
with a rubber-base adhesive and the edges covered with molding or tapered with a wood rasp and varnished or painted.

Peg-Board, a similar material, is perforated with 3/16-inch holes and makes ideal material for ventilated radio or TV rear covers, pegged tool boards or breadboards for experimental circuit layouts. The material is a fairly good insulator and highly resistant to wear, impact, soil, stains, moisture and other abuses.

Chances are, you'll also find it useful for many electronic applications other than those I have briefly mentioned. Try it. It's easy to work, too, and the electrical qualities are good as long as it's dry.—*J. C. Alexander*

EXPERIMENTAL COILS

This method of winding makes it easy to change the number of turns on experimental coils. Wind the coil with a thin strip of plastic or Bakelite between the winding and core. Anchor



the ends with one turn around the strip as shown in the drawing. After the exact number of turns has been determined, the ends can be anchored with a drop of cement and the leads soldered to lugs or pins on the form. —*Capt. Daniel Nof*

SERVICE LIGHT HOLDER

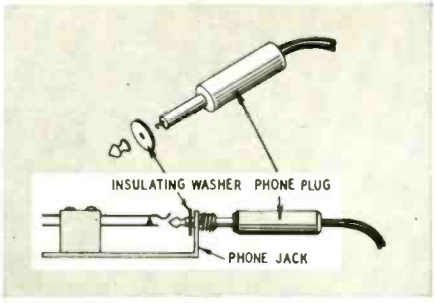
No technician's tool kit is complete without some sort of trouble light for illuminating the dark corners of a chassis. To save space in my tool kit, I just carry a small penlight, but often I have found jobs where an extra hand is needed to hold the light. I solved this problem by screw-fastening two spring clothespins back to back. With the light clamped in the jaws of one pin and the jaws of the other pin clamped to a pair of pliers or other heavy tool, I find that the light can be angled to nearly any position with very little difficulty.—*Scott Mack*

NICHROME ELEMENTS

When the nichrome element in an electrical appliance breaks, twist the ends of the broken section together in a loose joint. Then sprinkle a little borax over it and turn on the juice. The resulting spark will fuse the connection and save the element.—*Harvey Muller*

PHONE-PLUG SWITCH

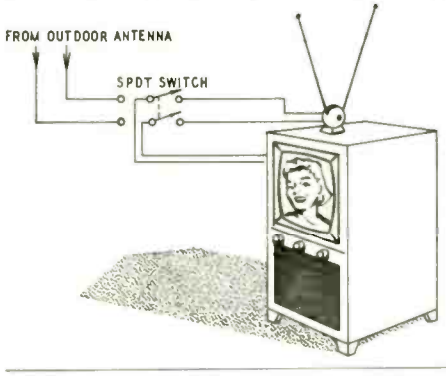
A push-switch arrangement for use with meters or headphones can be made by replacing the little insulating washer behind the tip of a phone plug with a larger one. Of course the tip has to be screwed back on after the plug



is inserted into its jack. Complete removal of the plug is prevented, but there is enough movement to break and make connections.—*Hugh Lineback*

COMBINATION TV ANTENNA SYSTEM

We all know that for ideal TV reception the outdoor antenna should be oriented toward the station being watched. Unfortunately, in most locations, stations do not all lie in the same general direction from the receiver and the fixed outdoor antenna does not provide maximum signal strength for all stations. Rotary beam antennas or their switchable multisection equivalents are expensive. But here is a simple trick that works well in areas of fair signal strength. Hook up a set of rabbit ears to one side of a dpdt switch and connect the outdoor antenna's lead-in to the other side. Run a length of twin lead from the arms of the switch to the receiver's antenna terminals. For stations that do not come in well on the outdoor antenna, switch to the rabbit ears and orient them for the best picture. This is also effective for eliminating ghosts.—*Lt. Col. Eugene Coriell*



TAPE CODES FUSES

I find it mighty handy to color-code boxes of fuses carried in my toolkit, with plastic gift-wrapping tape. This way I can select at a glance (even in dim light) the right box of fuses when making replacements. One might even use small strips of the tape to color-code the barrel of individual fuses. Until I got used to each color and its corresponding fuse value, I taped a card with the values and colors written on it to the inside lid of my toolbox. The tape is available in several colors, making it possible to set up numerous code combinations.—*John A. Comstock* END

new Devices

PHOTOCELL RELAY KIT, *model KT-133.* Light-controlled switching device can be used for burglar alarm, door opener, counter, etc. Uses cadmium sul-

phide photocell. Flashlight at 250 feet operates unit.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

110° PIX TUBE BRITENERS, *model C-211* (illustrated) for RCA type button-base tubes. *Model C-221* for shell-base Sylvania and DuMont tubes. Auto-

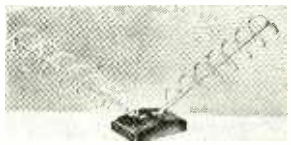
transformer types. Work in either series or parallel heater strings.—**Perma-Power Co.,** 3100 N. Elston Ave., Chicago 18, Ill.

PICTURE-TUBE REJUVENATOR, *model RE-2 Rejuvatube.* Tests for emission, gas and shorts. Cube-socket selector and switch assembly permit testing and rejuvenation of each gun of color tube, 110° and conven-

tional monochrome tubes. Cube socket *CS-2* is available separately as an adapter for model *RE-1* Rejuvatube. — **Central Electronics,** 1247 W. Belmont Ave., Dept. RE, Chicago 13, Ill.

TV LEAD-IN LINE. Low-loss open-line construction. For uhf or vhf signals. Designed for use in areas of high humidity and temperature and is resistant to salt corrosion. Large wire size permits maximum signal-carrying capacity.—**New Products Engineering & Manufacturing Co.,** 5305 Chicago Ave., Minneapolis, Minn.

INDOOR ANTENNA KIT, *model 606.* For channels 2–13. Gold-colored spiral element and brown plastic base.—**Hi-Lo Manufac-**



turing Corp., 1122 W. Newport Ave., Chicago 13, Ill.

