ANNUAL TELEVISION NUMBER

RADIO — ELECTRONICS

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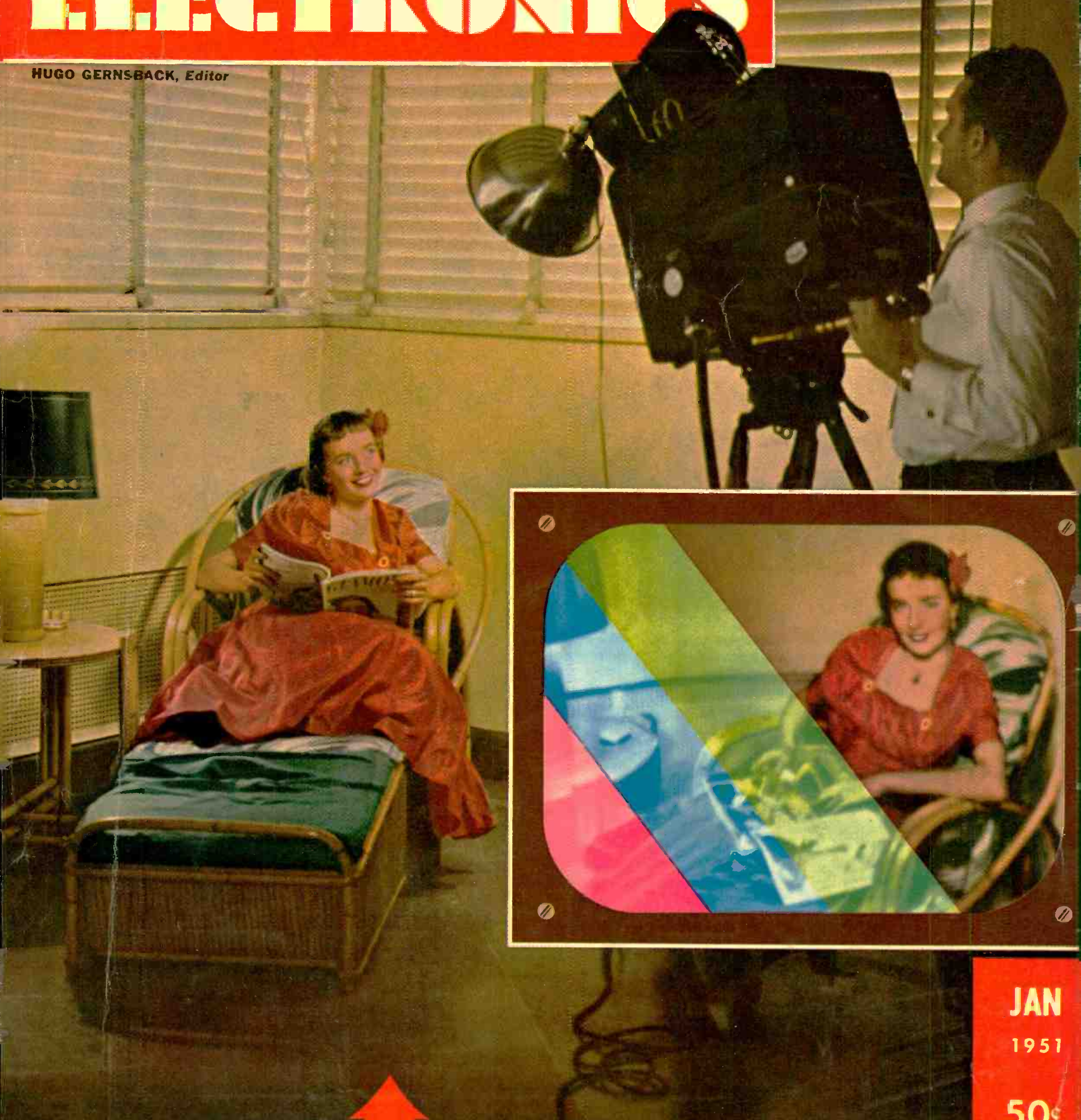
HUGO GERNSBACK, Editor



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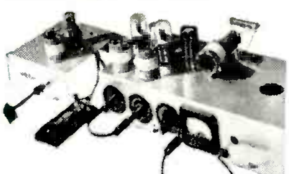
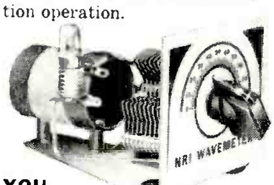


YOU PRACTICE setting up code, amplitude and frequency modulation circuits (put voice, music, etc., on "carrier signals" you produce). You learn how to get best performance.



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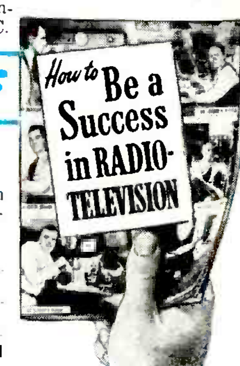

RADIO — ELECTRONICS

Incorporating
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Annual Television Number

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ON THE COVER: Model Naomi Riordan poses for the three-color camera in a demonstration of Du Mont closed-circuit 18-mc color television. Insert shows her appearance on the screen, with breakup into the three primary colors.
Kodachrome by Avery Slack.

RADIO ELECTRONICS, January 1951, Volume XXII, No. 4. Published monthly. Publication Office: Erie Ave., F to G Streets, Philadelphia 32, Pa. Entered as second class matter September 27, 1948, at the post office at Philadelphia, Pa., under the Act of March 3, 1879. **SUBSCRIPTION RATES:** In U. S. and Canada, in U. S. possessions, Mexico, South and Central American countries, $3.50; $6.00 for two years; $8.00 for three years; single copies 30c. All other foreign countries $4.50 a year, $8.00 for two years, $11.00 for three years. Allow one month for change of address. When ordering a change please furnish an address stencil impression from a recent wrapper. **RADCRAFT PUBLICATIONS, INC.** Hugo Gernsback, Pres.; M. Harvey Gernsback, Vice-Pres.; G. Aliquo, Sec'y.

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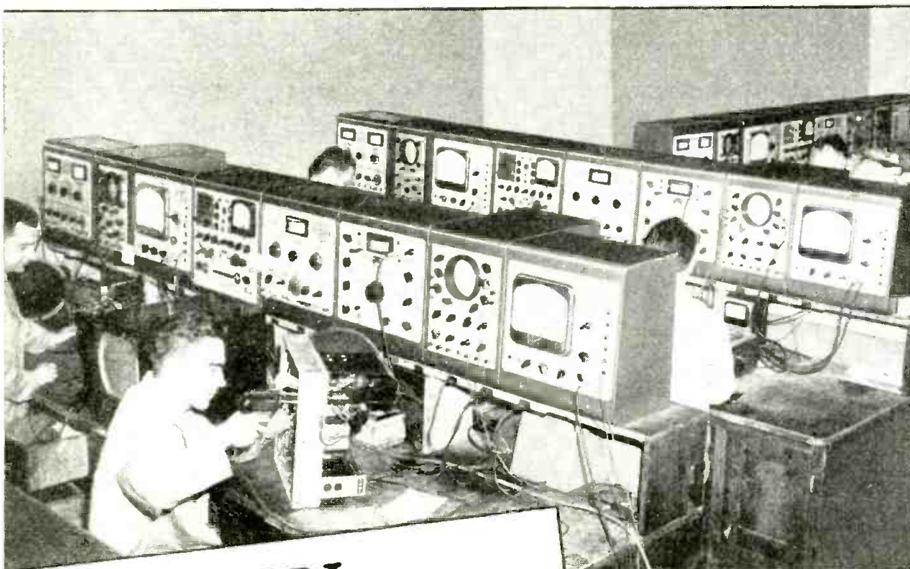

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can help you to better jobs in servicing or Armed Services!

ADS LIKE these testify to the demand that exists for qualified TV technicians. As one well-informed industry spokesman puts it, "Technicians may soon be as scarce as certain tubes." With the electronics industry expanding, and with growing military demands cutting sharply into the available supply of skilled personnel, now is certainly the time to improve your electronics know-how. And if you're headed for the Armed Services, your improved technical ability can be recognized and rewarded with interesting supervisory work at higher ratings in vital radar, navigation, or communications units.

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Now is unquestionably the time to prepare. If you want promotion, more money, and the kind of training that is respected by industry and the Armed Services, investigate CREI. Send for—and study—the free booklet offered below. The sooner you begin your training, the better off you'll be—in TV servicing work, or in military service. The cost is nominal for this training, the terms easy. Send for complete data—right now!

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GENERAL ELECTRIC

181-KA1

TV PIONEERS Hugo Gernsback, publisher of RADIO-ELECTRONICS, and Isidor Goldberg, president of Pilot Radio Corporation, were presented scrolls by student members of the Institute of Radio Engineers and the American Institute of Electrical Engineers at New

Mr. Gernsback, right, accepts a scroll honoring his part in the first regular TV broadcasts from Emilio M. Pacifico, AIEE student branch chairman at NYU.

York University in recognition of their contributions to the development of television. The occasion was a demonstration by the students showing how television looked in 1928 when Gernsback's station WRNY began the first regular broadcasting of images in New York. The students used equipment similar to that made for the original station by Pilot Radio Corporation.

The scroll which Mr. Gernsback received was inscribed "Members of student branches of the Institute of Radio Engineers and the American Institute of Electrical Engineers at New York University College of Engineering present this scroll to Mr. Hugo Gernsback, publisher, RADIO-ELECTRONICS, in recognition of his pioneering contribution toward the success of an historic television demonstration which took place on the same site twenty-two years ago in Amphitheatre, Philosophy Hall, University Heights, when station WRNY inaugurated regular daily television broadcast service." Robert Hertzberg, one of the technicians who helped with the original broadcast and now a writer well known to readers of technical magazines, was master of ceremonies.

ILLEGAL TV, the first case discovered by the FCC, was reported recently. Broadcasting intermittently from September 1 to October 19, the station was constructed and operated by the Tube Division of Sylvania Electric Products, Inc., at Emporium, Pa. The station picked up broadcasts from channel 13 station WJAC-TV in Johnstown, Pa., and rebroadcast them on channel 7.

The transmitter was located on a mountain top near Emporium and was built at a cost of about $7,000. Sylvania officials said they needed such facilities for their work. They did not apply for authority for the station because they knew the FCC could not grant it at the time (due to the television "freeze") and believed they were not interfering with any other service.

The townspeople of Emporium agreed that the Federal authority must be obeyed, but were somewhat irked at the closing of the station because it left them with no TV service other than erratic fringe reception.

BRAIN DIAGNOSIS with sound waves was disclosed at a recent joint meeting of the IRE and the AIEE. Low-intensity ultrasonic waves are passed through the brain and are picked up on the other side of the patient's head with a detector. The waves are attenuated as they pass through cerebral tissues, but they pass undiminished through the cerebral fluids. The result is a "map" showing the fluid-filled parts of the brain. This technique is superior to X-rays which pass through tissue and fluid with nearly the same strength.

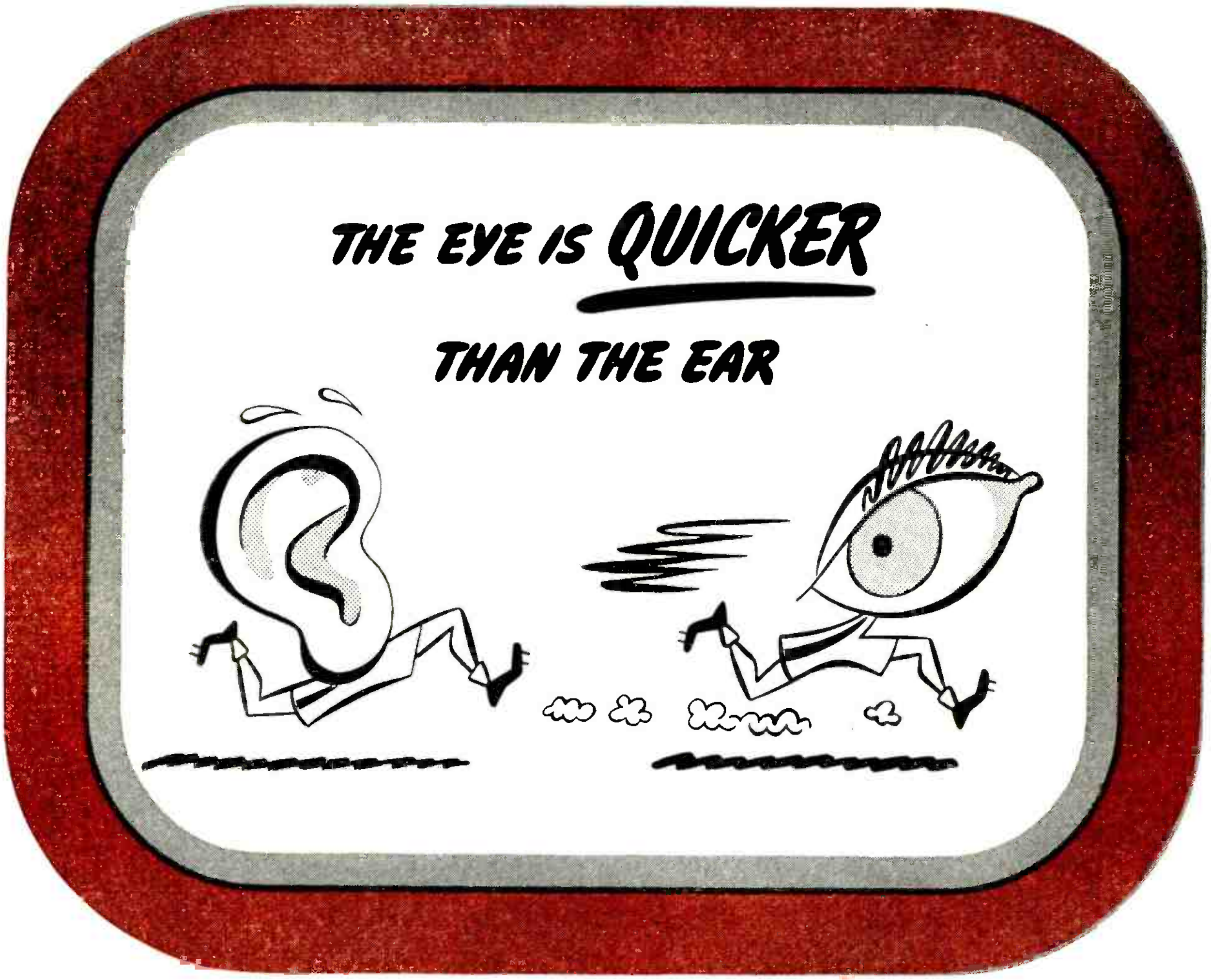
Stomach diagnosis of disease, including cancer, was reported at the annual clinical congress of the American College of Surgeons. Using improved apparatus, the technique measures the electrical potential difference between the empty stomach and some other part of the body. Certain stimuli, such as the ingestion of milk, are then applied to the stomach, and the response is observed. The change in electrical potential is different for different pathological states.

NEW OFFICERS have been elected by the Institute of Radio Engineers. Succeeding Raymond F. Guy as president

Ivan S. Coggleshall, new IRE president.

is Ivan S. Coggleshall, traffic manager of the Western Union Telegraph Co.'s overseas communications. The new vice-president is C. F. Rybner, professor of telecommunications at the Royal Technical University of Denmark in Copenhagen.

608-FOOT TOWER, built at a cost of $93,000 for radio station KHQ, in Spokane, Wash. crashed to the ground two days before it was to be completed. Built to almost three-fourths its planned height of 826 feet, the steel structure was to replace another tower snapped in half by a windstorm about a year ago.



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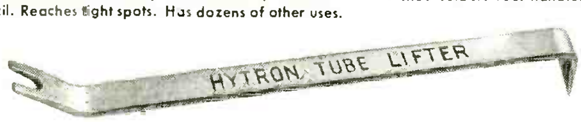
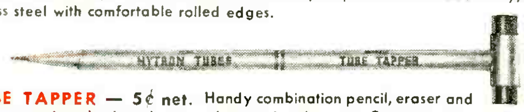


HYTRON TUBE LIFTER — 15¢ net. *Lift* 'em all the e-a-s-y prybar way: Tubes (GT, G, standard, lock-in, metal). Vibrators and plugs (Jones, Amphenol) — and knobs. A natural for compact auto radios, etc. Slotted end lifts lock-ins, snap-in trimounts . . . easily, safely. Of stainless steel with comfortable rolled edges.



HYTRON TUBE TAPPER — 5¢ net. Handy combination pencil, eraser and tube tapper. Discovers microphonism, shorts, and opens in tubes, etc. Compact, non-metallic, rugged. Doubles in brass for writing orders, etc.

HYTRON TUBE PULLER — 75¢ net. Pull or insert 7-pin miniatures the e-a-s-y way. Neoprene rubber puller works by suction and friction on top of tube. Positive grip. Reaches tight spots. Another Hytron time-temper-and-money saver.

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by SERVICEMEN A HYTRON TOOL for SERVICEMEN

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RADIO AND ELECTRONICS CORP.

MAIN OFFICE:
SALEM, MASSACHUSETTS

TV NETWORKS may have to share time more equally in communities having only a small number of TV outlets if rules proposed by the FCC are put in effect. In one case, an FCC survey showed that NBC, in one sample week, furnished more network programs to seventeen one-station communities than the other three networks using the same coaxial cables combined.

The proposal would limit the number of hours a station could take from any one network, and this would depend on the number of stations serving the same area.

SHIP COLLISIONS will be reduced by a new method of radar computation developed by Capt. Edward C. Holden, U.S.N.R. Failure of radar officers to determine accurately the course and speed of radar targets and evaluating the targets mentally was partly responsible for the 363 ship collisions during the year ending July 1.

Capt. Holden's new method requires an accurate plot of the target as seen on the radar screen and helps to determine the course and speed of the target. The plot shows the dead reckoning of the observing vessel as well as the course and speed of the target and the distance between the two. Five-minute checks, made possible by special scales on the plotting board, enable the officer to determine how close the vessels will pass each other and the exact time.

HIGH DEFINITION system for black-and-white television was submitted to the FCC by the General Electric Co. Robert B. Dome, G-E engineering consultant, stated that the system will provide upward of 50% increase in horizontal detail when incorporated in transmitters and receivers. Reception by present TV sets would not be affected.

The system provides for the sending and receiving of fine and super-fine detail alternately. Since all precision equipment is at the transmitter, receivers using the system would be relatively low in cost and easy to adjust and maintain, although several more tubes are needed than in present sets.

CLASSROOM TV, now in its third year in Philadelphia public schools, has been so successful that thirty states and four foreign countries have asked the Philadelphia school board how to start educational programs of their own.

The city's three commercial stations broadcast unsponsored, school-planned programs to 200,000 students who look in on 16-inch or larger sets provided by the Home School Council. There are now 40 sets in various elementary and high schools in the city and 60 more in suburban areas.

The children themselves participate in some of the programs which take up four hours a week of school time in half- to one-hour programs. Among the billings are Encyclopaedia Brittanica movies, a "science is fun" program, and others dealing in city government, local, national and world affairs.

ROBERT B. DOME, electrical consultant for the General Electric Co. will be awarded the Morris Liebman Memorial Prize for 1951 by the Institute of Radio Engineers for his contributions to intercarrier TV reception, wide-band phase-shift networks, and various innovations in FM receiver circuits.

Alan B. MacNee, brilliant young assistant professor of electrical engineering at the University of Michigan, will receive the Browder J. Thompson Prize for his paper "An Electronic Differential Analyzer," published in the November, 1949, *Proceedings of the IRE*. This award is given annually to the author under thirty years old for that paper recently published by the IRE which is the best combination of technical contribution and presentation of the subject.

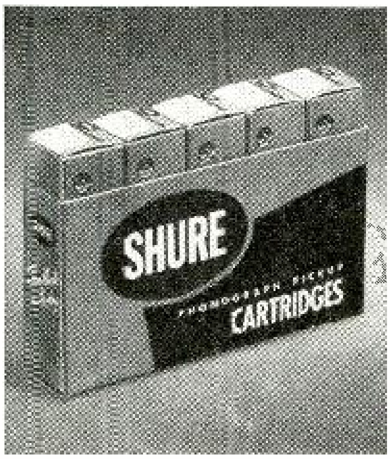
The Harry Diamond Memorial Award, given to persons in government service, will be presented to Marcel J. E. Golay of the Fort Monmouth Signal Corps Laboratories for his contributions to the Signal Corps research program, and for work with the infra-red-radio gap.

Willis W. Harmon, associate professor at the University of Florida, will receive the Editor's Award, established to stimulate good English in technical papers, for his paper "Special Relativity and the Electron", published in the November, 1949, *Proceedings of the IRE*.