INDOOR ANTENNA, *Spico Viscount.* Slide adjustment for matching antenna impedance to set impedance. 12-position phas-

ing switch. Dipole elements retract into case. — **Spirling Products Co., Inc.,** Henrietta & Duffy, Hicksville, N. Y.

TV ANTENNA, *Scotchman model 503* (illustrated). All-channel roof antenna. The series consists of 4 basic models and 4 attachment kits that can be combined to produce more than 30 antenna combinations. Attachment kits permit increasing gain and

front-to-back ratio to suit reception requirements. — **Winegard Co.,** 3000 Scotten Blvd., Burlington, Iowa.

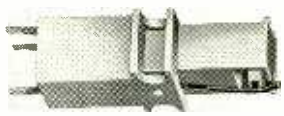
AUTO RADIO ANTENNA, *Tennamatic.* Built-in motor extends or retracts mast. Motor operates on 12 volts dc. *TM-1* (illustrated) for front mounting, *TM-2* for rear mount. *TM-3* is a conversion kit which permits the

TM-1 to be rear-mounted.—**Tenna Manufacturing Co.,** 7580 Garfield Blvd., Cleveland 25, Ohio.

STEREO CARTRIDGE, *Model 21D.* 0.7-mil diamond tip. Twin ceramic elements. Response: 20–16,000 cycles, within 2 db to RIAA. Tracking force: 6

grams. Standard mount. Turnover cartridge *model 26DST* has 0.7-mil diamond stereo stylus and 3-mil sapphire monaural stylus. — **Electro-Voice Inc.,** Buchanan, Mich.

STEREO CARTRIDGE. Designed to fit standard record players and changers. Plays back Westrex 45/45 stereo discs. Ceramic elements. Response 30–15,000 cycles. Tracking pressure between 5 and 9 grams



with a 1-mil sapphire stylus.—**Webster Electric Co.,** 1900 Clark St., Racine, Wis.

HI-FI PHONO CARTRIDGE, *Professional Dynetic.* Moving-magnet type for use in record changers and transcription pickup arms. Tracking force is 3–6 grams. Response is flat

from 20–20,000 cycles. Comes with a 1-mil diamond stylus for microgroove or a 2.7-mil sapphire needle for 78-rpm records. —**Shure Brothers Inc.,** 222 Hartrey Ave., Evanston, Ill.

DYNAMIC LOUDSPEAKER, *model RC-26.* For aircraft installations. 8-inch permanent-magnet type. 2 15/16 inches deep. Handles 10 watts of pro-

gram material. Frequency response from 60–8,500 cycles. 8-ohm impedance.—**Stromberg-Carlson,** Div. of General Dynamics Corp., 100 Carlson Rd., Rochester 3, N. Y.

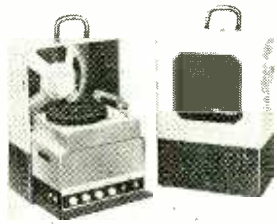
WRIST-WATCH CRYSTAL MIKE. *model PA-47.* Mike looks and mounts like a good wrist watch. Its thin, flexible cable is 6½ feet long and can be run

up a coat or jacket sleeve to a concealed tape recorder. Watch case is chrome-plated, has gold-finish numerals and tan leather strap.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

TAPE-REEL, *V-Slot Selection-Finder.* Features V-slot for quick threading. Permanent selection finder numbers are

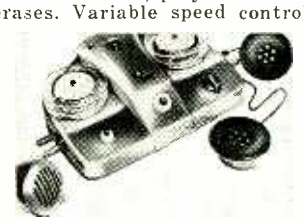
molded along the edge of this slot to aid in rapid location of the desired selection.—**Ferrodynamics Corp.,** Lodi, N. J.

PA PHONOGRAPH, *Add-A-Unit model MP-3.* 33⅓, 45 and 78 rpm. Turnover cartridge. Mounts on top cover of Audiosphere amplifiers (18- through 100-watt models). Combine with amplifier, speaker and carrying



case for a compact portable PA system.—**Mark Simpson Manufacturing Co., Inc., MASCO,** 32-28 49th St., Long Island City 3, N. Y.

TRANSISTOR TAPE RECORDER, *Tel Tape.* Portable unit is powered by 4 pen-light batteries. Records, plays back and erases. Variable speed control.



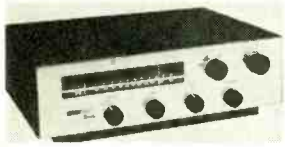
Weighs less than 2 pounds and measures only 8½ x 6½ x 2½ inches.—**Filnor Products Inc.,** Dept. P201, 101 W. 31st St., New York 1, N. Y.

PA AMPLIFIER, *model KN-3035.* 35 watts. 6 inputs: 3 for mikes; 2 for ceramic or crystal phono cartridges; 1 for a magnetic cartridge. Each input has its own volume control. Output impedances for 4-, 8-, 16-, 250- and 500-ohm speakers as well

as for 70.7-volt lines. Response within 2 db from 20–20,000 cycles. 2% distortion at 35 watts.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80.

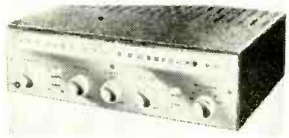
CHAIN AMPLIFIER, *model ABB-5.* Provides broad-band amplification of TV and FM signals in the 15–230-mc region with a gain of 20 db and frequency response flat within 1.5 db. 75-ohm output. Regular or rack mounting. — **Westbury Electronics Inc.,** 300 Shames Dr., Westbury, N. Y.

TUNER–PREAMP–AMPLIFIER, *Sonata model FA-10.* FM sensitivity 4 μv for 20 db of quieting. 200-kc bandwidth. Maximum



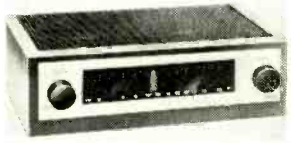
drift 5 kc. Antenna input 300 ohms. Distortion less than 1% harmonic and IM. Amplifier rated at 10 watts with a peak power of 16 watts. Response within 0.5 db from 15–30,000 cycles at 2 watts. Function, loudness, tuning, treble, bass and contour controls. Inputs for phono and tape. 8- and 16-ohm outputs.—**Harman Kardon Inc.,** 520 Main St., Westbury, N. Y.

HI-FI TUNER AMPLIFIER, *model KN-315.* Combines an FM–AM tuner and 15-watt amplifier on one chassis. Tuner sensitivity is 4 μv for 20 db quieting on FM and 10 μv for a



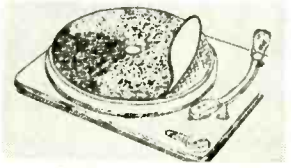
20-db signal-to-noise ratio on AM. Afc on FM section. Amplifier response within 1 db from 20–20,000 cycles at 15-watt output. Distortion at rated output is 2%. Loudness, volume, bass and treble controls. Rumble and scratch filters. 3-position record compensator and 3-position selector switch. Inputs for magnetic cartridge and tape recorder. 4-, 8-, 16-ohm and high-impedance outputs.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

FM TUNER, *model HFT 90,* kit or wired. Sensitivity, 1.5 μv for 20-db quieting. Response within 1 db from 20–20,000 cycles. 300-ohm balanced input. Maximum



drift of 20 kc from cold start. Hum is 60 db below 1 volt. 2 outputs: cathode follower and multiplex. — **Electronic Instrument Co., EICO,** 33-00 Northern Blvd., Long Island City 1, N. Y.

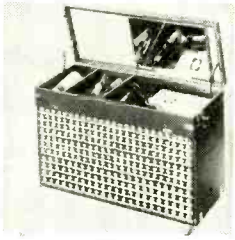
TURNTABLE REFLOCKING with *New-Flock.* A plastic sheet



with a flock-covered material on one side. Comes in 8-, 9-, 9½-, 10-, 12- and 16-inch diameter circles. Cements to turntable with plastic-to-metal glue.—**Colman Tool & Machine Co.,** Amarillo, Tex.

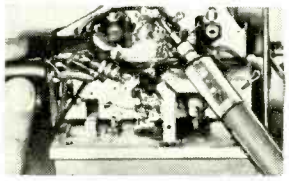
TUBE AND TOOL CADDY. The *Totemaster* holds 360 tubes and necessary tools. Consists of 4 box sections and a carrying top. Sections can be locked together in one master box or some smaller size as needed. Carrying top contains alignment mirror, 7- and 9-pin straighteners.—**Mastra Co.,** 2112 Superior Ave., Cleveland 14, Ohio.

TUBE AND TOOL CADDY. Holds 395 tubes plus tools.



Comes with 9½ x 12-inch test mirror. Plastic-covered case, metal corner reinforcements. Overall size 24½ x 16½ x 10 inches.—**Available from CBS-Hytron distributors.**

CIRCUIT TRACER. Does three jobs: continuity tracer for dead circuits, low-voltage live-circuit testing and high-voltage live-

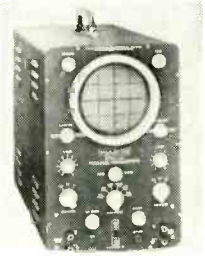


circuit testing.—**Hunter Tools,** P. O. Box 564, Whittier, Calif.

LEAKAGE TESTER, *model LC3.* Tests tubes and capacitors for leakage. Features positive test for heater–cathode leakage for series heater strings. Picture-tube socket for testing C-R tubes in the cabinet. Leakage

sensitivity, 100 megohms for tests from control grid to any other tube element and for conventional capacitor leakage tests. — **Service Instruments Corp. (Sencore),** 177 Official Rd., Addison, Ill.

OSCILLOSCOPE KIT, *model S-50.* Push-pull vertical and horizontal amplifiers. Printed-circuit amplifier design. High-



sensitivity, 1-mc vertical amplifier. Built-in 1-volt peak-to-peak calibrator. Horizontal sweep

frequency range from 20 cycles to 150 kc.—**Paco Electronics Co. Inc.,** Div. of Precision Apparatus Co., Inc., 70-31 84th St., Glendale 27, N. Y.

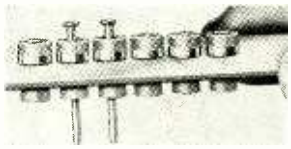
VTVM, *model 77.* Measures dc from 0–1,500 volts in 7 ranges at 11 megohms input resistance. 7 ac (rms) ranges cover 0–1,500 volts; 6 ac (peak-to-peak) ranges cover 0–2,000 volts. 7 resistance ranges from 0–1,000 megohms; 3 decibel

ranges from —10 to +58 db. Zero-center meter for discriminator alignment with full-scale range of 0-750 volts in 7 ranges.—**Superior Instruments Co.,** 2435 White Plains Road, New York 67, N. Y.

FEED-THROUGH CAPACITORS, *Tube-R-Cap.* Combine resistor and capacitor in a single ceramic tube 7/16 inches long which mounts in a 0.190-inch hole. For antenna filter applications in TV tuners. Rated at 1,000 volts dc and available in capacitances up to .001 μf. Resistances from 0.3–1 megohms.—**Centralab,** Div. of

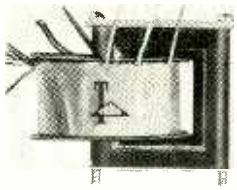
Globe Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

FEED-THROUGH CAPACITORS, *type CFT.* Rated at 600 volts dc and values from 4.7 μμf–.001 μf. Capacitors are only ⅜ inch long. The feed-through hole takes up to No. 15



AWG wire.— **Cornell-Dubilier Electric Corp.,** S. Plainfield, N. J.