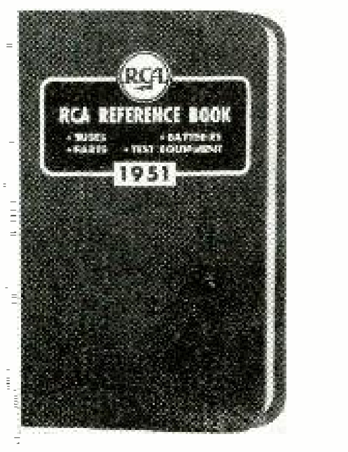
Merchandising and Promotion

Jensen Industries, Inc., is issuing a colorful new nylon-needle counter display card. The display holds 12 needles with sapphire or osmium tips. The needles come in three sizes: standard for 78 r.p.m.; microgroove for 45 and 33⅓ r.p.m., and all-purpose for all three speeds. Display and needles are available through distributors or directly from the company.

Shure Brothers, Inc., has a new cardboard sleeve which holds five phonograph pickup cartridge cartons. The sleeve permits neat arrangement and easy stock rotation. The company believes this is the first cardboard container sleeve ever devised for pickup cartridges.



RCA Tube Department has shipped the 1951 edition of its pocket *Reference Book* to tube and parts distributors for issue to service dealers, engineers, technicians, and purchasing agents. The book contains electronic information as well as a diary, calendar, memo, address book, and world atlas. A feature of the new edition is an article on TV trouble shooting by John Meagher, RCA Tube Division's TV specialist.



Electrovox Co., Inc., has introduced a new aid for phono servicing—a pocket manual with a summary of all phonographs by year, model number, cartridge, and needle. It lists cartridges with drawings and installation notes. Finally the manual includes a selection of 13 basic needles which cover about 90% of replacement demand. Complete with the needles, the condensed Walco Master Control Index, for service technicians is priced at $10.

Production

The **RTMA** reported that TV sets in October were produced at an all-time high rate of 203,462 per week, making a monthly total of 813,851. For the first ten months of 1950 production reached 5,777,610 TV sets.

The 10-month total on radio production in 1950 was 11,481,823. A breakdown of this figure shows 6,624,484 home radios, 3,357,544 auto radios, and 1,499,795 portables.

Servicing Business

RCA Service Co. president, E. C. Cahill, recently stated that an additional 10,000 service technicians will be required to install and service the 2,000,000 TV sets produced and sold in the last few months of 1950. He pointed to the incredible growth of the industry, the length of time required to train competent TV technicians, and the drain of defense and government agencies as the three main problems facing the servicing industry. RCA, he explained, is attempting to combat the increasing shortage of technicians by expanding its training program.

The number of homes with radio sets was 41,500,000 as of July 1950—more than 95% of all U. S. homes. About four out of ten homes own more than one set. The total number of radio sets in use is estimated at about 85,000,000. They are served by more than 2,000 AM stations and 500 FM stations.

New Plants & Expansions

Raytheon Manufacturing Co.'s new pilot plant in Quincy, Mass., is now in production. Operated by the company's receiving tube division, the plant manufactures miniature and subminiature tubes for military requirements.

Workshop Associates, Inc., Needham Heights, Mass., moved to a new factory. The new plant will triple the TV antenna production capacity.

Radio Receptor Co., Inc., purchased a 90,000-square-foot factory building in Brooklyn, N. Y. The new four-story concrete building will be used in addition to the company's present 50,000-square-foot plant to step up production of radio and electronic components.

The RAYTHEON *Bonded* ELECTRONIC TECHNICIAN PROGRAM provides four compelling ways to create customer confidence—Certificates, Identification Cards, Creed Displays and Decals. Bonded Dealers who use these service-business builders to identify themselves as capable, dependable technicians are finding them positive protection against the recent attacks on the integrity of Television and Radio Service companies.

If you're a Raytheon *Bonded* Dealer, prominently display your *new 1951 Certificate*—be sure your men use their *Identification Cards.* Ask your Raytheon Distributor for more *Creed Displays* for window and counter use, and get enough *Bonded Decals* to adorn every window and door. These *Bonded* pieces are as important to your business as the tools in your kit.

If you're not a Bonded Dealer, better get in touch with the Raytheon Distributor in your locality. Find out if you can qualify for the Bond! If you can, this great program that cash-protects your 90-day guarantee on TV and Radio repairs is yours *absolutely free,* because *the Bonded Program is Raytheon's investment in your future!*

HERE ARE MORE WAYS TO INFLUENCE CUSTOMERS!
RAYTHEON'S TERRIFIC COLLECTION OF SALES AND SERVICE AIDS!

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RADIO AND TELEVISION RECEIVING TUBES • CATHODE RAY TUBES
SPECIAL PURPOSE TUBES • SUBMINIATURE TUBES
MICROWAVE TUBES

The **Technical Appliance Co.**, Sherburne, N. Y., manufacturer of TACO antennas expanded its manufacturing facilities to provide for 50% greater production and new and larger quarters for the engineering department.

Financial Reports

First 9 months	1950	1949
American Phenolic Corp.		
Earnings	$722,710	$410,750
Sales	$8,857,700	$7,358,615
Belden Manufacturing Co.		
Earnings	$1,121,043	$275,596
Sales	not given	not given
Electric Auto-Lite Co.		
Earnings	$9,984,391	$7,330,652
Sales	$170,597,077	$167,975,049
Gabriel Co. (Parent Company of Ward Products)		
Earnings	$611,513	$278,270
Sales	not given	not given
General Bronze Corp. (Parent company of Brach Mfg., Co.)		
Earnings	$1,083,822	$355,606
Sales	$14,239,000	$7,800,333
Hytron Radio & Electronics Corp.		
Earnings	$2,514,374	$312,499
Sales	$26,619,753	$9,498,804
Muter Co.		
Earnings	$774,480	$34,486
Sales	not given	not given
National Union Radio Corp.		
Earnings	$606,891	$75,309 (loss)
Sales	$9,488,912	$5,653,082
Sylvania Electric Products, Inc.		
Earnings	$5,129,080	$1,911,597
Sales	$105,778,320	$73,041,240
Radio Corporation of America		
Earnings	$33,384,637	$14,095,186
Sales	$395,741,391	$275,673,666

Dividends

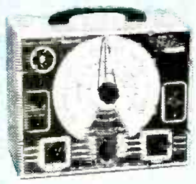
Gabriel Co., parent company of Ward Products, voted a 10% stock dividend and a quarterly dividend of 15¢ on common stock.
General Electric Co., announced a special dividend of $1 per share payable Dec. 6.
Hytron Radio & Electronics Corp., declared a special dividend of 10¢ on common stock. The company also recalled all outstanding preferred stock for conversion to common shares.
Westinghouse Electric Corp., declared an extra dividend of 40¢ plus the regular 40¢ interim payment.

Business Briefs

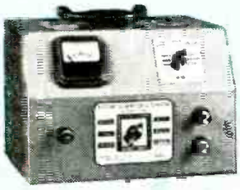
RTMA officers, committees, and directors met in New York Nov. 14-16 to discuss major problems facing the industry. A public relations program on color, u.h.f. proceedings, a code of advertising ethics, military procurement, and the proposed excess profits tax were among the subjects considered.
. . . **Capehart-Farnsworth Corp.**, donated a complete television transmitter unit to Indiana Technical College of Fort Wayne, Ind.
. . . **Stromberg-Carlson** has eliminated built-in antennas from current TV sets.
. . . **Allen B. Du Mont Laboratories** demonstrated its two-way, closed-circuit TV conference system by staging a dealer meeting covering an area from St. Louis to Boston.

EICO KITS and INSTRUMENTS

320K SIG. GEN. KIT $19.95
Wired $29.95

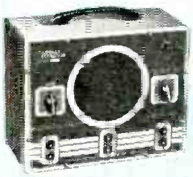


New 950K COND.-RES. COMP. BRIDGE KIT $19.95 Wired $29.95

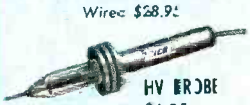


New 1040K BATTERY ELIM. KIT $22.95 Wired $29.95

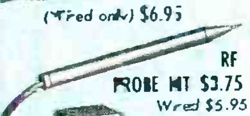
511K VOM KIT $14.95
Wired $17.95



145K SIG. TRACER KIT $18.95
Wired $28.95

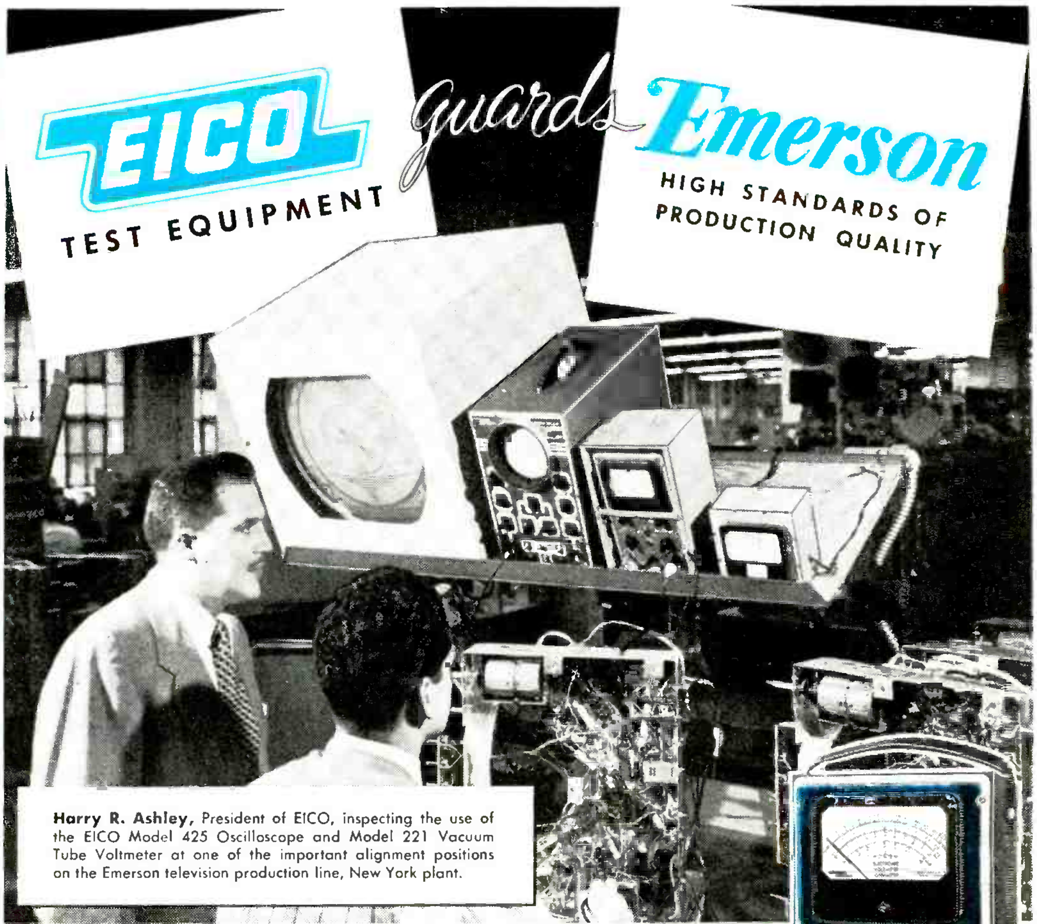


HV PROBE (Wired only) $6.95



RF PROBE KIT $3.75
Wired $5.95

C-5 3MC CRYSTAL $3.95



Harry R. Ashley, President of EICO, inspecting the use of the EICO Model 425 Oscilloscope and Model 221 Vacuum Tube Voltmeter at one of the important alignment positions on the Emerson television production line, New York plant.

For Laboratory Precision at Lowest Cost—the Leaders Look to EICO!

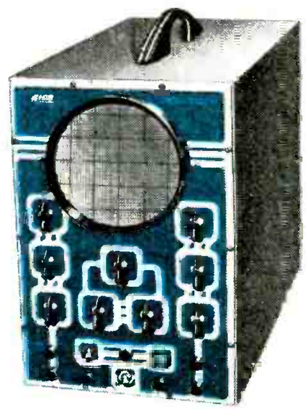
FOR electronics test equipment, there's no tougher proving ground than the factories where TV sets are made. There's where the pace is fastest, precision requirements the highest, costs the tightest—and day-after-day dependability an absolute *must.*

In both the giant New York and New Jersey television plants of the Emerson Radio & Phonograph Corporation — at the many critical constant-duty testing positions along the production line—EICO instruments stand guard. For Emerson has found that for speed, accuracy and trustworthiness, at lowest cost, EICO instruments always deliver the fullest measure of value.

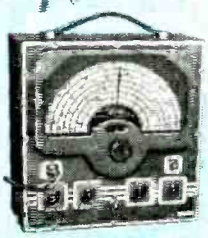
From coast to coast, in one leading TV factory after another, this is the experience—*this is the proof of EICO superiority*—that is repeated again and again. The top-flight TV set makers have discovered—and over 50,000 servicemen have learned—that *for the industry's greatest instrument values, at the industry's lowest costs—it's EICO!*

Be sure you look at the *EICO* line *before you buy any higher-priced equipment!* Each *EICO* product is jam-packed with unbelievable value. *YOU* be the judge—*compare EICO at your local jobber today*—and *SAVE!* Write *NOW* for free newest Catalog C.

New 221K VTVM KIT $23.95
Wired $49.95

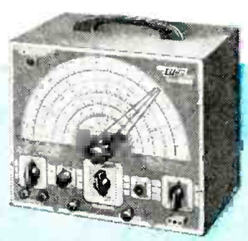


New 425K 5" SCOPE KIT $39.95
Wired $69.95



New 315K DELUXE SIG. GEN. KIT $39.95 Wired $59.95

New 625K TUBE TESTER KIT $29.95
Wired $44.95



360K SWEEP GEN. KIT $29.95
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276 NEWPORT STREET, BROOKLYN 12, NEW YORK

Prices 5% higher on West Coast. Due to unsettled conditions, prices and specifications are subject to change without notice.

The Tele-Theater

. . . The next great television development . . .

By HUGO GERNSBACK

TELEVISION in the home is only one of the many phases of a still new art. Commercial television is now in the ascendency, and no man can predict how far it will go.

Theater television is a term which has been misunderstood by many, even in the television industry. Television in the theater does not necessarily mean the showing in motion picture houses of newsworthy events such as baseball games, football matches, etc., as they take place.

There is, however, a very important TV phase, which, many years ago the writer termed "tele-theater." In this purely commercial aspect of television the plays are not shown in the home, but only in the theater—to persons who paid their admission.

In the United States the legitimate theater is actually represented in only a few of our larger cities. Even in these the hit New York shows are not always to be found. This makes for a unique and deplorable situation with visitors to New York storming the hit shows only to be turned away because no seats are available, frequently not even at a cost of $50 to $75 for a pair of tickets to such hits as *South Pacific*, etc.

By means of television, however, it will soon be possible to bring to every city and town in the United States *every* top-flight drama and show. No one will dispute the fact that New York is the theater's recognized center. By means of television every possible live show will be televised throughout the country at an admission price within the reach of everyone.

With color television now assured within the next few years and by using projection television, it will be possible for an audience in Sioux Falls to witness a New York musical as if the viewers were in New York.

This idea is by no means new. When television was in its infancy, the writer covered this subject under the title of "The Tele-Theater" in the January-February, 1932, issue of TELEVISION NEWS, of which the following is a condensation:

"The great inroads which the motion picture has made on the legitimate stage are becoming more serious right along and, if something is not done soon, we may have nothing but motion pictures left because, from year to year, it becomes more unprofitable for producers to put on legitimate performances. The reason for this is, of course, that it is impossible to give a "legitimate" performance for 50¢—a price which could compete with the motion-picture houses. The prices for the drama in New York, for a good orchestra seat, are from $3.50 up, and for musical comedy shows from $6.60 up.

"What, then, is the solution? I propose the following remedy, which I believe is sound, and I am certain that it will come about in the not too distant future. *Television is the key to the situation.*

"Recently, when the Sanabria giant television screen was about to be exhibited at the Broadway Theater in New York City, I was asked by the management to supply some new ideas to attract the public at large and secure favorable publicity for television.

"I suggested, at the time, that an attempt be made to connect the stage of another theater to the one at the Broadway Theater, and televise a distant performance on the Broadway screen. This suggestion was adopted, and the Broadway Theater, by means of a television transmitter, picked up the images of the actors on the stage of the Guild Theater, and showed this performance on the television screen of the Broadway Theater. *This, then, was the first time in history that two theaters were connected together by means of television.* The results were quite satisfactory. What has been done on a small scale here, will be done on a tremendous scale in the very near future, by the instrumentality which I call the 'Tele-theater'.

"Imagine a special building, erected in the City of New York, for the sole purpose of supplying the entire country with its daily theater program—not, mind you, motion pictures, which are a "canned" product,—but an *actual* theatrical performance.

"In order to do so, I visualize a building which will have a series of stages, grouped around a central shaft or pit. The idea behind the multiplicity of stages is that I propose to move the actors rather than move the scenery. At the present time it is necessary for the actors to go behind or before the curtain, when scenes are shifted. This is awkward and always takes up an amount of time for which the public in the future will not stand.

"In the central pit we have the stage director at the top of a skeleton steel structure with his assistant technical directors. Stage No. 1 is lit up and the orchestra located immediately beneath the director starts to play. Below the orchestra is a "battery" of television cameras. Microphones are located in wings in strategic positions. The television cameras are connected to a wire network radiating to all parts of the country, just as the wire network transmits radio broadcast programs to the different radio stations in the country now.

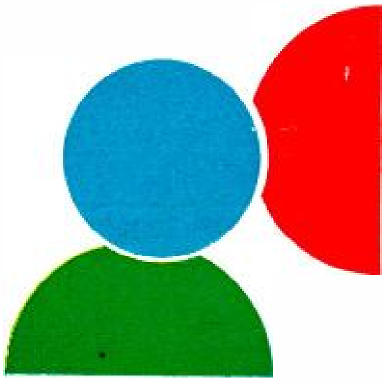
"In Boston, Chicago, Atlanta, San Francisco, and hundreds of other points, we will have local theaters where, for 50¢, audiences can nightly see the latest Broadway production. Instead of only 1,500 or 1,600 people seeing the "Follies", 5 or 10 million people will view them nightly, for one week, or for as long as the local theater feels it commands an audience. Immediately the undertaking becomes tremendously lucrative, because millions now support a production; whereas before only hundreds did so, at prices which only the well to do could afford.

"In the tele-theater, we will, of course, have *both sight and sound*, and the audience will actually see and hear their favorite actors at the exact time when the production is being performed in New York. And it will even be possible to have the actors enjoy the applause, because microphones in the tele-theater can pick up the applause of the audiences and convey it back to New York. Thus the actors will have the satisfaction and incentive of the applause which is now missing—so much to their detriment —in motion pictures.

"Naturally, there will be a number of tele-theaters in the larger cities, all supplied by the great theaters in New York; so that, if you wish to go out in the evening, you need not see a musical show if you do not wish to do so. You may, instead, see a comedy or straight drama in another tele-theater in your own town, because New York City will telecast a multiplicity of productions the same evening.

"To satisfy remote points such as the West Coast, duplicate performances must be put on later in New York, on account of the time difference. Thus, for instance, a man in San Francisco will be seated at 8.30 o'clock (his time), which is 11.30 P.M. in New York, when the second performance for Western points starts."

None of this is more fantastic than television is itself—you may be sure that it will all come about in the foreseeable future.



COLOR *Television* SYSTEMS

By FRED SHUNAMAN

OF THE three main systems of color television that have been battling for FCC and public recognition, the tentatively approved CBS *field-sequential* system is most prominent today. The FCC has stated, however, that the door is not irrevocably closed against other systems, so interest remains strong in the runners-up. These are the *line-sequential* system of Color Television Incorporated (CTI) and the *dot-sequential* system developed by RCA.[1]

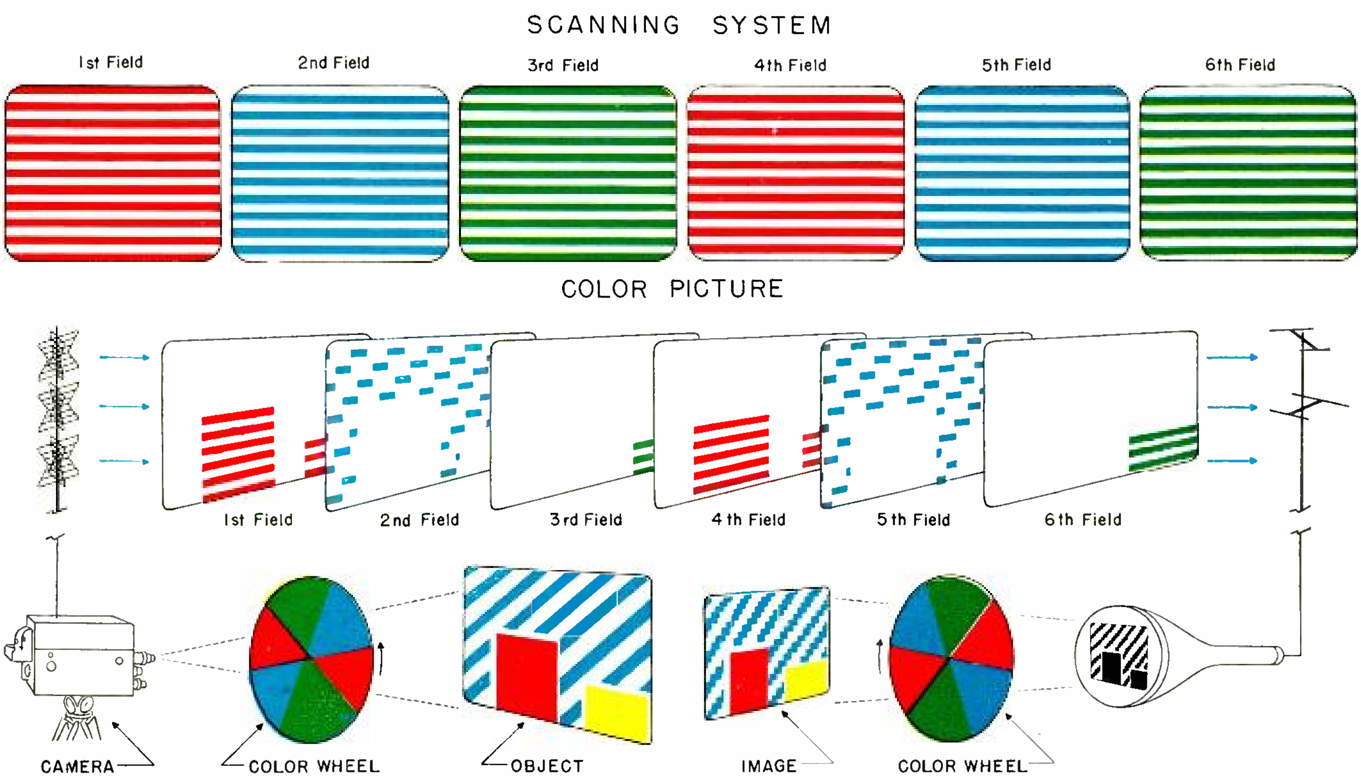
The pros and cons of these systems have been discussed with so much heat and so little moderation that the radioman is not quite sure of any one of their technical features. The public—at whom this barrage of facts and near-facts has been directed—is hopelessly confused. The terms "compatible" and "incompatible" have been bandied about to such an extent that many laymen believe that it would be possible to get color pictures without modifying their present sets, if only a "compatible" system of transmission were used. At the other extreme is a sizeable number who believe that present sets will become useless as soon as color television starts.

Let us review some of the technical facts to help clear up the nonsense. We have one system using relatively simple mechanical apparatus and two systems using more complex electronic equipment to produce roughly similar results. All three systems use standard black-and-white tubes with colored gelatine filters to insert the color into the images.

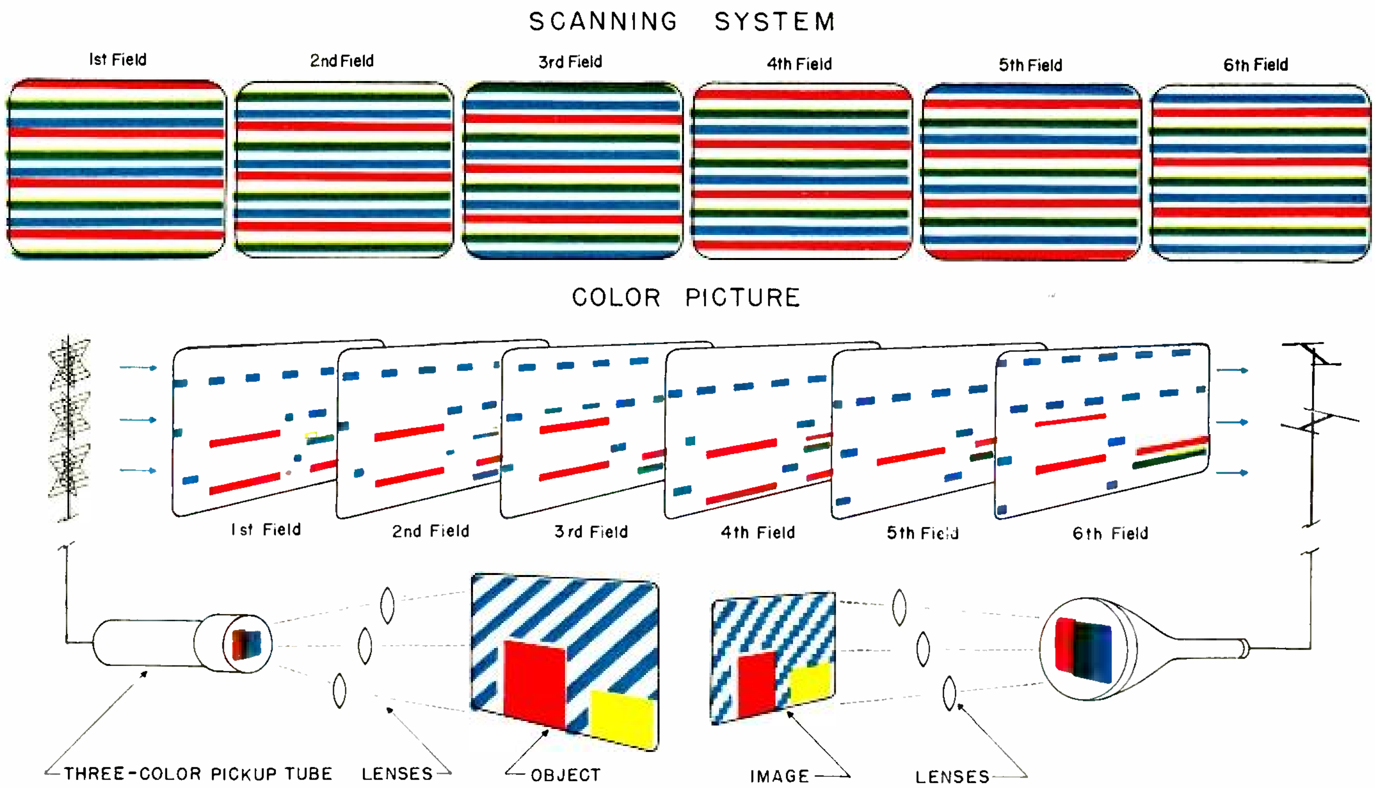
RCA has, it is true, demonstrated a single tube which produces the three colors with its own phosphors.[2] This promises a color system without filters and with only one instead of three kinescopes as used in the present RCA setup, but whether a three-color tube can be mass-produced economically enough to be used in home receivers remains to be seen. At least three types of three-color tubes (RCA, Geer, and Du Mont) have been patented; none have yet been proven to be (or not to be) practical.

Another abused catchword is "mechanical system." It is made even more puzzling when CBS spokesmen remark in passing that their system could also work with electronic color tubes. The fact is that the adaptability of any of the systems is a function of the speed of switching from one color to another. Equipment that can be used by the fastest-switching one can be used by the other two, but not vice versa! Colors are switched more than ten million times a second in the RCA system, 15,750 times in the CTI system, and only 144 times per second by the CBS method. Therefore either CBS or CTI could transmit and receive with equipment suitable for the RCA method. CBS could also use equipment of the type required by CTI's line sequences.

However, should CBS decide to rid itself of the stigma of a "mechanical system" and go electronic, it would have to accept some of the disadvantages as well as the advantages of the more complex systems. An excellent field-sequential system could be built up with three cameras and three kine-



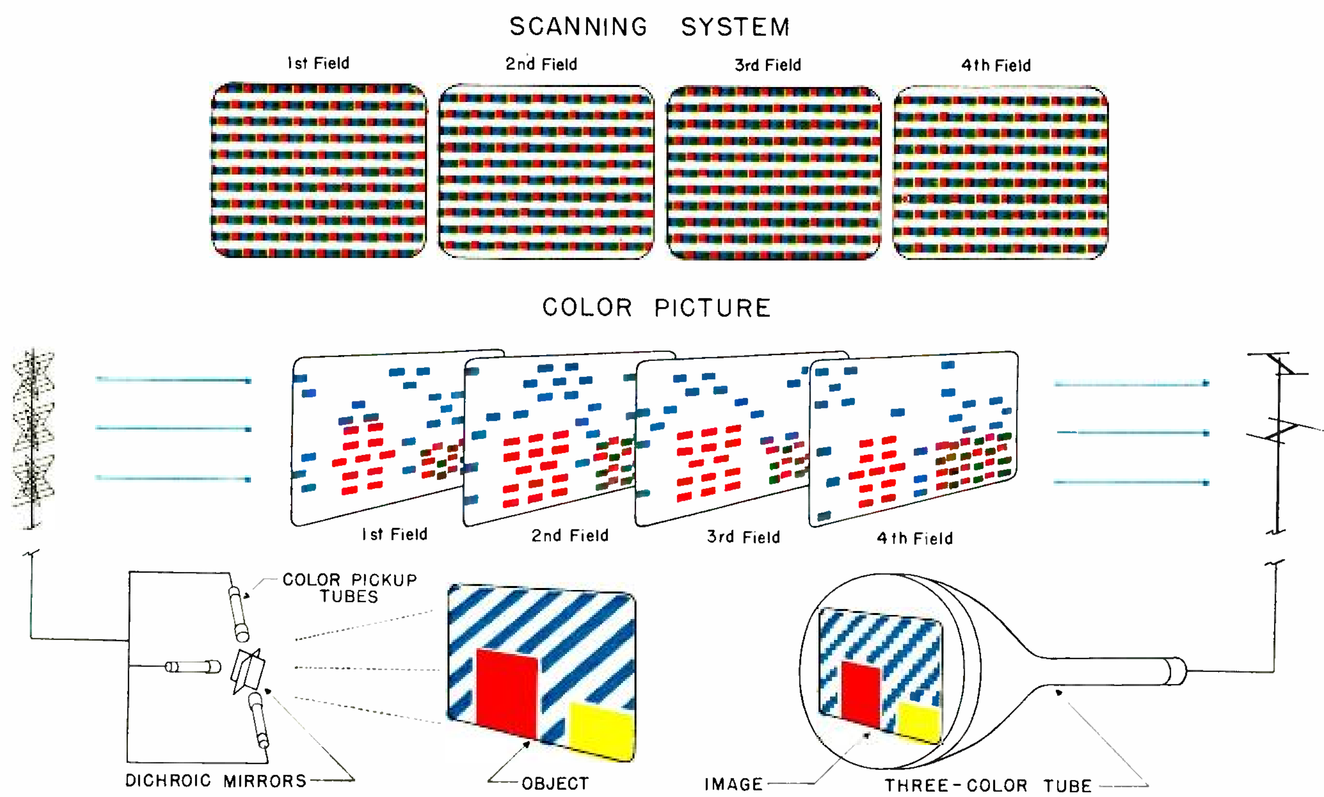
Color Illustration I—The CBS field-sequential system uses six one-color fields to make up a complete color image.



Color Illustration II—The CTI line-sequential system combines all three primaries in each of its six fields.

scopes, but it would be much more costly than the color wheel. A field-sequential system could undoubtedly use a three-color tube if such were available, but would be up against the same problems of color crawl, etc., as is the dot-sequential system, and similar complex and expensive methods would have to be used to solve them.

With the color-wheel system now used by CBS (Color Illustration I), receiving and transmitting equipment differ little from that used for black-and-white. [1,3] Color is supplied by transparent discs divided into red, blue, and green segments which rotate in front of camera and kinescope. The discs must be synchronized so that each segment



Color Illustration III—RCA's dot sequential system, with four fields per picture, has a complex interlace of dots.

is in position while the corresponding color field is transmitted. Thus, during a red field, a red filter ahead of the camera lens permits it to "see" only the red light from the scene, and the blue and green are not photographed. At the same instant, a red filter in front of the kinescope colors the partial image for the viewer. The same thing happens during the blue and green frames, and the eye receives the red, green, and blue primary images in such rapid succession that it sees a picture in full color.

Instead of black-and-white's two interlaced fields per frame, with 30 complete pictures per second, CBS pictures are composed of two interlaced color frames of three fields each. There are 144 fields per second, with 24 complete pictures. It was necessary to cut the number of lines from the standard 525 to 405 to transmit the 144 fields within the regular 6-mc channel. This is the reason for Columbia's *incompatibility*.

Main advantages of the CBS system are its simplicity and low cost. Since the only modifications required are the above-mentioned changes in the scanning frequency and the addition of a color wheel, the CBS system requires no extensive or complex new equipment. Transmitters and receivers for color—or for color and black-and-white—can be constructed or modified at a fraction of the cost of adapting for either of the other systems.

The chief disadvantage of CBS color is its incompatibility. Because of the different line frequency, a standard receiver tuned to a CBS color broadcast will see nothing, either in black-and-white or color. Another disadvantage is its lower definition, either in black-and-white or color. Its 405 lines cannot reproduce fine detail as well as systems using standard 525-line pictures. When used with a mechanical color wheel, picture size is limited to about 12 inches.

Other disadvantages are *flicker* and fringing. Its sponsors claim that the high field rate (144 per second) has fairly well eliminated flicker. Fringing—the breakup of color at the edges of rapidly moving objects—is still something of a problem.

The CTI system

The system demonstrated by CTI (Color Illustration II) is line sequential. Instead of transmitting a whole field or frame in one of the primary colors, the color is switched at the end of each line. Proponents of CTI's method claim that flicker is reduced enough by line switching to permit the system to be compatible. However, the 525 lines of the standard system introduce a problem. Since 525 is a multiple of 3, the same line in each field would always be scanned in the same color. A system had to be designed to skip lines regularly, so that all parts of the picture would be scanned in three colors. By skipping, line 1 (for example) in the first field may be scanned in red, in the third field in green, and in the fifth field in blue. (Even-numbered lines would be scanned in the second, fourth, and sixth fields.)

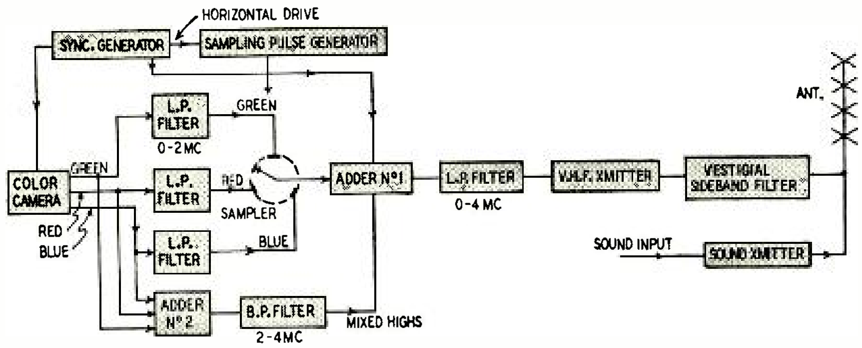


Fig. 1—RCA dot-sequential transmitter, showing mixing of the high frequencies.

CTI uses three lenses and three color filters ahead of its camera tube, so that three images, identical except for color, are formed on the mosaic. Instead of being speeded up as in the CBS system, the horizontal sweep is slowed down to one-third standard, so that a single sweep will give three lines, one in each primary color. Three cameras could of course be used. In that case a switching system would select lines successively from each of them.

The CTI receiver may consist of three kinescopes, each with a color filter and lens ahead of it. The lenses are so placed as to superimpose the three images on a screen, where they appear as a full-color picture. It may also be a single tube, with the three color rasters side by side on it, and the same optical mixing system.

CTI's great advantage is its compatibility. It uses the old 525-line interlaced system. The disadvantages are complexity (as compared to CBS) and another peculiar to a line-sequential system. This is *line flicker* or *line crawl*, in which the lines seem to be crawling up or down the picture. It can be avoided to some extent by the complex color interlace in which six fields are required for a single color picture. The number of complete pictures is thereby decreased to ten per second, which seems slow. Sponsors of the system say that the line-by-line color switch prevents this from producing objectionable flicker.

RCA dot-sequential color

Probably more has been said about the RCA (Color Illustration III) dot-sequential system than both others combined. It is the most complex, the hardest to understand, and offers the greatest possibilities for future development of any of the three systems. Instead of breaking the color up into its primaries by fields and lines, the RCA system breaks each line up into dots of primary color. Each color is scanned or "sampled"[4] 3.6 million times per second, and a stream of colored dots appear on the viewing screen. These combine to form a color picture much as do the dots of a color plate used in printing books or magazines. The dots of color printing do not fill the whole area, however, whereas those of RCA color television overlap about 50%. The small size and rapid succession of dots reduces problems of flicker and fringing to where they can be ignored.

Four fields are required for a picture. Two are the standard line interlace; the other two trace over the same lines, but the color dots are displaced so that a dot in field 3 is halfway between two dots of field 1 and one in field 4 halfway between those of field 2. This, plus the 50% overlap, insures that all parts of the scene are scanned in all three colors. There are 15 pictures a second, since the standard 60-field system is used.

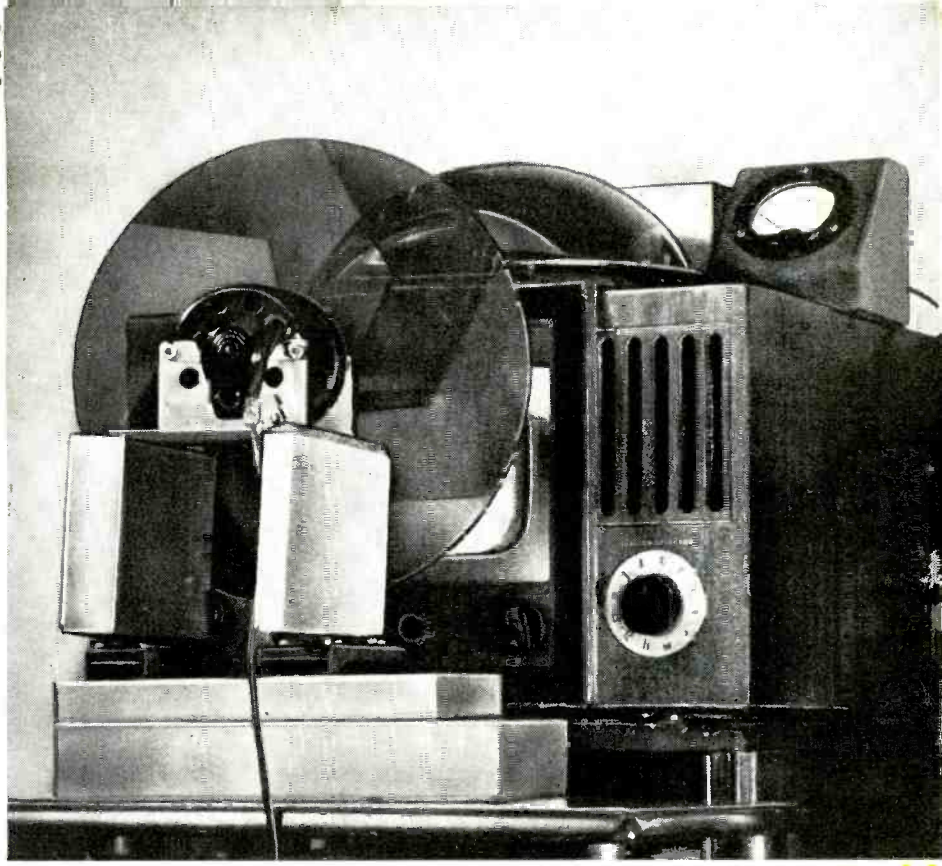
RCA's great advantage is compatibility, but it has another—that of greater definition than its rivals. The high frequencies from each of its three color cameras are mixed together, and the low frequencies are sent through the color sampler which transmits the signals to produce color in the received picture. Fig. 1 shows how this is done. Mixing the highs causes the fine detail of a scene to be reproduced in each of the colors, no matter what its original color. Therefore large bodies (which are reproduced by the low-frequency signals) are transmitted in color, while points, edges, and outlines are actually in black and white.

Strange as it sounds, this actually works. If, for example, two adjacent sides of a building appear in deep green, and the fine corner line that separates them appears as black or white (depending on whether it is in sun or shadow) the eye is satisfied. Indeed, there is reason to believe that the eye does not perceive color in fine detail, and the mixed-highs principle may produce pictures closely resembling what the eye sees in nature.

Disadvantages of the RCA system are the complexity and cost of the equipment and its operation. Colors are switched more than 10 million times a second, instead of 144 times as in the CBS system or the 15,750 times of the CTI system. The difficulty of keeping the apparatus in perfect adjustment is enormously increased. Color drift was one of the early problems of this system, and produced some interesting (but to the engineers hair-raising) effects. Thus bananas on a plate might apparently age, turning from yellow to brown as they were being carried to or from the center of the picture.

(*Continued on page* 32)

Simple changes in the sweep circuits often suffice to convert to CBS color. Circuits for converting popular makes of receivers are described in this article.



The color wheel in position in front of the video screen. The wheel may be any place between viewer and receiver, but should be near the receiver for best results.