TRANSFORMERS. For use with low-voltage transistor power



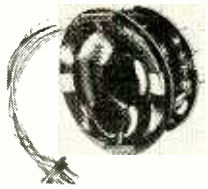
supplies. Operate on 12–14 volts dc. *Model TY-68S* delivers 250 volts at 65 ma; *TY-69-S,* 300 volts, 100 ma; *TY-70S,* 325 volts, 150 ma; *TY-71S,* 375 volts, 200 ma; *TS-74S,* 600 volts, 200 ma. — **Triad Transformer Corp.,** 4055 Redwood Ave., Venice, Calif.

ISOLATION TRANSFORMER, *Stancor model P-6371.* Specifically designed to isolate ac–dc portable TV receivers from the 117-volt line. Unit handles up

to 175 watts. One-piece drawn-steel case. Electrostatic shield. 6-foot line cord. — **Chicago Standard Transformer Corp.,** 3501 W. Addison St., Chicago 18, Ill.

REPLACEMENT FLYBACKS. *HVO-95* replaces Dumont 20006731; *HVO-104,* GE RTO-179, -4; *HVO-155,* Philco 32-8709-1; *HVO-157,* Philco 32-8572; *HVO-159,* Philco 32-8695, -1. Isolation transformer *P-3202* protects against shock hazard of ac-dc sets. Handles up to 175 watts.—**Merit Coil & Transformer Corp.,** 4427 N. Clark St., Chicago 40, Ill.

110° REPLACEMENT YOKES. *Stancor model DY-26A* replaces



RCA parts 104408, 104078, 105053, 972958-1, 2, 4, 5. *DY-27A* replaces RCA 104482 and 972958-3. — **Chicago Standard Transformer Corp.,** 3501 W. Addison St., Chicago 18, Ill.

SILICON RECTIFIERS, *type K.* Axial leads, polarity coded by colored resin at each end. Rated at 750 ma to 55°C (no

heat sink) and has PIV ratings of 100, 200, 300 and 400.— **Sarkes-Tarzian Inc.,** Rectifier Div. 415 College Ave., Bloomington, Ind.

SILICON RECTIFIERS. Complete line includes 1N1448 through 1N1481. Ratings range from 100 volts PIV at 750 ma to 400 volts at 200 amps. All-metal welded construction.— **Audio Devices Inc.,** Rectifier Division, 620 E. Dyer Rd., Santa Ana, Calif. END

All specifications given are from manufacturers' data.

Business and People

Les A. Thayer has been named general sales manager of Belden Manufacturing Co., Chicago. He had been manager of the Merchandise Division. E. K. (Gene) Butler, manager of the Industrial Division, was promoted to manager of Marketing Services. Photo shows the

company's new sales management team (left to right), Les Thayer, general sales manager; H. W. Clough, vice president, sales, and Gene Butler, manager of marketing services.

George M. Arisman, Jr., former controller of P. R. Mallory & Co. Inc., Indianapolis, has been made president and general manager of the Mallory Battery Co., Cleveland, Ohio, a Mallory

division. Frank P. Vendely (right), a distributor salesman for Mallory, was appointed merchandise manager of the Distributor Division.

Matthew D. Burns (below left) was elected a senior vice president of Sylvania Electric Products and appointed president of Sylvania Electronic Tubes, Emporium, Pa. in a move toward decentralization. Frank J. Healy was also elected a senior vice president of the company and elected president of Sylvania Lighting Products. Other new senior vice presidents include: Dr. Bennett S. Ellefson, engineering and research; W. Benton Harrison, finance;

Robert E. Lewis, Argus cameras and semiconductor products; Marion E. Pettegrew (above right), home electronics chemical and metallurgical products and

parts; **Howard L. Richardson** (upper left), electronic systems and special tubes, and **Barton K. Wickstrum** (upper right), marketing and international operations.

Harold A. DeMooy, manager of manufacturing for RCA receiving tube activities, has been appointed manager, receiving tube operations of the Electron Tube Division, Harrison, N. J.

Vincent E. Eitzen was promoted to technical assistant to S. N. Shure, president of Shure Bros., Inc., Evanston, Ill. He has been manager of manufacturing engineering since 1945.

Walther H. Feldmann was elected a director of Tung-Sol Electric Inc., Newark, N. J. He is president and a director of Worthington Corp.

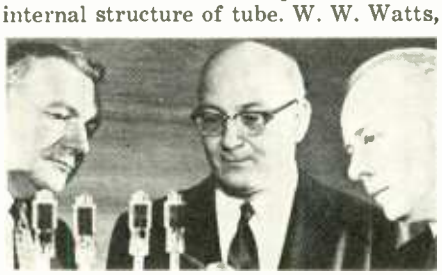
Lewis J. Shioleno, superintendent of manufacturing for the Erie Resistor Corp. Electromechanical Division, is now vice president and general manager of the corporation.

Obituary

William J. Barkley, director of the Nuclear Corp. of America and a radio industry pioneer, died recently. For 22 years he had been associated with Collins Radio Co. from which he retired in 1955 as executive vice president.

Business

RCA Electron Tube Division, Harrison, N. J., recently produced its 2-billionth electron tube. In the photo RCA president, John L. Burns, center, looks on as D. Y. Smith (right) vice president and general manager of the Electron Tube Division, points out the internal structure of tube. W. W. Watts,

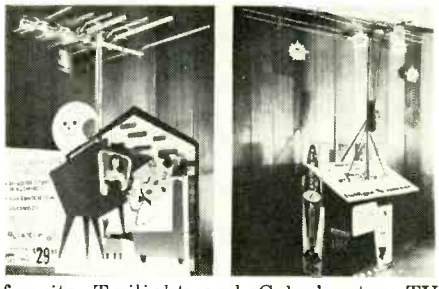


executive vice president–electronic components, is shown at left.

Transistor sales for 1957 totaled 28,738,000 units valued at $69,739,000, more than double the 1956 figure, according to a report by the EIA.