Convert Your TV Set For Color Reception

By NORMAN L. CHALFIN

WHILE the industry makes up its mind whether to go along on color TV as authorized by the FCC, you can still enjoy the CBS broadcasts on your own receiver by making simple changes in the sweep circuits.

Don't misunderstand me . . . you can get an enjoyable picture for your own use, but it may be unwise to offer to convert a customer's set on a commercial basis. To get a picture of exactly the same brightness, size and with the same scanning linearity as the original 525-line picture is an engineering feat of the first order, and may call for replacing important parts in many receivers.

A 7-inch electrostatically deflected set will be easiest to convert. Larger sets with r.f. power supplies are often simple to handle. TV receivers with flyback high-voltage systems will call for complex circuit switching. For a commercially acceptable job, it would probably be necessary to replace the flyback transformer and yoke in many of these.

The frequencies of the deflection oscillators in present black-and-white (monochrome) TV transmissions are 60 cycles per second for vertical and 15,750 cycles for horizontal sweep frequencies. For the CBS field-sequential color TV broadcasts these oscillator frequencies must be changed to 144 cycles for vertical deflection and 29,160 cycles for the horizontal line generator.

The hold control resistance must be adjusted to a smaller value in the multivibrator or blocking oscillator used to generate the sweep frequencies. The ratio of change will be the reciprocal of that between the monochrome and color sweep frequencies. For vertical this will amount to a value of 1/2.4 of the total frequency-determining resistance of the sweep oscillator in the black-and-white receiver. For horizontal the new value for color will be 1/1.851 times the black-and-white value. With these fractions you will be able to determine the values for any receiver different from those in the circuits illustrated.

In most of the circuits there is a limiting resistance connected between the frequency-determining grid of the sweep oscillator and the hold control. This connection is broken and a switch inserted. In some of the very early receivers there is only a hold control and in some cases no change is necessary other than the proper adjustment

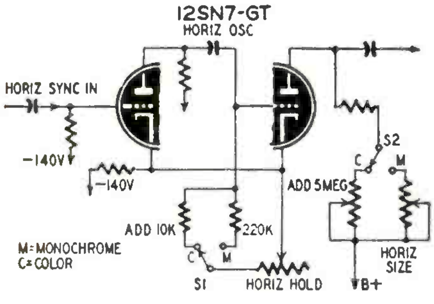


Fig. 1—Converted 7-inch sweep circuit.

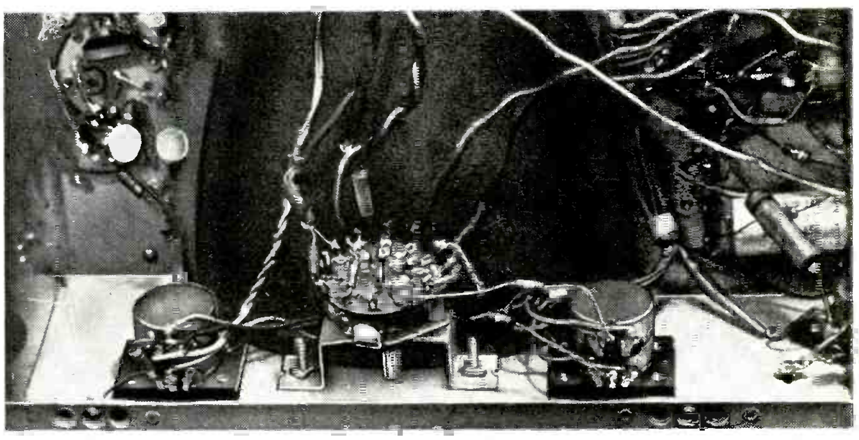


Fig. 2—How the changeover switch was installed on the Teletone TV 149 chassis.

of the hold control. Whether new resistors are switched into the circuit or an adjustment is made directly, the higher sweep frequency usually comes from the oscillator at a lower amplitude than

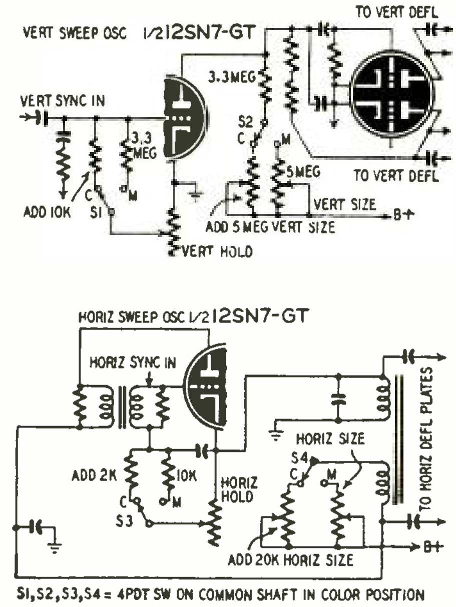


Fig. 3—The sweep circuits of a Motorola VT 71 adapted for color reception.

the original black-and-white sweep frequency. This will result in a smaller image and will require adjustment of the size control each time a change is made from monochrome to color reception, or back again. This problem is overcome by switching separately adjustable size controls (see Fig. 11) at the same time as the hold control values are switched. In some cases it may be advisable also to arrange to switch in separate linearity adjustment controls if they are present in the receiver.

Reference to the several circuits that accompany this article will clearly show the methods that have been developed by the author for making the color images broadcast by CBS visible in black and white on an existing receiver. These, in effect, are circuits the manufacturers would have had to include in sets to meet the bracket standards originally proposed by the FCC last fall.

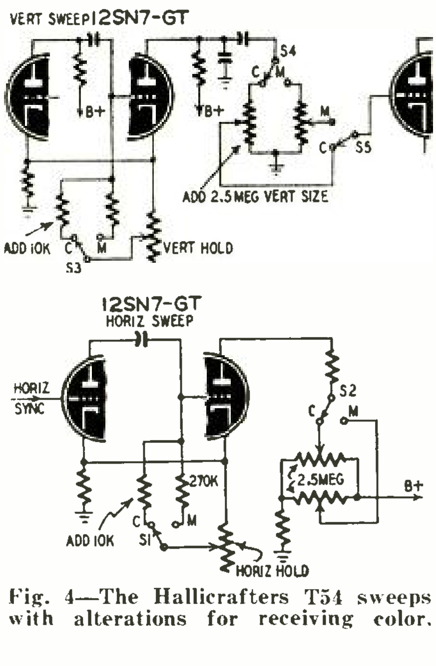


Fig. 4—The Hallicrafters T54 sweeps with alterations for receiving color.

Several circuits similar

A general similarity in the circuits of the 7-inch TV sets simplifies adaptation for color. Fig. 1 shows the Teletone TV 149 deflection circuit in which the horizontal and vertical oscillator circuits are identical with only the values of some components changed to establish the vertical or horizontal oscillator frequency. For this reason only one of the circuits is shown with the switching data that is required.

The photograph (Fig. 2) shows the placement of the switch on the chassis of the TV 149. It is a four-pole, double-throw unit which in one position retains the original circuit components and in the second position gives the color values their place in the circuits.

Fig. 3 shows the wiring arrangement for adapting the Motorola VT 71 7-inch TV sets so that they can receive the CBS color transmissions in black and white. Note, here, that there is no deflection amplifier in the horizontal sweep circuit. The horizontal blocking oscillator is very cleverly arranged to

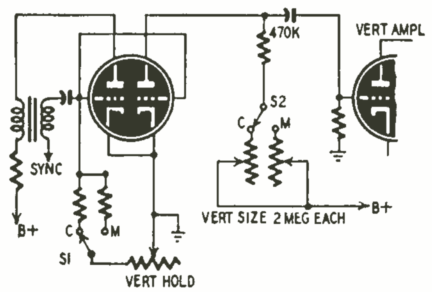


Fig. 5—A converted blocking oscillator of the type used in 630 chassis.

deliver push-pull deflection voltages directly to the cathode-ray tube plates. The vertical system resembles the Teletone previously described. The hold control is in the grid as in the Teletone circuit. The size control is in the plate load circuit. A four-pole, double-throw switch will cover this adaptation as for the Teletone.

In case insufficient horizontal voltage is supplied, however, it may be necessary also to switch the output transformer (Motorola No. T-6) with one that will tend to resonate with the two 900-μμf capacitors at the new frequency. The daring experimenter might even consider switching another pair of coils in parallel with the present ones to cut down the inductance.

The Hallicrafters T54 deflection oscillator circuits as shown in Fig. 4, are basically identical with the Teletone. There is a slight variation from the Teletone in size control placement. Horizontal size control in the T54 is connected in potentiometer fashion instead of as a rheostat. It is part of a B-supply bleeder system. The vertical size control is in the grid of the vertical deflection amplifier. The latter connection necessitates an extra switch position, as can be seen in the circuit diagram (Fig. 4) thus requiring a 5-pole, double-throw switch. The horizontal color size control is connected in parallel across the original control and is equal in resistance to it. No serious change in operation takes place as a result of halving the total resistance value. For those who prefer to retain the original operation, a sixth position can be added to the switch. With it, the connections for switching of the horizontal size controls can be made in similar manner to the vertical, by breaking two of the connections to the controls.

The circuit shown in Fig. 5 is the type of blocking oscillator used in the vertical deflection system of many receivers. The commercial variations of the RCA 630 TS use this circuit. RCA's own 630 uses a 6J5, and the discharge action is accomplished in the cathode circuit instead of a second triode, as shown. The 9T246, a similar arrangement, is seen in Fig. 6.

Other receivers

As previously indicated, the 7-inch sets and those with r.f. power supplies are easily adapted to meet the requirements of receiving the CBS color programs in black and white. Sets that have the flyback type of high voltage supply working from the horizontal deflection system will require more complex switching arrangements. Particularly, sets with horizontal a.f.c. systems fall into the more-difficult-to-convert category.

There is shown in Fig. 7 the switch-

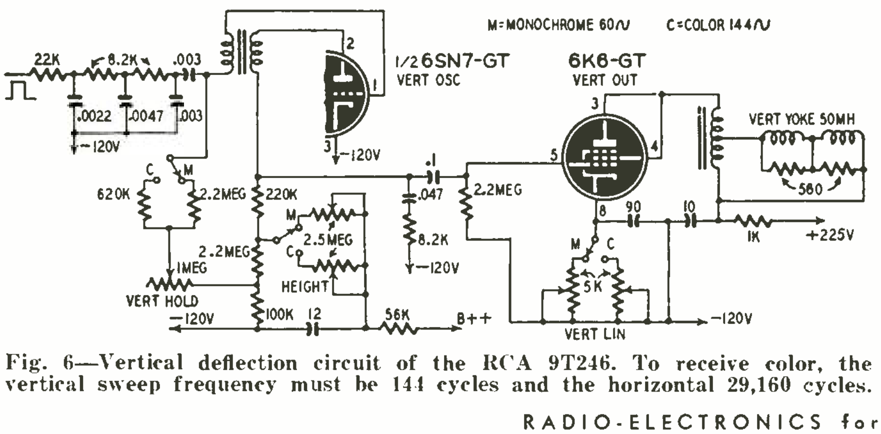


Fig. 6—Vertical deflection circuit of the RCA 9T246. To receive color, the vertical sweep frequency must be 144 cycles and the horizontal 29,160 cycles.

ing of components of the horizontal a.f.c. system employed in the 630 TS type of set. For this alone, three switch points are required: discriminator frequency adjusting capacitance is changed, horizontal oscillator reactance-tube frequency adjusting capacitance is changed, and the values of horizontal drive R-C network are changed. The right side of Fig. 8 shows the rest of the horizontal system changes that will be required for the 6BG6-G and flyback-output transformer system. Fig. 8 shows a typical Synchroguide system as adapted to the 29,160-cycle sweep frequency switching for color from the black-and-white 15,750-cycle sweep. Fig. 9 is a new horizontal output transformer with separate taps for the monochrome and color horizontal output connections to the deflection coils. The changes are necessary because, when the original system is used, there is a deterioration in horizontal output linearity and sweep amplitude in the color position. The new transformer has more turns for the color secondary connection to the horizontal deflection yoke than for the monochrome connection.

The transformer is wound on a square ferrite horizontal output transformer core, with a gap of .015 inch in each leg. The primary (1-2) is wound with 800 turns of No. 28 single-silk enamel insulated wire. The high-voltage winding in series with it consists of another 800 turns of 10-44 litz or No. 36 single-silk or single nylon enamel wire. The secondary is also wound with this wire. Position of the windings is the same as on the transformer it replaces, as is the method of winding. It will be practically impossible to wind such a transformer by hand, but they may become available commercially in the near future.

The modifications indicated in Figs. 6, 7, 8 and 9 were worked out by CBS engineers, to whom thanks are due for supplying the information.

The color converter

If the above changes are made, you will be able to receive color broadcasts in black and white. To see them in color you will need a rotating disc. The most effective disc diameter should be a little more than double the width of the picture to be received. Six sectors are arranged on the disc with the three colors in this order: Red, Blue, Green, Red, Blue, Green. This is shown in Fig. 10. This disc must rotate at a speed of 1,440 r.p.m. before the screen of your set. For three segments (120° each) motor speed would be 2,880 r.p.m. A standard 1,800-r.p.m. phonograph motor would have to be geared or friction-driven to lower the speed. Several methods of synchronization are possible. One of these would be to drive the motor with a 48-cycle oscillator synchronized by some frequency-dividing circuit deriving its sync pulses from the 144-cycle vertical sweep system of the receiver when set for color TV.

When observing the test pattern transmitted by CBS in New York, you will find it moving in a circular path at a rate of about one revolution in 20 seconds. This was done to prevent the test pattern from burning into the image orthicon on the color camera.

Several plastics suppliers make available colored sheet plastic suitable for color discs. Eastman Kodak is expected to put out a set of color television filters in the near future.

Good results can be obtained with Wratten No. 26 for the red; No. 47 for the blue, and No. 58 for the green. Approximately equivalent Plexiglas numbers are: No. 159 or 160, red; 263, blue; and 260 or 2004, green; and Lucite: No. 10539, red; No. 7456, blue; and No. 3526, green.

A commercial disc is on the market at a cost under $20. This is the Celomat unit and has a manual speed adjustment. It will hold synchronization for reasonable periods but does require frequent re-adjustment. It is intended that you look at the screen of your adapted TV set through this device where it is nearer to you than to the set. The larger the screen, the further away you will be. Used in this way the color disc has a particularly humorous deficiency. After getting the Celomat device into synchronization, so that flesh tones are of the proper hue, if you move to the left or right of the viewing position in which you first adjusted synchronism these tones turn to a predominantly blue or green tint. Possibly this effect can be used to add proper eeriness to mystery shows.

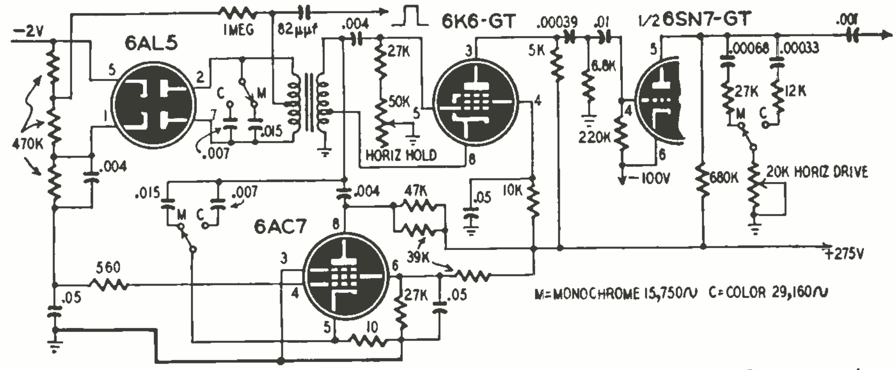


Fig. 7—Circuit showing how the components are switched for color reception in the 630 type receiver. This is the horizontal a.f.c. section of the set.

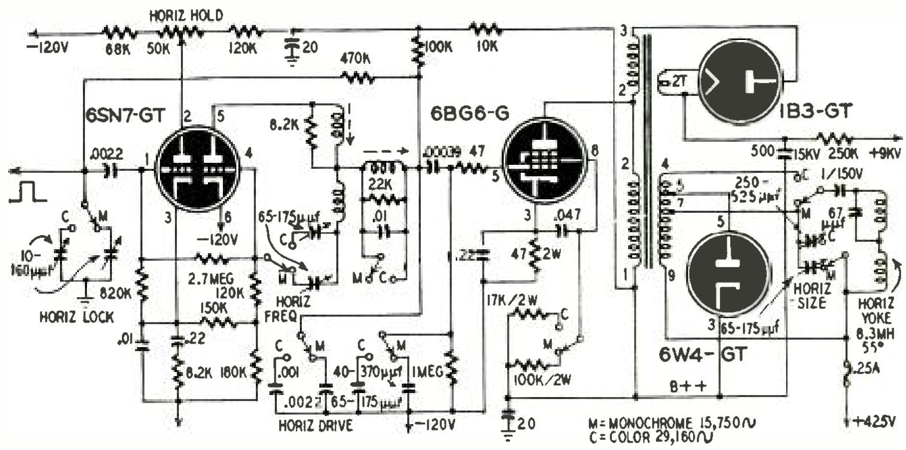


Fig. 8—The horizontal deflection and high-voltage circuit of the RCA 9T-246 type receiver showing the modifications that are made to receive color.

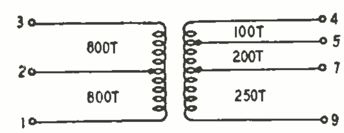


Fig. 9—Horizontal output transformer tapped for black-and-white and color.

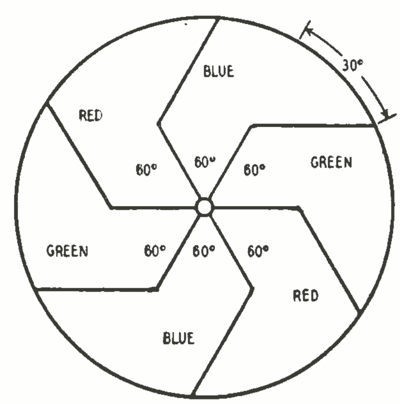


Fig. 10—The color wheel layout. It must rotate at a speed of 1,440 r.p.m.

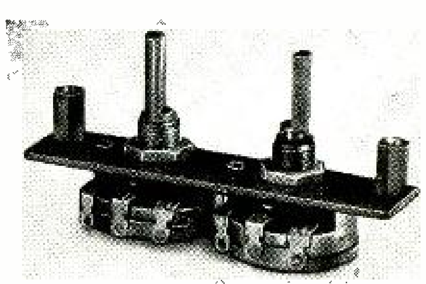


Fig. 11—The adjustable size controls.

Linearizing Circuits for Video Deflection

By SEYMOUR D. USLAN*

UNDISTORTED television pictures require linear scanning. For both horizontal and vertical linear scanning, the displacement of the electron beam in the picture tube must be linear with time. That is, the beam is displaced at a constant rate of speed. This insures the picture elements being spread uniformly over the entire screen.

Correct scanning is produced in electrostatic-type tubes by applying a *sawtooth voltage* to the deflection plates; and in electromagnetic tubes a *sawtooth current* must flow through the deflection coils.

In either case, if the deflection is not linear, that is, if the rising part of the sawtooth is curved, the reproduced picture is distorted. This distortion is illustrated by the test patterns of Fig. 1. Pattern 1-a shows nonlinear vertical deflection and 1-b shows nonlinear horizontal deflection. The defective scanning causes cramping and flattening at the picture top or side.

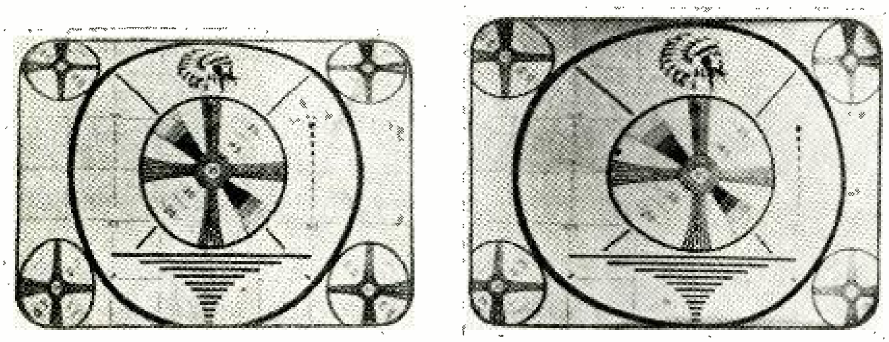


Fig. 1-a, left—Poor vertical linearity causes compression at top of picture. Fig. 1-b, right—Poor horizontal linearity causes compression at the side.

Capacitor charge

In practically all cases, a charging capacitor in the deflection circuit (usually of the blocking oscillator or multivibrator type), produces the sawtooth waveform. The charging-voltage-versus-time characteristic of a capacitor appears in Fig. 2-a. This curve is nonlinear. To produce a deflection waveform, the capacitor must be repeatedly charged and discharged at the same point in each case. The point of discharge usually occurs somewhere along the curve, as indicated in Fig. 2-b. Note that the repetitious charging point does not start at the very bottom.