Radio receiver production of 15,427,738 units in 1957 represented the industry's best year since 1948, according to the EIA. TV production for 1957, however, dropped to 6,399,345 and sales to 6,560,220 from 7.4 million production and 6.8 million sales in 1956.

Winegard Co., Burlington, Iowa, introduced two new dealer floor displays



for its Twilight and Color'ceptor TV antennas.

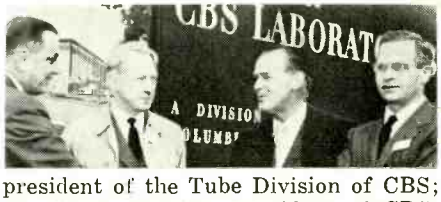
Howard W. Sams & Co., Inc., Indianapolis, designed a life-size full-color floor display for distributors of its Photofact folders. The display is part of a pro-

motion offering all-steel single-drawer files free to service technicians who purchase 60 sets of Photofact folders.

ORRadio Industries, Inc., Opelika, Ala., designed a colorful banner which

it is offering to dealers who sell its Irish Brand recording tape.

CBS officials recently presided at the ground-breaking ceremonies of CBS Laboratories' new facility in Stamford, Conn. Left to right Arthur L. Chapman,



president of the Tube Division of CBS; Dr. Frank Stanton, president of CBS; Thomas F. J. Quigley, former Mayor of Stamford, Conn., and Dr. Peter C. Goldmark. END

technical Literature

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

CONSTRUCTION MANUAL for transistor radio kit *KT-119A*. Describes in detail the building of a 6-transistor AM superhet radio. Complete specifications of the receiver are included.—Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y.

MASTER REPLACEMENT GUIDE, *Permanent Edition*. 244-page loose-leaf book of TV replacement parts. Has parts list, model index and chassis index. Also contains service notes with each manufacturer's listing. Each copy is registered in the name of the service dealer. Pages will be replaced when a change or addition to existing information is made.—**Available through Thordarson-Meissner Distributors.**

MANUFACTURER'S CERAMIC CATALOG, highlights High Alumina bodies in addition to Steatite, Cordierite and Zirconite ceramics. The 16-page 2-color catalog has sections of standard extrusions, ceramic properties and specifications, and metalizing.—Centralab, Div. of Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

COAXIAL COMPONENTS is a 28-page catalog describing a complete line of attenuators, filters, terminations, power dividers, crystal mounts, stub tuners and other coaxial components. Theory of operation and application data are included for all products as are performance data and mechanical and electrical specifications.—Microlab, 71 Okner Parkway, Livingston, N.J.

ELECTRONIC COMPONENTS CATALOG, *No. 5811*. Six sections cover flybacks, power transformers, chokes, if transformers and coils, yokes, audio transformers and rf transformers, coils and chokes. Each section features a table of exact replacement by manufacturer's part number.—Merit Coil & Transformer Corp., 4427 N. Clark St., Chicago 40, Ill.

PA AND HI-FI EQUIPMENT, *catalog No. 3000*. In its illustrated 12 pages a variety of public-address components including amplifiers, turntables, speakers and carrying cases are presented. A separate section details a hi-fi tuner and amplifier.—Mark Simpson Manu-

facturing Co. Inc. MASCO, 32-28 49th St., Long Island City, 3, N. Y.

DEFLECTION COMPONENTS are described in a 4-page 2-color catalog sheet. Descriptions and specifications are listed for each model.—**Standard Components Inc.**, 519 S. Fifth Ave., Mt. Vernon, N. Y.

FILTERS AND CAPACITORS miniaturized to cut weight and bulk are described in *Bulletin No. 57B*. Photos, schematics, charts and graphs illustrate the products listed. Data on the use of Mylar film is furnished.—**Airborne Accessories Corp.**, 1414 Chestnut Ave., Hillside 5, N. J.

SERVICE TOOL CATALOG *PA-6* presents a detailed description of several service tools and aids. Among the items offered are printed-circuit soldering aids, tube and tool caddy, miniature pin straighteners, tube pullers and lifters, tube test adapters. — **CBS-Hytron**, Advertising Service, Parker St., Newburyport, Mass.

PISTON TRIMMER CAPACITORS are offered in *bulletins 205 and 206*. Comprehensive specifications for assorted types of these units are presented. These bulletins supersede previous notices numbered *100, 101, 102* and *104*. —**JFD Electronics Corp.**, 6101 16th Ave., Brooklyn 4, N. Y.

CLOSED-CIRCUIT TV camera systems, applications and equipment are discussed in a 16-page booklet titled *What Closed-Circuit Television Means to You*. Uses in education, medicine, traffic control, production control, safety engineering and many other fields are shown. — **Blonder-Tongue Laboratories Inc.**, 9 Alling St., Newark 2, N. J.

REPLACEMENT GUIDE *STV-8* is devoted to this manufacturer's line of *Stancor* TV replacement transformers, including flybacks, yokes, powers, vertical outputs, etc. Cross-reference tables and charts make it easy to find the right replacement.—**Chicago Standard Transformer Corp.**, 3501 Addison St., Chicago 18, Ill.

TRANSFORMER CATALOG describes the full line of this manufacturer. Specifications, performance curves, application data and prices are given for all units. Transformers used in hi-fi, broadcast, and recording equipment are listed.—**Peerless Electrical Products**, Div. of Altec Lansing Corp., 6920 McKinley Ave., Los Angeles 1, Calif.

RF FILTERS, including high-pass, low-pass, diplexing and multiplexing networks and preselectors. Representative types and performance characteristics are given. The frequencies covered by the filters in this 8-page catalog ranges from 10–12,500 mc.—**Microphase Corp.**, Box 1166, Greenwich, Conn.

STEREO TAPE CATALOG lists all available tapes, including titles, artists,

selections, catalog numbers and prices. The catalog, titled *Complete Catalog of Stereo Music*, is published quarterly. —**Mooney-Rowan Publications**, Severna Park, Md. **50c each, $2 per year.**

NEEDLE CATALOG *No. 53* offers a comprehensive listing of replacement phonograph needles. Steel, durosmium, sapphire and diamond types. All are listed by manufacturer of the original equipment and all are illustrated.—**Jensen Industries Inc.**, 7333 W. Harrison St., Forest Park, Ill.

SOLDERING IRONS are described and illustrated in a colorful 8-page publication *GED-3553*. Features of the irons are explained.—**General Electric Co.**, Schenectady 5, N. Y.

ANTENNA ACCESSORIES are presented in an illustrated 8-page *catalog No. 1957* titled *Aids to Better Televiewing*. The booklet is a digest of reception aids for the home, including system components, accessories and test equipment.—**Jerrold Electronics Corp.**, 23rd & Chestnut Sts., Philadelphia 3, Pa.

PROGRESSIVE SPEAKER EXPANSION is discussed in a practical guide to aid the hi-fi consumer in planning and building up his speaker system in stages. Descriptions of speakers, networks and enclosures are also given.—**University Loudspeakers Inc.**, 80 S. Kensico Ave., White Plains, N. Y.

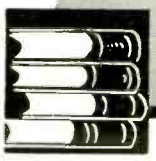
HI-FI SPEAKER AND ENCLOSURES are offered in 2 illustrated folders. One describes a speaker with a polymerized cone—the 217—and various enclosures. The other presents the details of the Hartley-Luth "Holton" speaker system.—**Hartley Products Co.**, 521 E. 162 St., New York 51, N. Y.

QUESTIONS AND ANSWERS about X-ray diffraction, diffractometry and spectography are contained in a 16-page booklet. Specimen preparation and fields of application for the three basic X-ray analysis methods are explained.—**Phillips Electronics Inc.**, Instruments Div., 750 S. Fulton Ave., Mt. Vernon, N. Y.

PICTURE-TUBE BRIGHTENERS and audio accessories such as brighteners for series and parallel heater TV sets, audio cables and accessories are listed in a 1-sheet bulletin.—**C-B-C Electronics Co., Inc.**, 2601 N. Howard St., Philadelphia 33, Pa.

VARIABLE TRANSFORMER interchangeability chart provides equivalent data on type number and output amperage of *Adjust-A-Volt*, *Powerstat* and *Variac* variable transformers. The 4-page booklet provides a cross-reference by current ratings between equivalent units of the three major manufacturers of this equipment.—**Standard Electrical Products Co.**, Dept. Q, 2240 E. Third St., Dayton, Ohio. END

Books



INSTRUCTIONS FOR AUTO RADIO REMOVAL—1956—1957. Howard W. Sams & Co. Inc., 2205 E. 46 St., Indianapolis 5, Ind. 5½ x 8½ inches, 1956—99 pages; 1957—116 pages. $2.95 each.

If you work on auto radios these guides can save you hours. Step-by-step instructions for removing the radio, power supply and speaker from most models of cars are given. A brief summary of preliminary servicing procedures, to see if you have to pull the radio, is included.—*LS*

INDUSTRIAL ELECTRONICS CIRCUITS, by R. Kretzman. Philosophical Library Inc., 15 E. 40 St., New York 16, N. Y. 9 x 6 inches, 194 pages. $10.

In this originally German work, a sequel to the *Industrial Electronics Handbook*, the circuitry of industrial electronic apparatus is the topic and over 200 circuits are shown. Among the devices discussed are photoelectric control circuits, counting circuits, switching and control circuits, rectifying circuits and motor controls. The text is intended for engineers, technicians and students concerned with the development and design of electronic equipment.—*LS*

SIMPLIFIED ELECTRONICS by Rufus P. Turner. Trend Books, Inc., 5959 Hollywood Blvd., Los Angeles 28, Calif. 6½ x 9½ inches, 129 pages. 75c.

For the beginner who knows very little or nothing of this subject. It discusses radio, radar, transistors and instruments from elementary theory to modern practice. Topics range from make-it-yourself radios to atom smashers.—*IQ*

PICTURE BOOK OF TV TROUBLES, Vol. 6—Horizontal & Vertical Sync Circuits. John F. Rider Publisher, 116 W. 14 St., New York, N. Y. 5½ x 8½ inches, 120 pages. $1.80.

This sixth part of an eight-part series covers the sometimes confusing horizontal and vertical sync circuits. A typical fault as seen on the screen is presented. Then the circuit is traced (waveforms shown) until the faulty part is discovered. An aid to the technician and student.

SERVICING TV SYNC CIRCUITS by Jesse Dines. Howard W. Sams & Co. Inc., 2205 E. 46 St., Indianapolis 5, Ind. 5½ x 8½ inches, 311 pages. $3.95.

Here, presented for the TV techni-

cian, is the theory of operation, circuit function and circuit variations of the many types of sync systems found in TV receivers. More important than just theory, many pointers toward analyzing and troubleshooting these circuits are presented.—*LS*

ENERGY, by Sir Oliver Lodge; SOUND, by Alexander Efron; HEAT, by Alexander Efron (Basic Science Series). John F. Rider Publisher, Inc., 116 W. 14 St., New York, N. Y. 5½ x 7½ inches, 54, 72 and 105 pages, respectively. *ENERGY* and *SOUND*, $1.25 each. *HEAT*, $1.50.

A series of books intended to give the electronics technician some idea of the various fields of physics which interlink with his own. (Other books planned for the series are *Optics, Mechanics, Liquids and Gases* and *Nuclear Energy*.)

The subject matter is held to fundamentals, as might be expected in texts of this type. *Energy* is Lodge's famous 1929 work updated to 1957. All three are illustrated effectively.—*FS*

THE SPACE ENCYCLOPAEDIA, E. P. Dutton & Co., Inc., 300 4th Ave., New York, N. Y. 6¼ x 9½ inches, 287 pages. $6.95.

Nearly everybody is excited about space and sputniks. This space guidebook explains relativity, the universe, space medicine and the most recent rockets.