The capacitor charge curve is most nearly linear at the bottom rising portion. If the point of discharge occurs at a low voltage compared to the available charging voltage, then the linearity of the sawtooth waveform is improved. However, the charge and discharge conditions within the receiver are such that a certain degree of nonlinearity always exists—enough to cause distortion in the reproduced picture.

Certain other circuit operations, besides that of the sawtooth-producing circuit, may cause a linear curve to become appreciably nonlinear.

To correct these defects, special circuits are used to "linearize" the deflection signals before they are applied to the picture tube. The circuits provide correction by presenting some frequency discrimination to the nonlinear waveform or by causing the waveform to be subject to the characteristics of some deflection amplifier.

Three important types of correction circuits used in television receivers are: nonlinear amplifiers, damper tube circuits, and auxiliary time-constant circuits.

Nonlinear amplifier

If the defective sawtooth wave can be fed through an amplifier that has a nonlinear characteristic just the opposite to that of the wave itself, we can straighten out the wave. Wave A of Fig. 3 is the input nonlinear sawtooth fed to the amplifier and B the output sawtooth signal. By operating the tube over the correct part of its transfer characteristic, the output sawtooth can be made very nearly linear.

The nonlinear amplifier is usually of the remote-cutoff or variable-mu type. The bias on the tube must be correctly adjusted for the input sawtooth to operate over the proper part of the transfer characteristic. In most television receivers using this method of linearization, the bias on the tube is made variable for adjusting linearity. A typical circuit appears in Fig. 4. R1 and R2 are the cathode bias resistors and C1 is the cathode bypass capacitor. By making resistor R2 variable, the bias on the tube can be changed and the correct operating point selected.

Such types of linearizing circuits are found most often in the vertical deflection circuit of television receivers where the tube usually is the vertical output amplifier. Adjustment of the linearity control in this circuit also affects the vertical size of the picture because a change in bias also changes the amplification of the tube.

Damping tube circuits

In kickback horizontal output systems a ringing or oscillation is produced during the retrace period of the electron beam. This is caused by the horizontal output transformer, deflection coils, and associated circuit capacitances breaking into oscillation. Oscillation may continue long enough to affect the linear rise time of the deflection waveform. To reduce this effect, a damper tube is used as shown in Fig. 5.

Immediately after the retrace period of the deflection waveform, a high positive pulse is applied to the plate of the damper tube and causes it to conduct heavily. This strong conduction loads the oscillatory system, and damps the undesired oscillations. Besides loading the oscillatory circuit, the damper supplies additional voltage to the plate of the horizontal output ampli-

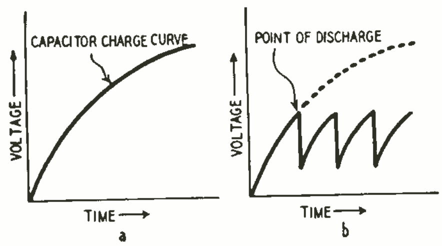


Fig. 2—Charging curves of a capacitor.

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fier as it rectifies the positive pulse.

Although the damper tube prevents continued oscillations, enough energy is stored in the magnetic field of the

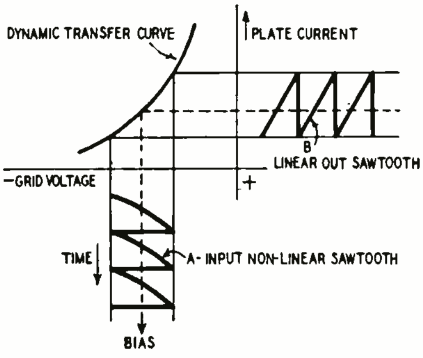

Fig. 3—Transfer characteristic of tube compensates for the nonlinear sawtooth.

oscillatory circuit to keep the tube conducting until this energy is dissipated. This energy dissipation makes the resultant current flow through the deflection coils linear, as indicated from points A to B in Fig. 6. After point B the current is no longer linear, but tapers off rapidly from points B to C.

Now the horizontal output amplifier takes over. The amplifier does not conduct during the retrace period of the beam and remains at cutoff during most of the time the damper tube is conducting because a negative pulse from the sweep oscillator is applied to its grid.

The amplifier starts to conduct when the deflection current, due to damper conduction, starts to become nonlinear. Current in the amplifier causes a continuation of current flow in the deflection coils. This initial current flow is nonlinear as from D to E in Fig. 6, and somewhat opposite in shape to that from points B to C of the same figure. After point E, the deflection current flow is linear. At point F, the retrace begins and the action starts again.

The circuit of Fig. 5 is so arranged that the nonlinear deflection current of the damper tube and of the amplifier (currents B to C and D to E in Fig. 6)

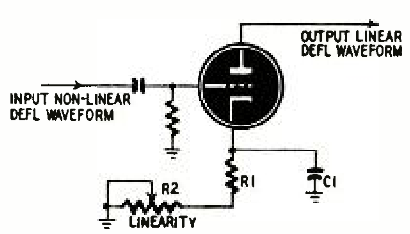

Fig. 4—Linearizing circuit that works on the tube's transfer characteristic.

are opposite in shape and produce a resultant current that is linear. The total trace from A to F is then linear. As an additional function, the damper tube together with the amplifier produces a linear trace and is a method of linearizing the deflection waveform.

We mentioned that the supply voltage on the amplifier plate is increased due to the kickback of the oscillator system. This increased voltage is applied to the plate of the amplifier by C1 and C2 because these capacitors become charged by the kickback voltage. This kickback voltage is pulsating and, although C1, C2, and L1 smooth out these pulsations, a certain amount of ripple voltage still exists. This ripple voltage is used to control the linearity of the resultant current.

By making L1 of Fig. 5 variable, the phase of the ripple voltage on the plate of the amplifier can be varied with respect to its grid signal. This means that the initial flow of amplifier plate current can be changed. Varying this inductance helps the nonlinear current (D to E in Fig. 6) produced by the amplifier to be exactly opposite to the nonlinear current (B to C) pro-

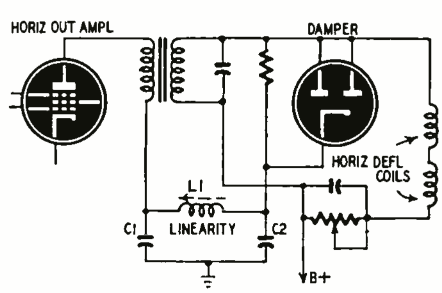

Fig. 5—A damper tube in the horizontal output helps to linearize the sawtooth.

duced by the damper tube. In this way any nonlinearity in the dashed part of the trace is kept to a minimum.

Time-constant circuit

Another way to correct linearity is to use an extra time-constant circuit to offset the one in the circuit producing the sawtooth waveform.

The additional time constant introduces a frequency discrimination to the nonlinear sawtooth waveform to straighten it out. The graph of Fig. 7 shows what is theoretically wanted. Curve A in part "a" of this drawing is the nonlinear trace of the sawtooth waveform. Curve B is the shape of the curve introduced by the time constant. Its shape and location on the graph must be such that when combined with the nonlinear sawtooth, the result is a straight line, as indicated in Fig. 7-b.

The complete circuit appears in Fig. 8. V1 is the discharge tube of the deflection circuit, and V2 is an amplifier to which the corrected waveform is fed for amplification. Components R1 and C1 are the grid resistor and coupling capacitor of tube V2. The sawtooth producing capacitors are C2 and C3 and the resistor through which they charge is R2. Components R3 and C4 are the additional time-constant circuit that corrects the linearity of the sawtooth waveform. Capacitors C2 and C4 are usually equal and C3 is approximately one-half their value. The corrected sawtooth deflection signal is taken across capacitors C3 and C4.

To understand how correction occurs, we will assume capacitors C2, C3, and C4 are being charged from B-plus. Capacitors C2 and C3 charge through R2 alone, but C4 charges through R2 and R3. When the discharge tube starts conducting, all the capacitors begin to discharge. Since C2 and C3 are directly across V1, they discharge very rapidly. However, C4 discharges slowly because the discharge current also flows through R3 which has a high value

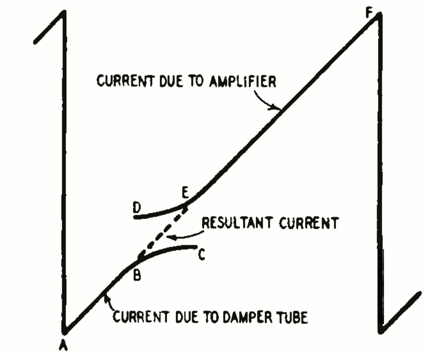

Fig. 6—Damper tube current and amplifier current produce the resultant sawtooth current in the circuit of Fig. 5.

compared to the resistance of the discharge tube.

By the time V1 stops conducting, C2 and C3 are practically all discharged, but C4 has only given up a small part of its charge. C2 and C3 begin to charge again, but C4 continues to discharge because its previous charge is high compared to the voltage across C2. The discharge of C4 causes an additional charge on C2. In other words, the

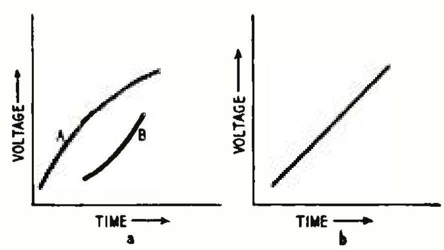

Fig. 7—Curves A and B add together to produce the linear voltage at right.

charge on C2 from the B-supply is an increasing voltage but the charge due to C4 is decreasing. When the total charging voltage on C2 equals that on C4, the latter stops discharging and starts charging through R2 and R3.

Across C3 we have the nonlinear deflection voltage represented by curve A in Fig. 7-a. Across C4, however, is a voltage which includes the action of C2 charging from two sources, plus the later charging action of C4. The result is a curve shaped similarly to that shown in Fig. 7-b.

So that R3 and C4 present the correct time constant to linearize the waveform, R3 is variable.

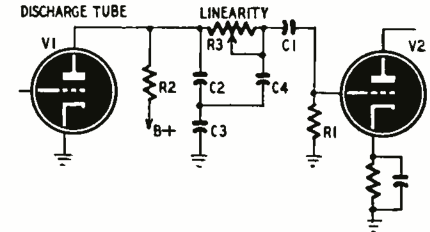

Fig. 8—A circuit for linearizing the sweep wave with an R-C time constant.

New Trends in Television

Larger picture tubes, fast-acting a.g.c., and the gated beam discriminator are some of the features found in many of the latest TV sets

By WALTER H. BUCHSBAUM*

TODAY'S television receivers have come a long way since the 441-line, 5-inch sets to be found in some 5,000 homes in 1940. Their quantity and quality has advanced with seven-league boots. Present 525-line standards and greatly improved techniques combine to give the American people entertainment of a quality and at a price that everyone can afford and enjoy.

Since 1946, when television receiver production first started on a large scale, each year has brought improvements in design and price reduction, both important for mass acceptance of television.

The outstanding aim of the television industry during the past months has been to bring television to the low-income groups. Most of the new designs stress low cost without sacrifice of quality and the most pronounced improvement in this respect is the use of large-screen, wide-angle picture tubes. Five years ago the largest direct-view picture tube was a 20-inch, all-glass monster which required a tremendous cabinet and cost several hundred dollars. Today's 19AP4 (Fig. 1) fits into most cabinets and costs less than $50 at the manufacturer's level. Its shorter length is due to a wider deflection angle which in turn requires more deflection power. To get sufficient brilliance on such a large screen the second anode voltage ranges from 12 to 15 kilovolts.

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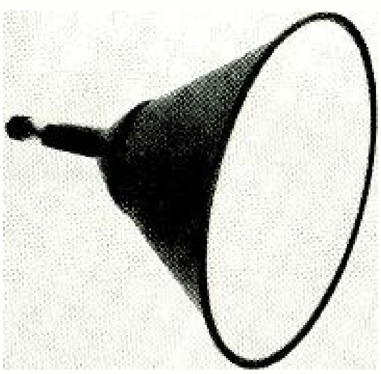


Fig. 1—The 19AP4, a large-screen picture tube used in many 1951 receivers.

A real cost reduction is possible with the new rectangular picture tubes. Fig. 2 shows a Hytron 16RP4, and Fig. 3 gives an idea of the dimensions of such a tube compared with a 16-inch round picture tube. While the price of the rectangular tube is not substantially below that of the round tube type, the manufacturer can use a smaller cabinet, save on shipping and storage space, and use a less expensive mounting harness. The actual difference in cabinet prices at wholesale level ranges from $5 to $8, a considerable saving for the manufacturer.

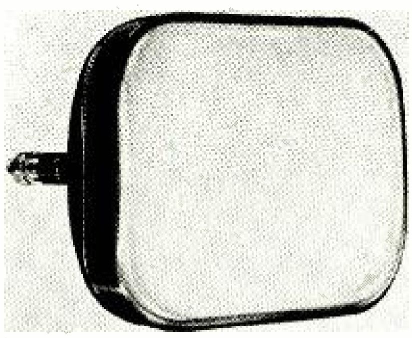


Fig. 2—Rectangular tubes such as this 16RP4 are popular in the new receivers.

Other new picture tubes are the 14-inch rectangular, giving a 12-inch picture, and the new 17-inch metal-envelope rectangular tube. Reduced weight and prices are the advantages expected from the metal 17-inch, which goes into mass production this month. Rectangular 20-, 21-, and 24-inch tubes are also scheduled for 1951, but so far only the 20-inch is being delivered. Du Mont has announced a 30-inch tube having a deflection angle of 90 degrees.

Most of the new picture tubes have either a "black face" or etched screen which reduces glare but also requires more brightness. This increased brightness is obtained by using a higher anode voltage, usually from 12 to 13 kilovolts. A higher anode voltage again increases the deflecting power needed to cover the screen. Last year several manufacturers solved the problem of higher voltage and more sweep by using powdered-iron flyback transformers with a voltage doubler in the high-voltage section and two horizontal output tubes in parallel. Aside from being expensive, this system uses more B-plus and filament power, requires more chassis space, and dissipates more heat.

Deflection circuits

New, high-efficiency flyback systems were developed during the past year which furnish the required deflection as well as the higher anode voltage without using more power or using more tubes than the original flyback for the 10- and 12-inch tubes. As a matter of fact, most of the newly developed horizontal output tubes operate with less B-plus power than the old 6BG6-G. Such new tube types are the 6AV5-GT, 6AU5-GT, 6BD5-GT, 6BQ6-GT, and 6CD6-G, the first three of which use no top cap for the plate connection and are of the same physical size as the 6SN7-GT or 6K6-GT.

These high-efficiency flyback circuits depend on a special transformer which has high permeability and a high-Q core made of a ceramic material called Ferrite. The windings and the core material of these transformers keep dissipation losses at the horizontal sweep frequency very low. Several manufacturers are now using these transformers together with wide-angle deflection yokes. A circuit using this high-efficiency flyback system is shown in this issue in the article by Matthew Mandl.

To economize on the vertical deflection system, three new tubes were developed and are used in most 1951 receivers. The 6S4 is a miniature triode used as a vertical output tube. The 12BH7 and the 6BL7 are both double triodes, the former using a nine-pin miniature base and having a tapped filament for either 6.3- or 12-volt operation. The 6BL7 looks like a 6SN7-GT but is a more rugged version, capable of dissipating more plate power. Several manufacturers use a simple autotransformer with these new tubes to couple the vertical output tube to the deflection yoke.

The deflection yoke used with the new wide-angle picture tubes is different in two respects. First its physical length is reduced to avoid neck shadow (see "Television Service Clinic," RADIO-ELECTRONICS, December, 1950). Second, its Q must be high or it will ruin the high Q of the ceramic-core flyback. Most yokes use a Ferrite or similar material ring instead of the powdered iron or iron wire of older type deflection yokes.

Some of the 1951 receivers use no flyback transformer at all. High-impedance deflection yokes and special air-core autotransformers for high-voltage stepup are used in a few models, while some use paralleled output tubes in circuits familiar from 1949 and 1950. The deflection yoke inductance (horizontal coils only) is 8.3 mh for 10- and 12-inch tubes. The new, high-efficiency circuits use either a 10-, 12-, or 18-mh winding, while the so-called high-impedance yokes have about 30-mh windings.

Fast-acting a.g.c.

Among the more important advances in TV designs is the perfection of a better fast-acting automatic gain control (a.g.c.) system which can compensate for airplane flutter and is almost immune to noise. Referred to as "gated" or "keyed" a.g.c., this system has been described before in RADIO-ELECTRONICS, but now it is being used in so many 1951 television sets that it deserves another brief description.

The circuit shown in Fig. 4 is typical of most of the fast-acting a.g.c. circuits now in use. In this particular circuit a special winding in the width-control coil supplies the keying pulse.

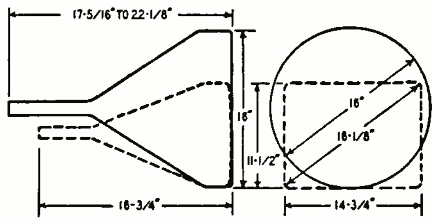


Fig. 3—While picture size is about the same, the rectangular tube has smaller overall dimensions than the round tube.

Keyed a.g.c. operates only on the amplitude of the horizontal synchronizing pulse and is in operation only while that pulse appears on the a.g.c. tube grid. The a.g.c. filter, therefore, need filter out only about 15 kc and can have a much faster charging and discharging rate than in an ordinary a.g.c. system. The rapid changes in signal strength due to airplane flutter are fully compensated as rapidly as they occur.

Noise riding in with the picture signal can hardly affect the a.g.c. bias. Only those noise elements riding in with the synchronizing pulses can have any effect on the bias. Since the synchronizing pulses occupy only 5% of the total signal, only 5% of the total noise can get through. If the top of the synchronizing pulse is clipped at the first video amplifier, the system will be almost entirely independent of noise.

The 6AU6 a.g.c. tube in Fig. 4 has a constant bias of about 5 volts due to the voltage drop across R1, one of the plate resistors of the first video amplifier. This bias cuts the tube off completely unless a strong positive signal appears on the grid. The plate of the tube is at ground potential, while the cathode is 150 volts positive. No current flows in this condition; but when a 300-volt flyback pulse from the width coil winding appears on the plate, it

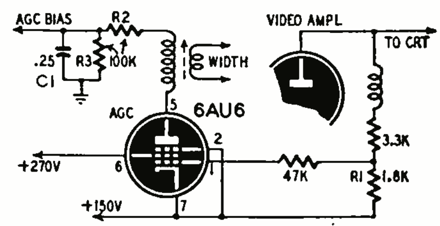


Fig. 4—A simple keyed a.g.c. circuit.

becomes positive and current could flow through the tube. But the bias cuts the tube off unless, at the same instant, a positive synchronizing pulse appears on its grid. Depending on the amplitude of that synchronizing pulse, more or less current flows through the a.g.c. tube.

If a strong station is received, the synchronizing pulse on the grid drives it more positive, permitting more current to flow. This plate current through the a.g.c. tube goes to ground through R2 and R3, setting up a voltage negative with respect to ground. If more current flows, a large negative bias is developed which reduces the gain of the r.f. and i.f. amplifiers and therefore the amplitude of the synchronizing pulse at the video amplifier. A balance is reached almost instantly, giving a constant and steady picture over a wide range of weak and strong signals. C1 and R3 form the a.g.c. filter, and the relation of R2 and R3 determines how much of the total bias is being applied to control the r.f. and i.f. stages.

Keyed a.g.c. is used in Admiral, Andrea, Westinghouse, Air King, Stewart-Warner, Silvertone, Teletone, Stromberg-Carlson, and other well-known receivers. When properly adjusted, this circuit is not only trouble-free but relieves the set owner of having to adjust contrast and brightness for different stations.

Gated beam discriminator

Used in one or two 1950 models, the gated beam discriminator is becoming rapidly the most popular FM detector for low- and medium-priced TV receivers. The two main advantages of this circuit are its economy and its excellent performance in AM rejection and limiting.

The operation of this circuit (Fig. 5) is based on the internal structure of the tube. Only a narrow beam of electrons travels from cathode to plate. The electron beam is formed by the accelerating grid Ga which is at a constant

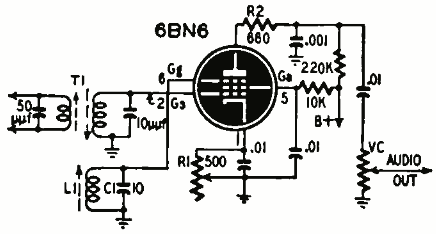


Fig. 5—Gated beam FM detector circuit.