Electronics will play a heavy role in space travel safety. Among references to be found here are: radio astronomy, Geiger counters, communications and Doppler radio.

The book is prepared by eminent scientists, but is nontechnical and well illustrated.—*IQ*

TELEVISION RECEIVING EQUIPMENT, 4th Edition, by W. T. Cocking. Philosophical Library, Inc., 15 E. 40th St., New York 16, N.Y. 5½ x 8¾ inches, 454 pages. $15.

This new edition is highly informative, covering British TV receiving circuits. It is slanted toward theory and design rather than servicing, but can be helpful to service technicians because it describes the function and operation of each portion of a receiver. Many charts and numerical examples are incorporated in the text. Useful design equations are presented in several appendices at the end of the book. —*IQ*

BASIC MATHEMATICS FOR ELECTRICITY, RADIO AND TELEVISION. by Bertrand B. Singer. McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N.Y. 6 x 9 inches, 513 pages. $7.50.

Every radioman, whether mechanic, technician or engineer must know some math. From this clearly written book he can acquire that knowledge or refresh his memory. It is purely practical,

with many problems worked out in detail. Even if you dislike the subject, you may find it not so uninteresting after all.

Beginning with simpler circuits, topics include meter multipliers, wire tables, load resistance and cathode bias. Under ac, reactance and impedance problems are worked out among others. Elementary trig and vectors are also applied to radio circuits.

VHF TELEVISION TUNERS by D. H. Fisher. Philosophical Library Inc., 15 E. 40 St., New York 16, N. Y. 8½ x 5½ inches, 136 pages. $6.

The text presents a detailed technical discussion of television tuners. It deals only with the two major types—switch and turret. Although highly technical and perhaps difficult (due to the difference between some American terms and the English terms of the author), it is a good reference for the engineer or advanced technician.—*LS*

LIMITERS AND CLIPPERS, edited by Alexander Schure, John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N. Y. 5½ x 8½ inches, 56 pages. $1.25.

This is one of a review series of booklets on electronics. It describes diodes, triodes and multi-grid tubes as limiters. It shows various methods by which portions of a wave are clipped. Among applications described are noise clippers, voltage regulators, wave shapers and square-wave generators. END

AUTOMATIC CONTROL

The University of Michigan, College of Engineering, has announced a summer intensive course in automatic control scheduled for June 16 to 25, 1958, inclusive. The course is intended for engineers who wish to obtain a basic understanding of the field, but cannot spare more than a few days for this purpose. The aim of the course is to make the subject matter easy to learn by a coherent presentation in class of the fundamentals of modern automatic control, and by providing a comprehensive set of notes which will serve as a framework for further study.

The course is built around the principles and application of measurement, communication and control. The material will begin with the fundamentals in each of these fields and will include some basic work in nonlinear systems. This will be followed by applications of the fundamentals to more advanced problems. There will be four hours of lecture each morning and three hours of laboratory demonstration in the afternoon. Extensive use will be made of computing, instrumentation, and servo laboratories on the campus. The role of analog computing methods will be emphasized. This course has been given in the summers since 1953.

April 15 is the closing date for registration. Further information may be obtained by writing to Prof. L. L. Rauch, Room 1525 B, East Engineering Building, University of Michigan, Ann Arbor, Mich.

SCHOOL DIRECTORY

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

SCHOOL DIRECTORY PAGE 157

Baltimore Technical Institute
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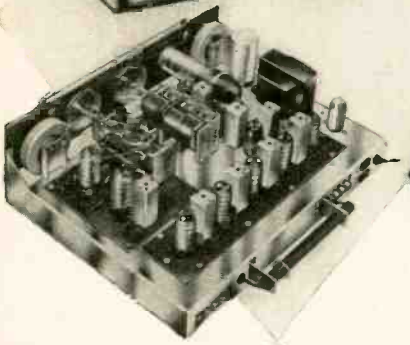


KT-500 IN KIT FORM **74.50**

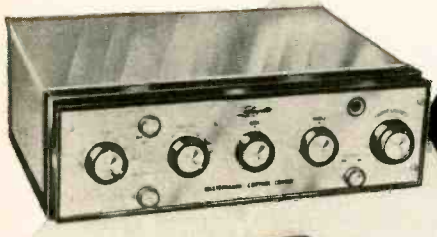
More than a year of research, planning and engineering went into the making of the Lafayette Stereo Tuner. Its unique flexibility permits the reception of binaural broadcasting (simultaneous transmission on both FM and AM), the independent operation of both the FM and AM sections at the same time, and the ordinary reception of either FM or AM. The AM and FM sections are separately tuned, each with a separate 3-gang tuning condenser, separate flywheel tuning and separate volume control for proper balancing when used for binaural programs. Simplified accurate knife-edge tuning is provided by magic eye which operates independently on FM and AM. Automatic frequency control "locks in" FM signal permanently. Aside from its unique flexibility, this is, above all else, a quality high-fidelity tuner incorporating features found exclusively in the highest priced tuners.

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.

The new Lafayette Model KT-500 Stereo FM-AM Tuner is a companion piece to the Models KT-300 Audio Control Center Kit and KT-400 70-watt Basic Amplifier Kit and the "Triumvirate" of these 3 units form the heart of a top quality stereo hi-fi system.

KT-500 ..... Net **74.50**



KT-300 IN KIT FORM **39.50**

LAFAYETTE MASTER AUDIO CONTROL CENTER with BINAURAL CHANNEL AND DUAL VOLUME CONTROL.