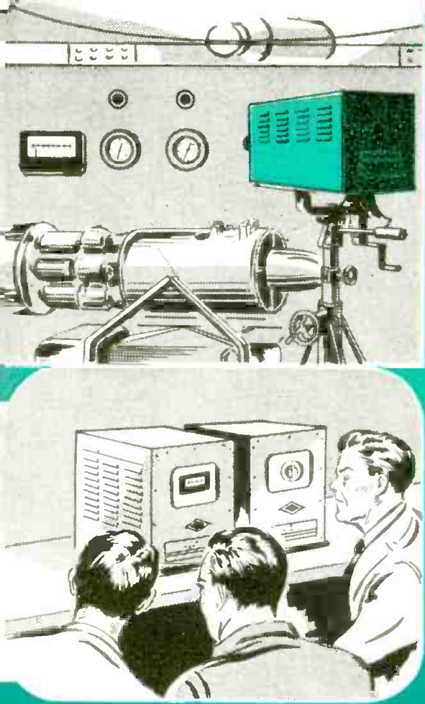
d.c. potential. The FM signal is injected at the usual grid Gs and R1 establishes a self-bias in the cathode circuit. The key element is the tuned circuit L1-C1 which forms the return path of the fourth tube element, the gating or quadrature grid Gg. This tuned circuit resonates at the center frequency and must have a very high Q, at least 150, at that frequency. At resonance, maximum voltage is developed across a parallel tuned circuit, or maximum signal is absorbed by it, so that practically no electrons reach the plate at the resonant frequency. This is especially true in the case of the 6BN6 tube used here, where the internal structure is different from ordinary pentodes.

As the input frequency deviates from the resonant frequency of the gating grid circuit, more electrons reach the plate. In other words, the plate current varies as the input frequency varies, and an audio signal is developed across the 220,000-ohm plate load resistor, depending only on the frequency change of the FM signal.

Especially useful in intercarrier systems, the gated beam FM detector eliminates the need for a 6AU6 i.f. amplifier and limiter, the usual ratio detector transformer, and a double diode with a triode audio driver tube. When properly designed, the output of the 6BN6 circuit shown in Fig. 5 is sufficient to drive any standard audio output amplifier such as the 6V6, 25L6, or 6K6-GT.

The cathode bias potentiometer R1 is adjusted for maximum AM rejection; in other words, for minimum buzz. L1 is tuned to the center frequency (4.5 mc in intercarrier sets) just like T1. While T1 is tuned for maximum audio output, L1 is adjusted to give minimum output voltage when a 4.5-mc unmodulated signal is fed in through T1. This adjustment is as critical and touchy as the ratio detector adjustment in earlier circuits. Once adjusted, the gated beam detector stays aligned and operates properly for a long time.

During the past year only very few large manufacturers have used the gated beam FM detector circuit, but as more 6BN6 tubes become available and as component suppliers tool up for the gating coil, more sets will use this system in 1951. Zenith, Teletone, and many others include the gated beam detector circuit in their intercarrier receivers.



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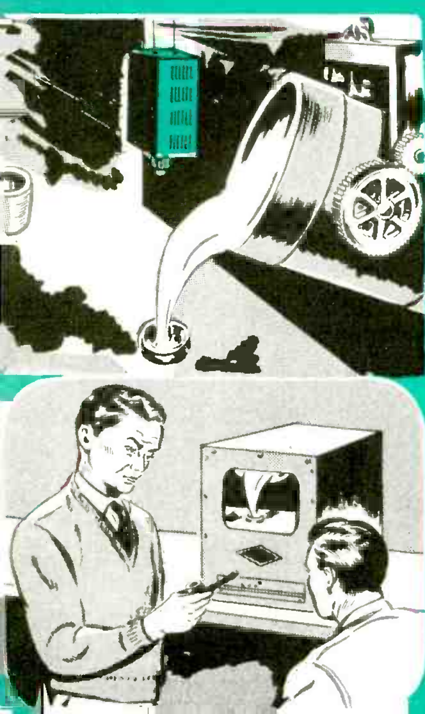
Industrial Closed-Circuit TELEVISION

COLOR increases utility of this rising new medium

WHILE the battle over color television broadcasting rages, another type of color television has been taking over without fanfare or opposition. The field being conquered peacefully is industrial closed-circuit television. Already established in monochrome, it is finding color a valuable adjunct.

The term "industrial television" has been interpreted to mean roughly all non-entertainment uses of the new medium, including its employment at fashion shows and in banks. In a number of applications, industrial television supervises operations too dangerous for human beings. It makes possible certain types of advertising displays and saves manpower in work requiring observation at a number of separate points.

Possibly the most publicized application of closed-circuit color television is televising surgical operations. Since internes can learn operating techniques only by watching skilled surgeons, making the operation visible to larger num-



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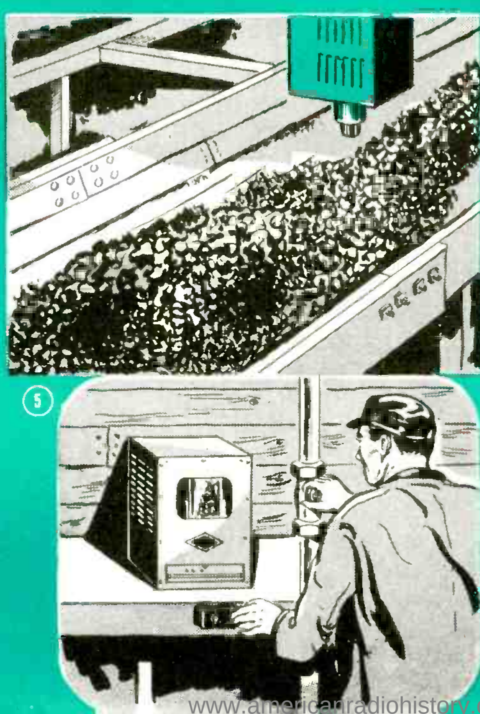

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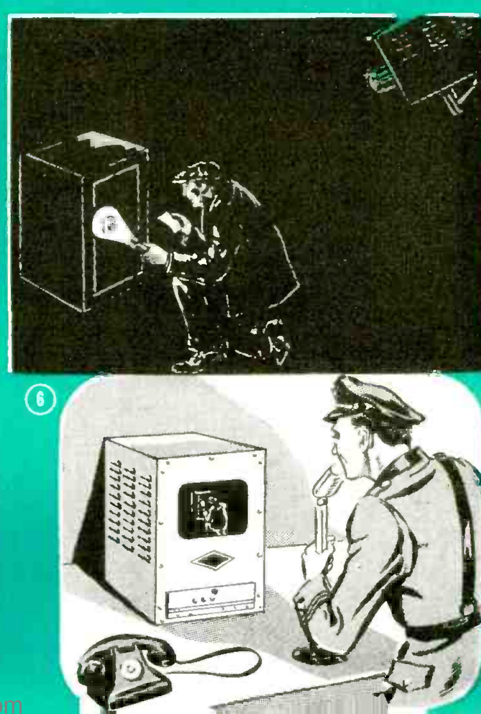

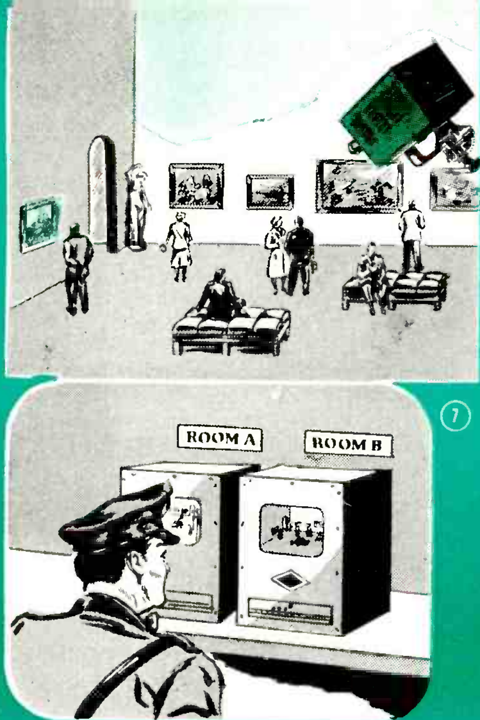

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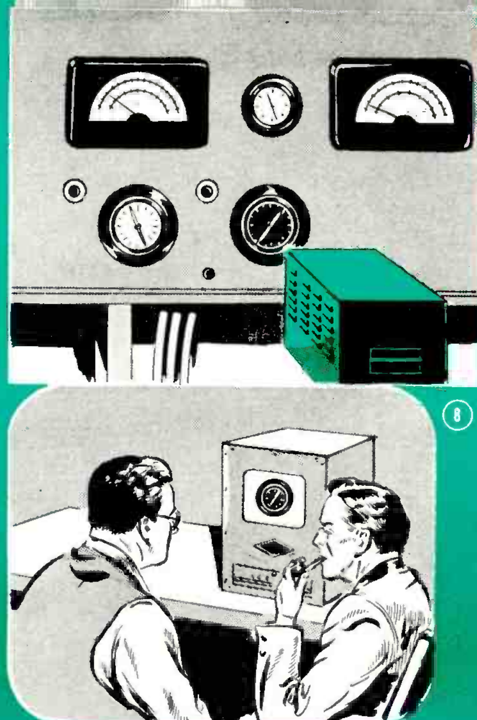
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bers is important. The equipment shown on the cover was part of an installation by Du Mont at St. Clare's Hospital, New York City, where it was used during a large meeting of doctors and surgeons, who viewed a number of important operations which otherwise could have been seen by only a few.

Certain tests on machines, such as high speed motors (and now, jet units) used to be made in concrete pits, with engineers watching over a wall. In case of an explosion or a motor flying apart, the engineer's ducking speed was more important than his technical knowledge. Now these tests can be made with a camera focused right on the most important feature of the test; either on the meters as in Image 1 or on some critical part of the equipment itself.

Large department stores have already found use for television in making their displays visible to a larger number of people as well as to bring colorful displays to the attention of customers in other parts of the store or to windowshoppers, as indicated in Image 2. Gimbel's of Philadelphia and Gertz' of Jamaica, New York, have done considerable experimental work with store televisers. The scene on our cover also shows how closed-circuit industrial-type television could be used by a model to demonstrate clothes or to advertise other items.

Time is occasionally lost in a bank while a signature is being identified, and under some circumstances good will and a valuable account is lost as well. Image 3 shows how this can be prevented. The clerk can call for a copy of any signature, which can be flashed to him in a matter of seconds. The same equipment can also be used to make records available for inspection at a number of points. The records can then be kept in a central depository.

Some types of inspection, while not perilous in the sense of Image 1, bring hazards of fumes, heat, gases or splashing melted metal which make the inspector's work difficult and unpleasant, if not immediately dangerous. Image 4 shows how the pouring of metal in a mold can be viewed from much closer range than was possible under the old system of stationing a man 50 feet from the operation. Working in comfort at closer effective range, the operators can do a much better job of controlling the work.

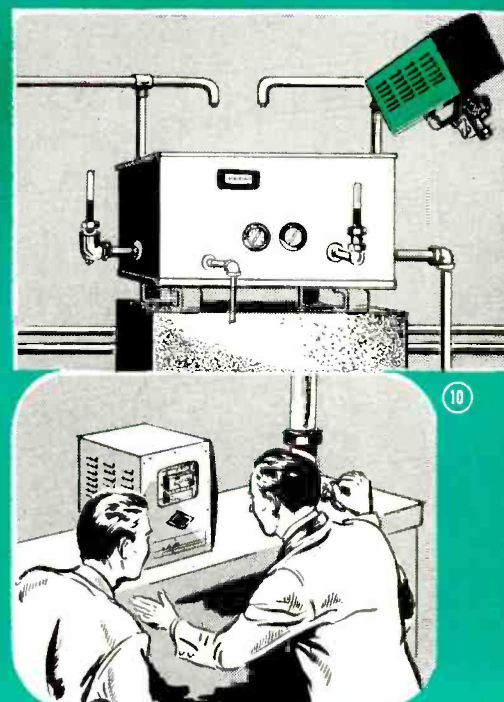
Where material is borne along a chute there is always the danger of clogging or piling up. In the case shown in Image 5, coal is moved with the help of water. One person viewing the operation on a television screen and increasing or reducing the flow of water can replace two or more men, who would otherwise be placed at various points along the chute to watch for pile-up.

The television camera can be a more efficient watchman than any human, for it can be made to operate with infra-red light. Thus it may maintain a perfect watch in a "dark" area, throwing a bright and detailed image on the screen. Image 6 is a burglary that didn't quite come off as planned.

Another type of property protection in which television can be particularly useful is that of watching objects in a museum or art gallery as in Image 7. It has a double advantage over direct supervision. The would-be thief cannot see the guard and cannot tell when he is not under direct supervision. Neither can the thieves create a diversion to draw the guard away from a given spot.

Image 8 is another instance of television used for meter reading. In certain cases direct viewing of a number of meters is more advantageous than a telemetering system, and in others optical viewing is required by law, as in the case of water-gauges on steam boilers. Industrial television equipment is the answer.

The portability of the camera is a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factor in its versatility. It can be used for a short-time job with little expense, as in the meter-viewing project, where setting up a telemetering system would be practical only in a permanent installation. In many cases of disaster, a camera can be placed where humans are not safe, due to obstructions, gases, danger of falling material, etc. Image 9 shows how an industrial television camera might be used in a mine disaster.

Nuclear research and work with radioactive material call for remote control operations in enclosures where no person may enter once the process has started. A television viewer to watch flow of materials, gauges, reactions, and in some instances to control mechanical robots, is of course the natural solution to the problem, as shown in Image 10.

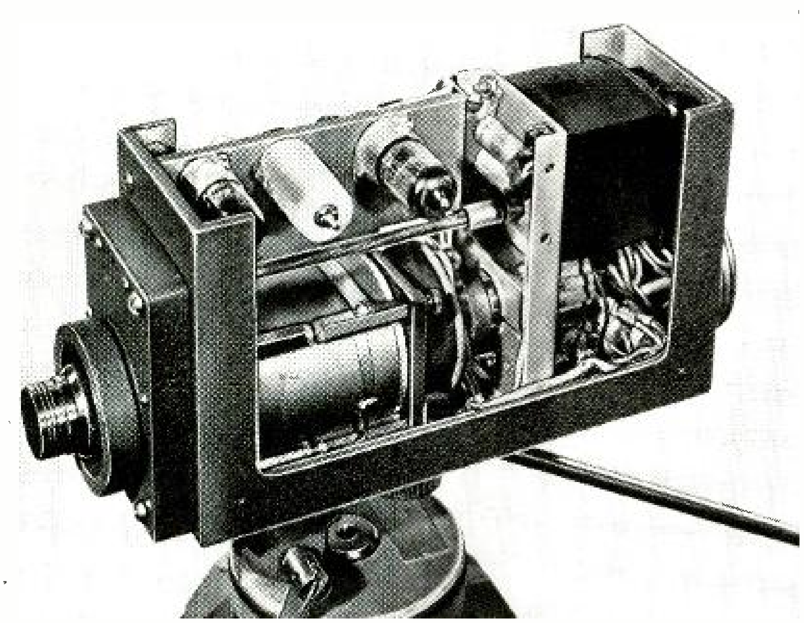
Another version of the "chute" problem is seen in Image 11. Vehicular tunnels pose a problem of traffic control which requires policemen at a number of points along the tunnel. Monoxide gas makes the job dangerous and unpleasant, and accidents pose a hazard, as in the recent case where a guard in a New York tunnel was crushed when a truck got out of control. With the help of television, one man can do the work of a number, and do it in safety and comfort.

In many of these applications, color is quite unnecessary and is not used. In others, it is essential. For example, the effect of the fashion show of Image 2 would be reduced tremendously in black-and-white. Compare the models' dresses with the one on the cover, for example.

Image 4 is another good example where color is extremely useful. In many applications dealing with great heat, temperature is often estimated by color of metals or gases.

The same is true in observing chemical reactions, as in Image 10. Often the color of a solution is the most important phenomenon to be observed.

The closed-circuit feature of industrial television has one great advantage. Since there is no broadcasting through space, there is no need of regulating bandwidth. So the industrial color televiser can use as wide a band as convenient. The Du Mont system illustrated on the cover uses 18 mc, the equivalent of three 6-mc channels, with a mechanical wheel for color.



Closeup of the RCA Vidicon, a compact TV camera especially for industrial use.

Hampered to some extent by its very originality and the fact that it presents previously unheard-of solutions to industrial problems, industrial television got off to a slow start, but has been making steadily increasing progress during the past year. There are now four main brands on the market: Vericon, with its new Vericolor; RCA's Vidicon; the Utiliscope handled by Diamond Power Specialty Corporation; and the Du Mont 18-mc color equipment.

Of these, the Vericon, made by Remington-Rand, and originally described in RADIO-ELECTRONICS March 1949, has recently added color, using the CBS color disc and a considerably wider band than the older monochrome equipment. Previous users of the equipment have been quick to realize the additional value of color and two large Vericon installations in college medical schools are now switching to Vericolor.

The RCA Vidicon has been used up to the present as a monochrome system, though its designers have pointed out that by using three Vidicon cameras to pick up the three primary colors, it can be adapted to color transmission.

The Utiliscope system is possibly the oldest of those described, and has a number of installations in various types of industry, some of which have been described or shown in photos in past issues of the magazine. No statement as to a proposed switch to color has been received from them as yet.

The Du Mont system uses standard equipment modified to operate at 180 fields per second. Unlike the other systems, it was designed primarily for color. Yet, where color is not needed, it is also available as a monochrome system. For example, the country-wide meeting of Schenley representatives, which was the first closed-circuit program to be "broadcast" was in black-and-white. This meeting consisted of 18 separate groups totalling more than 2,300 persons in cities as far apart as Boston and St. Louis. Transmission over long lines was the reason for use of monochrome in this case, as the frequency limits of the lines would have made color broadcast difficult.

Thanks are due to Diamond Power Specialty Corporation for the ideas underlying the larger number of the illustrations on pages 30 and 31.

COLOR TELEVISION SYSTEMS

(Continued from page 22)

This problem has been solved with a synchronizing system in which timing pulses are transmitted to provide exact dot registry.

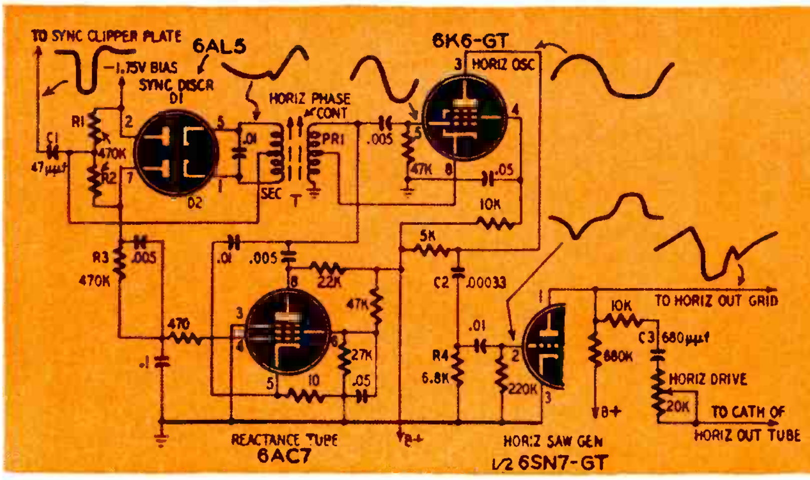
Many engineers point to these very problems, and the ones that still exist, as one of the strong points in favor of RCA's system. This admittedly crude development already produces images which some feel are equal to those of any system, and cannot lag far behind by anyone's reckoning. Yet the system is new and at the beginning of its development, whereas others are well in sight of the end of theirs. To say that a system shows great room for improvement may not always be praise, but it is a significant factor when planning for the future.

In typical RCA receiving equipment, three kinescopes are used, one for each of the primary colors. The separate colors are mixed with the aid of dichroic mirrors, which are transparent to two of the primaries and reflect the third. The viewer sees a full-color picture on what appears to be the screen of the green tube, though actually the red and blue components are reflected from the mirrors. As stated before, a single three-color direct-viewing tube has been demonstrated, but is still in the developmental stage.

Besides the three methods described, a number of other incipient color television systems—not developed to the point of demonstration—have been proposed to the FCC. None of them are likely to replace one of the present systems as the final answer to color television, but the possibility cannot be excluded.

References

[1] **Television in Color.** Fred Shunaman, *Radio-Electronics*, January, 1950, page 28.
[2] **New Picture Tube for Color TV.** *Radio-Electronics*, June, 1950, page 27.
[3] **Color Television.** Harry W. Secor, *Radio-Craft*, Part I, June 1947, page 20.
[4] **PPM—New Technique.** Fred Shunaman, *Radio-Craft*, February, 1946, page 314. **Pulse Code Modulation.** Fred Shunaman, February, 1948, page 28.