- **Self-Powered**
- **DC On All Filaments**
- **24 Positions of Equalization**
- **Tape Head Input, High Impedance**
- **Dual Cathode Follower Output Stages**

This is not only the finest hi-fi preamp characterized by unmatched features, but it has been functionally designed to keep pace with the conversion of your present hi-fi system to binaural (Stereophonic) sound. Incorporates an extra channel and dual volume control for binaural reproduction. Features include DC on all tube filaments, negative feedback in every stage, dual cathode follower output stages and latest printed circuit construction. Less than 0.09% IM distortion and less than 0.07 harmonic distortion at 1V. Hum and noise level better than 80 db below 3V. Uniformly flat frequency response over entire audible spectrum. 7 inputs for every type of phono, tuner or tape. Tasteful styling, brilliantly executed. Size 12¾ x 9⅛ x 3¾". Shpg. wt., 10½ lbs.

KT-300—Lafayette Master Audio Control Kit Complete with cage and detailed assembly instructions. ..... Net **39.50**

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- **Conservatively Rated At 70 Watts**
- **Inverse Feedback**
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- **Available In Kit and Wired Form**

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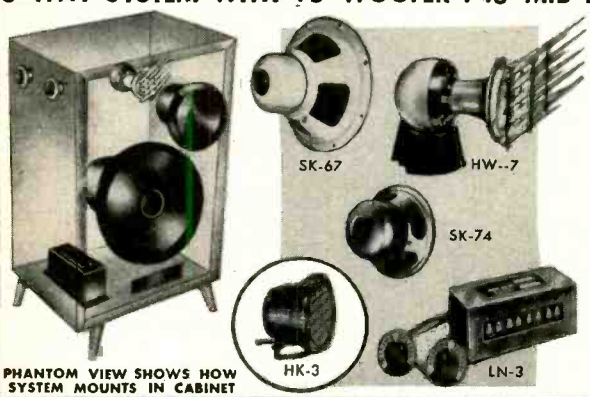

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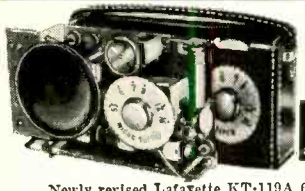

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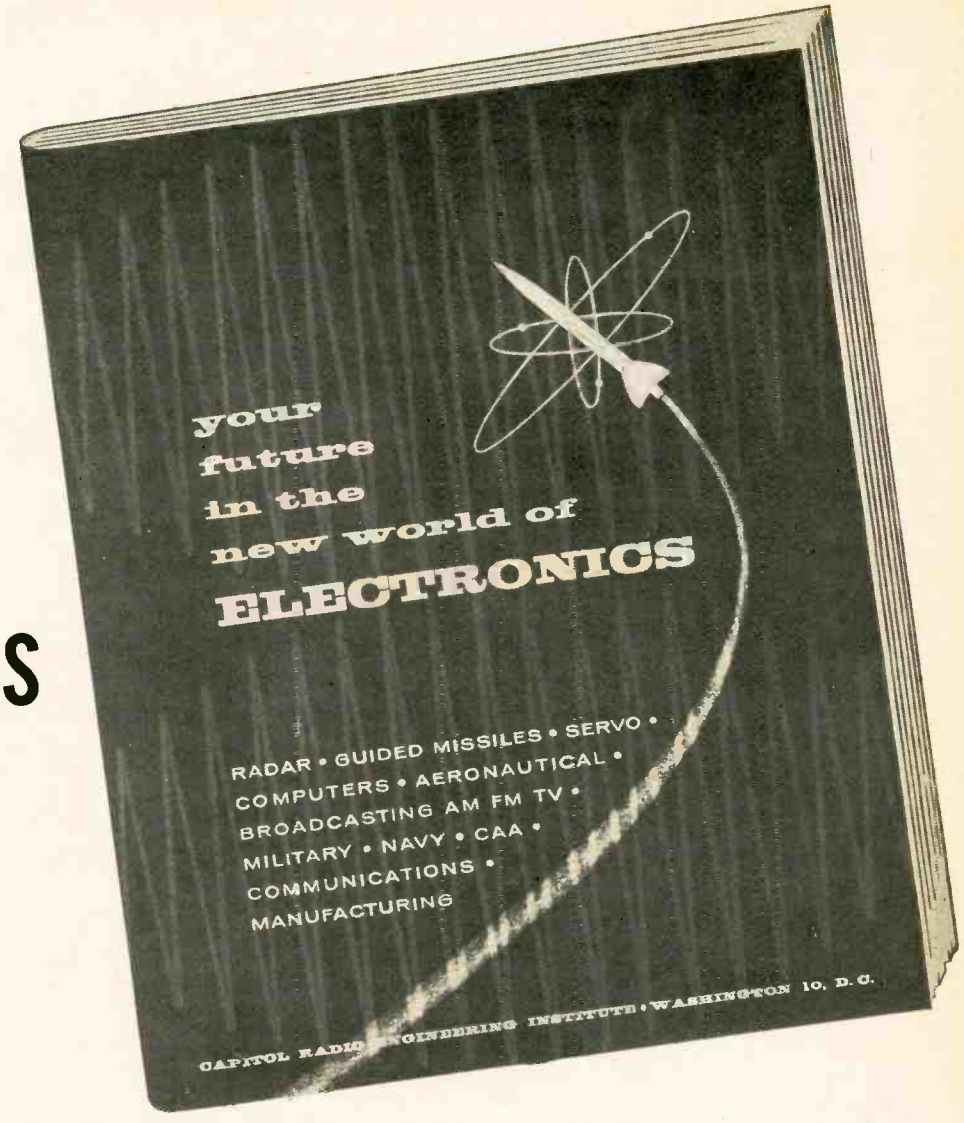

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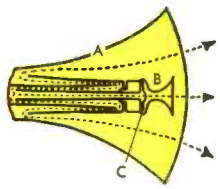
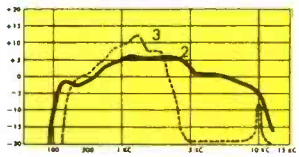


2 This is the frequency response curve of a CDP.

3 This is the frequency response curve of a conventional P. A. horn.



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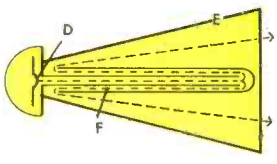

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