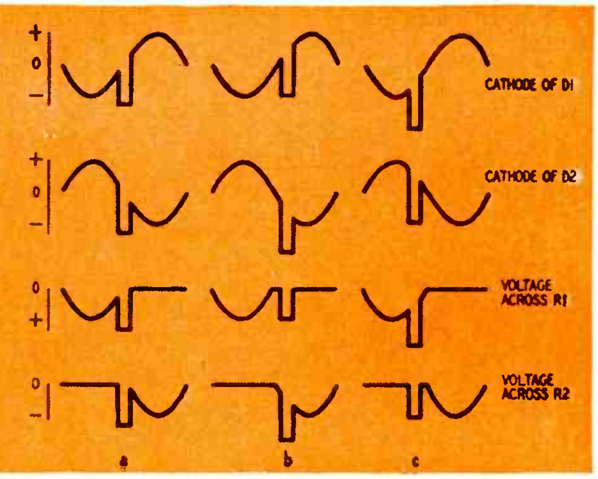


Fig. 1, left—The Stromberg-Carlson TV-12 employs this version of the popular RCA synchrolock a.f.c. circuit. Fig. 2, right—Waveforms show how sync pulses are superimposed on the sine wave output of the 6K6-GT horizontal oscillator.

Horizontal A. F. C. Circuits Used in Television Receivers

By HENRY O. MAXWELL

BECAUSE the horizontal deflection generator is easily affected by weak signals, noise, and some forms of interference, the horizontal sync may be lost because of instability, maladjustments, and minor defects in the antenna, tuner, and video i.f. Several types of automatic frequency controls have been developed to hold the horizontal oscillator in sync with the horizontal scanning generator at the transmitter.

In the receiver, the horizontal deflection signal may be generated by a sine-wave oscillator, multivibrator, or blocking oscillator, and the frequency-correcting voltage may be produced by several types of discriminators and phase detectors. To enable the service technician to give faster and more efficient service, we will discuss the theory of a.f.c. systems and deflection generators in this article.

The Synchrolock

Perhaps the best known of all a.f.c. systems is the RCA Synchrolock used in many versions of the 630-type chassis and in many other sets having 28 or more tubes. The circuit in Fig. 1 is used in the Stromberg-Carlson model TV-12. Other versions are used in the Freed-Eisemann 1620C, Zenith 28F20, and in sets of other makes and models. Component values and tube types may vary, but the circuit operation remains the same.

The 6K6-GT is a Hartley-type horizontal oscillator operating at a natural frequency of 15,750 cycles. A 6AC7 reactance tube, connected in parallel with the tuned circuit, acts as a shunt reactance which can control the resonant frequency of the L-C network. The magnitude of the shunt reactance is determined by the bias voltage and transconductance of the 6AC7. With a fixed negative bias of approximately 2 volts, a change of 0.5 volt will change the oscillator approximately 100 cycles. The frequency shifts in one direction when the bias increases and in the other when it decreases.

The horizontal oscillator develops a sine-wave voltage across the secondary of the discriminator transformer T so that the cathode of one diode is negative at the instant that the other is positive. Negative sync pulses are fed to C1, R1, and R2 which have a time constant which develops sharp pulses at the center tap of the secondary winding. These pulses are applied in phase to the cathodes of the 6AL5 sync discriminator. The amplitudes of the sine wave and pulses are constant. The mixture of sine wave and pulse causes D1 and D2 to conduct when their cathodes are driven negative and voltages are developed across R1 and R2, respectively. These resistors are connected so the algebraic sum of their voltages is produced be-

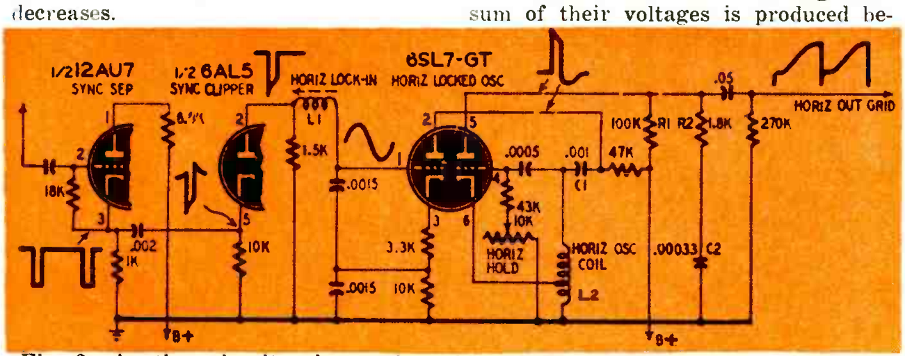


Fig. 3—Another circuit using a sine wave oscillator. Negative pips from the sync clipper are used to control the frequency of the horizontal oscillator.

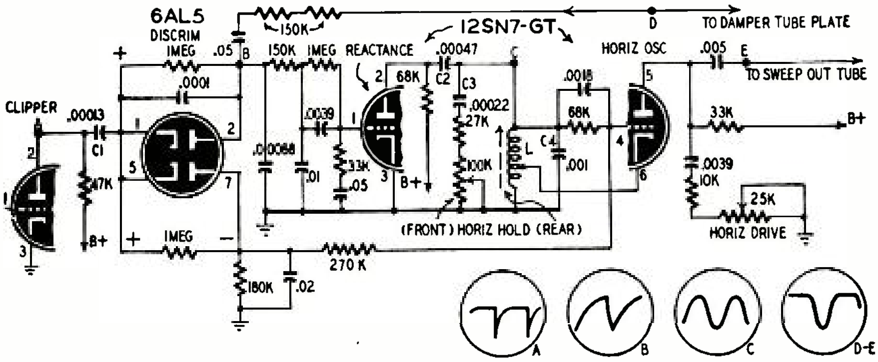


Fig. 4—The Gruen a.f.c. circuit which is used in many of the late G-E models.

tween ground and the junction of R2 and R3. A network consisting of the 470,000-ohm resistor R3 and the .005- and 0.1-μf capacitors filters the control voltage and applies it to the control grid of the 6AC7.

When the oscillator is in sync, the pulses arrive at the instant the sine wave on the cathodes is crossing the zero axis, as shown at a in Fig. 2. The voltages across R1 and R2 are equal and opposite, and the net voltage is zero.

Consider what happens when the oscillator shifts frequency so the negative sync pulse arrives when the cathodes of D1 and D2 are negative and positive, respectively. (See c in Fig. 2.) During the first half of the cycle, D1 conducts and the voltage across R1 corresponds to the voltage on the cathode of D1. At the same time, the sine wave is positive on D2 and will conduct only for the duration of the pulse which has sufficient amplitude to drive the cathode negative. The voltage across R1 being greater than that across R2, a positive voltage will be applied to the grid of the 6AC7. The reactance tube draws more current, its effective reactance increases, and the oscillator frequency decreases.

The drawings at b show how a negative corrective voltage is produced when the oscillator is running too slow.

The output of the oscillator is coupled to the horizontal sawtooth generator—often called a discharge tube—through a differentiator consisting of C2 and R4. The tips of the differentiated pulse cause the sawtooth generator tube to conduct and discharge the sweep-generating capacitor C3.

The horizontal drive control adjusts the shape of the sine wave applied to the grid of the output tube and is therefore capable of affecting the linearity and size of the picture as well as the high voltage in circuits using flyback power supplies.

In the 630 and most other sets, the sync pulses are positive and the plate and cathode connections are reversed on the discriminator diodes.

Motorola circuit

Another circuit which uses a sine-wave oscillator is employed in the Motorola TS-30A and similar chassis. In this circuit (Fig. 3), the negative sync pulses appearing at the cathode of the sync separator are differentiated by the .002-μf capacitor and the 10,000-ohm resistor in the cathode return of the sync clipper. The diode passes the negative pulses and clips the positive pips. The negative pips, which correspond to the leading edges of the sync pulses, are used to control a 15,750-cycle sine-wave oscillator consisting of L1, the two .0015-μf capacitors, and half of the 6SL7. This oscillator is locked in with the sync pulses.

The negative half of the sine wave across L1 drives the oscillator grid to cutoff and produces a positive pulse in the plate circuit. This plate waveform is differentiated by C1 and L2 to make a pulse which triggers the grid of the blocking oscillator consisting of the other half of the 6SL7. The time constant of the 500-μμf capacitor and the resistance in the oscillator grid return determines the frequency of the blocking oscillator. The sawtooth which drives the horizontal amplifier is developed by the charging and discharging of C2 through R1 and R2. The voltage across R2 and C2 produces a negative spike which drives the output tube to cutoff during the retrace period.

Note that this circuit does not provide a corrective voltage to hold the blocking oscillator on frequency. Instead, it is triggered by a pulse derived from a sine wave. The locked-in sine-wave oscillator acts as a buffer to prevent noise pulses from riding through and affecting the performance of the blocking oscillator.

The Gruen system

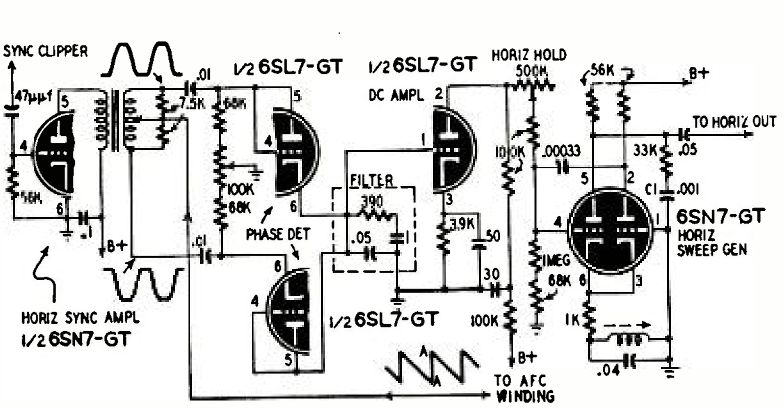
The Gruen a.f.c. circuit used in the G-E 12T7 and other late G-E sets is shown in Fig. 4. This circuit uses a 6AL5 balanced discriminator, and a 12SN7 reactance tube and sine-wave oscillator. The oscillator is controlled by the inductance of the tapped coil L and the capacitance of C2, C3, and C4. The reactance tube acts as a resistance in series with C2 across the tank coil.

In this circuit, the discriminator produces a d.c. voltage having an amplitude and polarity determined by the phase difference between the sync pulses and the negative pulses at the plate of the damper tube. The negative sync pulses are applied to the cathodes and the pulse from the damper tube is integrated into a sawtooth by the 680-μμf capacitor.

The peak-to-peak voltage of the sawtooth on the plates is approximately half that of the sync pulses fed to the cathodes. When the diodes conduct because of the presence of sync pulse or sawtooth alone, the voltages across the 1-megohm load resistors are equal with opposite polarity, making the discriminator output zero.

The sync pulses charge C1 to approximately 60 volts and bias the cathodes positive by this amount. As long as this bias is on the cathodes, the sawtooth cannot cause conduction because its peak value is too low.

If the oscillator is in sync with the pulses from the transmitter, the pulses arrive at the instant that the retrace portion of the sawtooth crosses the zero axis and the voltages across the load resistors are caused by the portion of the sync pulse which is above the bias developed by C1. These voltages cancel



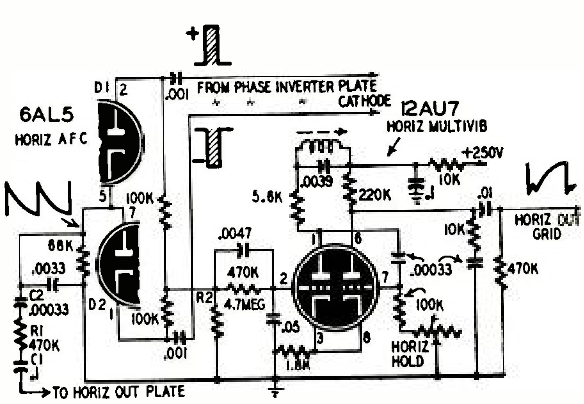


Fig. 5, left—The d.c. amplifier boosts the discriminator output to insure positive control over the horizontal oscillator. Fig. 6, right—A phase inverter does the work of the transformers which the discriminators in Figs. 1 and 5 use.

each other and therefore no d.c. voltage comes out of the discriminator.

When the oscillator is fast or slow, the sync pulse falls on the retrace of the sawtooth. Now, the sawtooth will add to or subtract from the sync pulse on the diodes and cause a difference in the voltages across the load resistors. The algebraic sum of the voltages—positive if the oscillator is fast and negative if it is slow—is filtered and fed to the grid of the reactance tube.

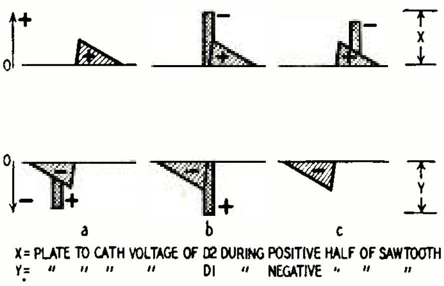


Fig. 7—Waveforms showing how the circuit of Fig. 6 controls the frequency.

If the correction voltage is positive, the plate-to-cathode impedance of the reactance tube will be lower and the capacitance of C2 will have a greater effect on the tuned circuit and lower the oscillator frequency. A negative voltage increases the plate-to-cathode impedance of the reactance tube, the effect of C2 is reduced, and the oscillator speeds up.

The .0039-μf capacitor and the series resistance to ground produce the sawtooth deflection voltage as do R1, R2, and C2 in Fig. 3.

A G-E circuit

The a.f.c. circuit in Fig. 5 is used in the G-E model 901. Here, an unbalanced discriminator or phase detector, d.c. amplifier, and multivibrator are used. A sawtooth from a special winding on the

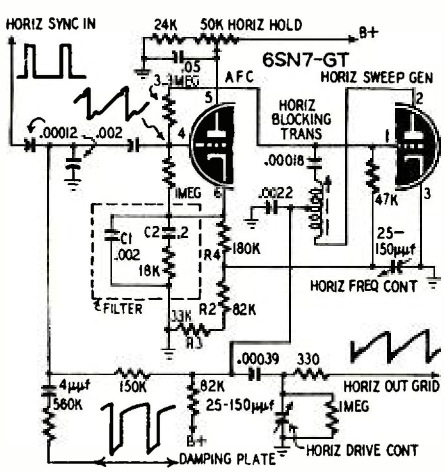


Fig. 8—An a.f.c. circuit of the pulse-width type which is used in some sets.

horizontal output transformer is applied to the center-tapped secondary of the a.f.c. input transformer. This voltage—in phase at the ends of the secondary—is compared with the sync pulses which are out of phase across the halves of the winding. The diodes conduct equally when the sync pulses coincide with points A on the sawtooth and the net d.c. voltage is zero.

If the sync pulse falls at any other point, the voltages across the diodes are unequal and a positive or negative corrective voltage is produced. After being filtered, the voltage is amplified by a d.c. amplifier and then applied to a grid of the multivibrator-type oscillator. The filter has a time constant which averages voltages over a frame rather than over individual lines, thus making the circuit less sensitive to noise and interference pulses.

The coil and capacitor in the cathode returns of the 6SN7 are shocked into a ringing condition which produces a sine wave. The charge-and-discharge capacitor C1 converts the sine into a sawtooth required for deflection.

Westinghouse a.f.c.

Another interesting circuit is used in the Westinghouse H-223. In Fig. 6, the sync pulses from the sync separator are fed to a phase inverter which develops equal pulses of opposite polarity at its plate and cathode. The positive pulse is fed to the plate of D1 at the instant that the negative pulse is fed to the cathode of D2. A square-wave pulse from the plate of the horizontal output tube is applied to the cathode of D1 and plate of D2 through an integrator (C1, R1, and C2) that converts the signal to a sawtooth which is alernately positive and negative. Note that the voltages on the cathode of D1 and plate of D2 are in phase while the sync pulses on the plate of D1 and cathode of D2 are 180 degrees out of phase.

Fig. 7 shows the operation of this circuit. At a, the arrival of the sync pulses coincides with the leading edge of the negative-going sawtooth. The sum of the negative cathode and positive plate voltages on D1 being greater than the positive sawtooth acting alone on the plate of D2, a negative d.c. voltage appears across R2. The negative sync pulse is not shown at a because it is canceled by the negative sawtooth on the plate of D2.

At b, the pulses are centered over the trailing edge of the negative-going sawtooth and the leading edge of the positive-going sawtooth with the result that the voltages developed during successive halves of the sawtooth cycle are equal and opposite and the net voltage across R2 is zero.

At c, the pulses arrive on the trailing edge of the positive sawtooth, D2 conducts more heavily than D1, and a positive correction voltage is produced.

The sawtooth deflection voltage is generated by the 10,000-ohm resistor and .00033-μf capacitor just as in the other charge-discharge circuits we have discussed.

Pulse-width system

Fig. 8 is one of several versions of the pulse-width a.f.c. system. This circuit, used in the G-E 810, operates in much the same manner as the RCA Synchroguide. A single 6SN7-GT is the a.f.c. tube and blocking oscillator. The grid of the a.f.c. tube is biased to cutoff by the negative voltage applied to it through the 3.3-megohm resistor connecting it to the oscillator grid.

Positive pulses from the plate of the damper tube are converted to modified sawtooth waveforms and fed to the grid of the a.f.c. tube along with positive sync pulses. Neither voltage has sufficient amplitude to overcome the bias on the a.f.c. tube but their amplitudes can be combined to cause conduction.

When the oscillator is in sync (see Fig. 9), the leading half of the pulse is on the leading edge of the sawtooth and its trailing edge corresponds to the trailing edge of the saw. Thus the pulse is only half its normal width. The pulse falls higher on the sawtooth and more of it is clipped when the oscillator is fast. If the oscillator is slow, the full width of the pulse may fall on the leading edge of the sawtooth.

C1 and C2 charge during the time that the a.f.c. tube is conducting. The voltage on them is determined by the duration of plate-current flow. A portion of the voltage across these capacitors is applied as bias to the grid of the blocking tube. If the oscillator is slow,

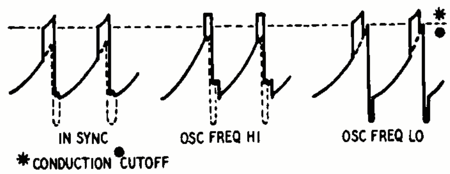


Fig. 9—Waveforms showing pulse width differences of the circuit of Fig. 8

the voltage across the capacitor will be more positive than when the oscillator is in sync, the oscillator speeds up until the grid bias returns to its normal value.

Troubleshooting hints

Troubles in a.f.c. circuits can be numerous and may be caused by minor changes in the values of many components. These few hints are useful when servicing a.f.c. circuits:

1. Always check the damper tube in circuits where the feedback voltage is taken from the plate of the horizontal output or damper tubes.

2. Check the feedback windings for open circuits and shorted turns in circuits like Fig. 5.

3. When replacing resistors and capacitors in the a.f.c. circuit, always use units having tolerances equal to or closer than those of the original. Check the parts list and diagram to be sure.

4. Check all tubes which are even remotely connected with the horizontal deflection circuit. Sync separators, d.c. restorers, clippers, amplifiers, and clamps can affect the operation of some circuits.

We plan to follow this article with another describing some of the tricks and short cuts which can be used in adjusting and servicing horizontal a.f.c. systems.

Guided TV Bomb

By HUGO GERNSBACK

TELEVISION-CONTROLLED weapons are by no means a novelty. Indeed the first television-controlled plane was proposed by the writer in 1924*.

It became a reality in World War II, when 34 of our B-17 and B-24 bombers, with automatic pilots and TV cameras in their noses were guided by radio right into the mouths of V2 hangars in occupied France.

Flying high over the English Channel our radio control planes guided the bombers accurately into the small openings of the hangars. Each bomber contained 2,400 pounds of TNT and Torpex which exploded on contact, atomizing the bomber as well.

During World War II our Navy and Air Force had also experimented with actual *television bombs.*

These tests took place at Lake Muroc, Cal. The bomb used had a TV camera in its nose and was steered by a bombardier who corrected the drop by changing the pitch of the fins on the bomb as it fell. But this bomb was not very effective as its direction could not be changed except during the first few seconds of its fall.

* See "The Radio-Controlled Television Plane" by H. Gernsback, in *The Experimenter*, page 22, November, 1924.

Improved television bombs of this type will certainly be used in future wars. As a guided weapon, such a bomb has a great many advantages which cannot be overlooked in future conflicts.

At present, bombing at very great heights is more or less a hit-or-miss proposition. Far too often only one or two out of ten bombs are effective. Particularly when aimed at a comparatively small target most bombs are ineffective. All bombs are subject to "drift": first because of the motion of the plane from which they fall, and second because of winds over the target. The bombardier is supposed to correct for such drift, but at best his aim is only approximate. Targets such as bridges, railroad tracks, etc., are particularly difficult to hit and usually a large number of bombs must be wasted to make a strike that will actually demolish such objects.

Moreover, the bombardier has to count on overcast weather and erratic flying when pursued by fighter planes or attacked by antiaircraft fire.

All this makes for a large waste of bombs. It is true that toward the end of World War II guided bombs came into use, but even these were not accurate in overcast weather, during fog, etc., even when radar was used.

If, however, radar and television are combined in such a manner that the bombardier can have the target outlined on his radar screen, then during the last stages of the television bomb fall (after it has cleared the clouds), the bombardier then can actually see the target and can make a better strike.

For this reason the television bomb will not only prove a formidable weapon but will sharply reduce the waste of expensive bombs.

A television bomb for many reasons will have to be a large one, usually of the blockbuster or the large incendiary type. In its nose it will contain a television camera operated either by special powerful batteries or a small electric generator. Such a generator can be powered by an air turbine operated by the airstream as the bomb falls through the air, generating enough current to operate the television transmitter.

The television bomb has special fins and a tail, both of which can be moved by compressed air, stored in a tank in the bomb, to guide the bomb's fall accurately. The bomb is steered from the bomber by radio remote control in the usual manner of guided missiles. Thus the television bomb is a regulation guided weapon except that the television bombardier can watch on his television screen the EXACT progress of the "falling" missile. By radio control he manipulates the bomb's flight accurately toward any target selected. On his television screen the bombardier can watch the bomb's progress through the thickest clouds, rain, fog, or snow up to the instant of the hit.

Nor is the extra cost of equipping such a missile with a television transmitter excessive. Large bombs of this type often cost up to fifteen thousand dollars and over.

As the television bomb is far more accurate than the regulation type, the few hundred dollars spent on a television transmitter is insignificant when the cost of the wasted bombs, normally expended on a target, is taken into consideration.

Picture Tube List

By F. WILHELM

Listing the physical and electrical characteristics of all magnetically deflected picture tubes, the chart opposite is prepared especially as an aid to planning conversions to bigger tubes. For this reason, the over-all size, deflection angle, type of focusing, and typical operating conditions are pushed toward the front where they won't be overlooked when making comparisons between tube types.

Special notes:

Type numbers of rectangular tubes are in light face type.

Capacitance of inner and outer coatings of some glass tubes may vary widely because of differences in the width of the band and the conductivity of the coatings

Some manufacturers give only the diagonal deflection angle of rectangular picture tubes. Because the horizontal deflection angle is somewhat less than the diagonal some 70° yokes will overdrive the tube. For this reason, the horizontal deflection angle is given for all types of tubes.

The 7AP4, 9AP4, 12AP4, and 12PC4 have 2.5-volt, 2.1-ampere heaters, all others have 6.3-volt, 600-ma heaters.

Footnotes:

1—Projection tube with aluminized screen.
2—Suffix A indicates a masking aperture.
3—Aluminized screen.
4—Screen made from special nonreflecting glass.
5—Data published by Thomas Electric and Sylvania specify a single magnet. Du Mont and Tung-Sol specify a double magnet.
6—Current in RMA focus coil No. 109, all others for RMA focus coil No. 106.
7—Some manufacturers use clear glass on face.
NG—This tube does not have accelerator (No. 2) grid.
M5—Medium, 5 pins.
M6—Medium, 6 pins.
M9—Miniature, 9 pins.
MSO8—Medium shell octal, 8 pins.
S5—Special, 5 pins.
SSD5—Small-shell duodecal, 5 pins.
SSD7—Small-shell duodecal, 7 pins.
3NP4—Special socket for 3NP4.
Dim. A—12½ x 19-11/16 inches.
Dim. B—12-17/32 x 9-23/32 inches.
Dim. C—14¾ x 11½ inches.
Dim. D—14¾ x 11-17/32 inches.
Dim. E—15⅜ x 12 1.4 inches.
Dim. F—15-21/64 x 12-9/64 inches.
Dim. G—16-1/16 x 12⅜ inches.
Dim. H—17 x 13-3/32 inches.

Type of cathode-ray tube	Diameter of tube face (inches)	Over-all length of tube (inches)	Construction of envelope	Deflection angle in degrees (Horizontal)	Method of focusing	Type of ion trap, if used	Capacitance (uuf) between inner and outer conductors when tube has outer coating	Typical anode voltage (kilovolts)	Typical accelerator or grid No. 2 voltage	Control grid or cathode voltage for extinction of undeflected spot. Values are positive for cathode and negative for grid	Maximum anode voltage (kilovolts)	Maximum grid No. 2 volts	Focus current in ma (See Note 6)	Anode terminal	Type of socket	Color of face	Base wiring diagram (Figure No.)	Type of cathode-ray tube
3NP4[1]	2 9/16	10	Glass	42	M	None	375	24	NG	60	25	NG		Ball	S5	Clear	7	3NP4[1]
5FP4-A[2]	4 15/16	11 1/8	Glass	53	M	None	None	6	250	45	8	300		Ball	MSO8	Clear	8	5FP4-A[2]
5TP4[1]	5	11 3/4	Glass	50	E	None	500	27	200	70	27	350		Cavity	SSD7	Clear	4	5TP4[1]
7AP4	7 1/8	13 1/2	Glass	55	E	None	None	3.5	NG	67.5	3.5	NG		None	M5	Clear	9	7AP4
7CP4	7	13 7/16	Glass	57	E	None	None	6	260	45	8	300		Ball	MSO8	Clear	1	7CP4
7DP4	7 3/16	14 1/16	Glass	50	E	Double	1500	6	250	45	8	410		Cavity	SSD7	Clear	2	7DP4
7HP4	7 3/16	13	Glass	50	M	None	500	6	250	55	8	410		Ball	SSD7	Clear	4	7HP4
8AP4	8 1/2	14 1/4	Metal	54	M	Single	None	7	NG	45	10	NG	112	Cone	SSD7	Clear	3	8AP4
8AP4-A	8 1/2	14 1/4	Metal	54	M	Single	None	7	NG	45	10	NG	112	Cone	SSD7	Gray	3	8AP4-A
9AP4	9 1/8	21	Glass	35-40	E	None	None	7	250	87.5	7	250		Cap	M6	Clear	5	9AP4
9CP4	9 1/16	15 7/8	Glass	50	M	None	None	7	NG	100	7	250		Cap	M6	Clear	6	9CP4
10BP4	10 1/2	17 5/8	Glass	50	M	Double	2500	9	250	45	12	410	132	Cavity	SSD7	Clear	4	10BP4
10BP4-A	10 1/2	17 5/8	Glass	50	M	Double	2500	9	250	45	12	410	132	Cavity	SSD7	Gray	4	10BP4-A
10CP4	10 1/2	16 5/8	Glass	50	M	None	500	9	250	48	12	410		Ball	SSD7	Clear	4	10CP4
10DP4[3]	10 1/2	17 5/8	Glass	50	E	None	None	9	250	60	12	410		Cavity	SSD7	Clear	2	10DP4[3]
10EP4	10 1/2	17 5/8	Glass	50	M	Double		8	250	43	11	330	132	Ball	SSD7	Clear	4	10EP4
10FP4[3]	10 1/2	17 5/8	Glass	50	M	None	2500	9	250	45	12	410	115	Cavity	SSD7	Clear	4	10FP4[3]
10FP4-A[3]	10 1/2	17 5/8	Glass	50	M	None	2500	9	250	45	12	410	115	Cavity	SSD7	Gray	4	10FP4-A[3]
10MP4	10 1/2	17	Glass	52	M	Double	2500	9	NG	45	12	NG		Cavity	SSD5	Clear	3	10MP4
10MP4-A	10 1/2	17	Glass	52	M	Double	2500	9	NG	45	12	NG		Cavity	SSD5	Gray	3	10MP4-A
12AP4	12 3/16	25	Glass	35-40	E	None	None	7	250	75	7	250		Cap	M6	Clear	5	12AP4
12CP4	12 1/16	18 5/8	Glass		M	None	None	7	NG	110	7	NG		Cap	M6	Clear	6	12CP4
12JP4	12	17 1/2	Glass	56	M	Double	None	10	250	45	12	410	158	Ball	SSD7	Clear	4	12JP4
12KP4[3]	12 7/16	17 5/8	Glass	54	M	None	2500	10	250	45	12	410	140	Cavity	SSD7	Clear	4	12KP4[3]
12KP4-A[3]	12 7/16	17 5/8	Glass	54	M	None	2500	10	250	45	12	410	140	Cavity	SSD7	Gray	4	12KP4-A[3]
12LP4	12 7/16	18 3/4	Glass	54	M	Double	3000	11	250	45	12	410	114	Cavity	SSD5	Clear	4	12LP4
12LP4-A	12 7/16	18 3/4	Glass	54	M	Double	3000	11	250	45	12	410	114	Cavity	SSD5	Gray	4	12LP4-A
12QP4	12 7/16	17 1/2	Glass	55	M	Single	None	10	250	45	12	410	148	Ball	SSD7	Clear	4	12QP4
12QP4-A	12 7/16	17 1/2	Glass	55	M	Single	None	11	250	45	12	410	148	Ball	SSD7	Gray	4	12QP4-A
12RP4	12	17 1/2	Glass	56	M	Single	None	10	250	45	12	410	148	Ball	SSD7	Clear	4	12RP4
12TP4	12 7/16	18 3/4	Glass	54	M	Double	None	11	250	45	12	410	114	Cavity	SSD7	Clear	4	12TP4
12UP4	12 7/16	18 5/8	Metal	54	M	Double	None	11	250	45	12	410	114	Cone	SSD7	Clear	4	12UP4
12UP4-A	12 7/16	18 5/8	Metal	54	M	Double	None	11	250	45	12	410	114	Cone	SSD7	Gray	4	12UP4-A
12UP4-B	12 7/16	18 5/8	Metal	54	M	Double	None	11	250	45	12	410	114	Cone	SSD7	Gray[4]	4	12UP4-B
12VP4	12 3/8	18	Glass	55	M	Double	750	11	NG	45	12	NG		Cavity	SSD5	Clear	3	12VP4
12VP4-A	12 3/8	18	Glass	55	M	Double	750	11	NG	45	12	NG		Cavity	SSD5	Gray	3	12VP4-A
12WP4	12 7/16	17 3/4	Glass	65	M	Single	2000	10	NG	45	12	NG	70	Cavity	M9	Gray	10	12WP4
14BP4	Dim. A	16 13/16	Glass	65	M	Double	500	11	250	45	12	410	115	Cavity	SSD5	Gray	4	14BP4
14CP4	Dim. A	16 3/4	Glass	65	M	Single	1500	12	300	45	14	410	115	Cavity	SSD5	Gray	4	14CP4
14DP4	Dim. A	16 3/4	Glass	65	M	Double	None	11	250	45	14	410	115	Cavity	SSD5	Gray	4	14DP4
14EP4	Dim. B	16 3/32	Glass	65	M	Single	1250	12	300	45	14	410	115	Cavity	SSD5	Gray	4	14EP4
15AP4	15 1/2	20 1/2	Glass	57	M	None	None	12	250	45	15	410	159	Ball	SSD7	Clear	4	15AP4
15CP4	15 1/2	21 1/2	Glass	57	M	Double	None	9-15	250	45	15	410	133	Cavity	SSD7	Clear	4	15CP4
15DP4	15 1/2	20 1/2	Glass	57	M	Single	None	12	250	45	15	410	140	Ball	SSD5	Clear	4	15DP4
16AP4	15 7/8	22 1/4	Metal	53	M	Double	None	12	300	55	14	410	89	Cone	SSD5	Clear	4	16AP4
16AP4-A	15 7/8	22 1/4	Metal	53	M	Double	None	12	300	55	14	410	89	Cone	SSD5	Gray	4	16AP4-A
16CP4	15 7/8	21 1/2	Glass	52	M	Double	None	12	250	45	15	410	110	Cavity	SSD7	Clear	4	16CP4
16DP4	15 7/8	20 3/4	Glass	60	M	Double	None	12	250	45	15	410	115	Cavity	SSD7	Clear	4	16DP4
16DP4-A	15 7/8	20 3/4	Glass	60	M	Double	None	12	250	45	15	410	115	Cavity	SSD7	Gray	4	16DP4-A
16EP4	15 7/8	19 5/8	Metal	60	M	Double	None	12	300	55	14	410	105	Cone	SSD5	Clear	4	16EP4
16EP4-A	15 7/8	19 5/8	Metal	60	M	Double	None	12	300	55	14	410	105	Cone	SSD5	Gray	4	16EP4-A
16FP4	16 1/8	20 1/4	Glass	62	M	Single	None	13	350	45	16	410	140	Ball	SSD7	Clear	4	16FP4
16GP4	15 7/8	17 15/16	Metal	70	M	Single	None	12	300	55	14	410	100	Cone	SSD5	Gray[7]	4	16GP4
16GP4-B[4]	15 7/8	17 15/16	Metal	70	M	Single	None	12	300	55	14	410	100	Cone	SSD5	Gray	4	16GP4-B[4]
16HP4	15 7/8	21 1/4	Glass	60	M	Double	2000	12	300	55	14	410	110	Cavity	SSD5	Clear	4	16HP4
16HP4-A	15 7/8	21 1/4	Glass	60	M	Double	2000	12	300	55	14	410	110	Cavity	SSD5	Gray	4	16HP4-A
16JP4	16 1/8	20 3/4	Glass	60	M	Double	1500	11	250	45	14	410	120	Cavity	SSD5	Clear	4	16JP4
16JP4-A	16 1/8	20 3/4	Glass	60	M	Double	1500	11	250	45	14	410	120	Cavity	SSD5	Gray	4	16JP4-A
16KP4	Dim. C	18 3/4	Glass	65	M	Single	1500	14	300	55	16	410	109	Cavity	SSD5	Clear	4	16KP4
16LP4	15 5/8	22 1/4	Glass	52	M	Double	2000	12	300	55	14	410	120	Cavity	SSD5	Clear	4	16LP4
16LP4-A	15 5/8	22 1/4	Glass	52	M	Double	2000	12	300	55	14	410	120	Cavity	SSD5	Gray	4	16LP4-A
16MP4	16 1/8	21 3/4	Glass	60	M	Double	2500	12	300	55	14	410	110	Cavity	SSD5	Clear	4	16MP4
16MP4-A	16 1/8	21 3/4	Glass	60	M	Double	2500	12	300	55	14	410	110	Cavity	SSD5	Gray	4	16MP4-A
16QP4	Dim. D	19 1/8	Glass	54.5	M	Double	None	14	250	45	16	410	125	Cavity	SSD7	Gray	4	16QP4
16RP4	Dim. C	18 3/4	Glass	65	M	Single	1500	12	300	55	14	410	100	Cavity	SSD5	Gray	4	16RP4
16SP4	15 7/8	17 5/16	Glass	70	M	Double	2500	12	300	55	14	410	110	Cavity	SSD5	Clear	4	16SP4
16SP4-A	15 7/8	17 5/16	Glass	70	M	Double	2500	12	300	55	14	410	110	Cavity	SSD5	Gray	4	16SP4-A
16TP4	Dim. C	18 1/8	Glass	65	M	Single	1500	12	300	55	14	410	115	Cavity	SSD5	Gray	4	16TP4
16UP4	Dim. C	18 1/8	Glass	65	M	Single	None	12	300	55	15	410	100	Cavity	SSD5	Gray	4	16UP4
16VP4	15 7/8	17 3/16	Glass	70	M	Single	None	12	250	45	15	410	110	Cavity	SSD5	Gray	4	16VP4
16WP4	15 7/8	17 3/4	Glass	70	M	Double	None	12	250	45	15	410	110	Cavity	SSD5	Gray	4	16WP4
16WP4-A	15 7/8	17 3/4	Glass	70	M	Double	2000	12	250	45	16	410	110	Cavity	SSD5	Gray	4	16WP4-A
16XP4	Dim. D	18 3/4	Glass	65	M	Double	None	12	350	45	15	410		Cavity	SSD5	Gray	4	16XP4
16YP4	15 7/8	17 5/16	Glass	70	M	Single	1500	12	300	55	14	410	100[6]	Cavity	SSD5	Gray	4	16YP4
16ZP4	15 7/8	22 1/4	Glass	52	M	Double	2000	12	300	55	16	410	110	Cavity	SSD5	Gray	4	16ZP4
17AP4	Dim. E	18 5/8	Glass	62	M	Single	2000	12	300	55	16	410		Cavity	SSD5	Gray	4	17AP4
17BP4	Dim. F	19 1/4	Glass	65	M	Single	2000	12	300	55	16	410		Cavity	SSD5	Clear	4	17BP4
17BP4-A	Dim. F	19 1/4	Glass	65	M	Single	2000	12	300	55	16	410		Cavity	SSD5	Gray	4	17BP4-A
17CP4[4]	Dim. G	19	Metal	66	M	Single	None	12-14	300	55	16	410	100	Cone	SSD5	Gray	4	17CP4[4]
19AP4	18 5/8	21 1/2	Metal	66	M	Single	None	13	250	45	19	410	140	Cone	SSD7	Clear	4	19AP4
19AP4-A	18 5/8	21 1/2	Metal	66	M	Single	None	13	250	45	19	410	140	Cone	SSD7	Gray	4	19AP4-A
19AP4-B[4],-C[3,4]	18 5/8	22 1/2	Metal	66	M	Single	None	13	250	45	19	410	140	Cone	SSD7	Gray	4	19AP4-B[4],-C[3,4]
19DP4	18 7/8	21 1/2	Glass	66	M	Double	3000	13	250	45	19	410	140	Cavity	SSD5	Clear	4	19DP4
19DP4-A	18 7/8	21 1/2	Glass	66	M	Double	3000	13	250	45	19	410	140	Cavity	SSD5	Gray	4	19DP4-A
19EP4	Dim. H	21 1/8	Glass	65	M	Single[5]	2500	13	250	45	19	410	140[6]	Cavity	SSD5	Gray	4	19EP4
19FP4	18 7/8	22	Glass	66	M	Double	None	13	250	45	19	410	126[6]	Cavity	SSD5	Gray	4	19FP4
19GP4	18 7/8	21 1/4	Glass	66	M	Single	None	13	250	45	19	410	126[6]	Cavity	SSD5	Gray	4	19GP4
20BP4	20	28 3/4	Glass	54	M	None	None	10 15	250	45	20	410	122	Cap	SSD7	Clear	4	20BP4
20DP4-A	20 3/32	21 7/8	Glass	55	M	Single	750	12	300	55	18	410	95	Cavity	SSD6	Gray	4	20DP4-A
22AP4	21 11/16	22 7/8	Metal	70	M	Single	None	14	300	55	19	410	117	Cone	SSD5	Clear	4	22AP4
22AP4-A	21 11/16	22 7/8	Metal	70	M	Single	None	14	300	55	19	410	117	Cone	SSD5	Gray	4	22AP4-A

Charts Identify TVI

Eliminating arithmetic, charts simplify detection of radiating TV sets

By N. H. CROWHURST

INTERFERENCE with television reception can be caused by a variety of interactions between local oscillator or i.f. and other television channels. Articles have from time to time described methods of identifying the interference, but the tracking down to source involves repeated arithmetical calculations that become somewhat arduous. Use of the charts here presented will not only facilitate the calculations, but also help in getting a better visual understanding of the problem.

This kind of interference can be divided into two groups: Group 1, interference originating in the same receiver, and Group 2, that originating in another receiver. The solution of Group 1 problems is relatively simple, because all the causes of trouble are at the same site; but Group 2 can be more difficult, as cooperation with the owner of the interfering receiver is necessary, unless pickup from it can be eliminated by antenna orientation.

Interference from i.f. harmonic

Under Group 1, the simplest range of possibilities consists of stray coupling from the i.f. stages back into the r.f. section. It is harmonics of the i.f. that cause trouble, either sound or picture i.f. producing harmonics that can stray into the r.f. stages to interfere with either sound or vision channel. Charts 1 and 2 assist in identifying these possibilities. Chart 1 is for the lower band, channels 2 through 6, and Chart 2 for the higher band, channels 7 through 13. The horizontal dotted lines indicate carrier frequencies, the thick horizontal lines the boundaries between adjacent channels. Thin lines divide sound and vision on the same channel.

Use of the chart is simplicity itself. The diagonal lines indicate where the various harmonics fall. For instance, a receiver has the common video i.f. of 25.75 mc. Locating that point (three-quarters of the way between 25 and 26 on the bottom line) and laying out a vertical line from that point, we cross the 3rd harmonic line in channel 5 very near the picture carrier. Obviously i.f. 3rd harmonic is suspect if channel 5 is being interfered with.

Conversely, if interference is experienced on channel 3, only i.f.'s between 21 and 22 mc would be likely to cause it. If the set's i.f. is higher and there is no other nearby receiver, the trouble is likely to be from some other cause.

Because the vision channels occupy most of the available spectrum, interference is most likely to appear in them, but there are also narrow ranges of i.f. at which interference may appear in a sound channel. The 2nd, 3rd, and 4th harmonics can cause interference in the lower band. Second harmonics of i.f.'s between 27 and 30 mc can cause interference on channel 2. Just below 30 mc the interference will be in the sound channel. Third harmonic can cause interference on channels 3 to 6, according to value of i.f., and the 4th can cause interference on channel 5 or 6. As detailed in Chart 2, the 6th to 10th harmonics can cause trouble in the higher band. Harmonics of the sound i.f. can cause serious picture interference, too.

Image interference

Still considering Group 1, the next possibility is the old second-channel (image) trouble, and other channels that can produce the i.f. by mixing with harmonics of the oscillator instead of its fundamental. Presence of harmonics indicates that the oscillator waveform is poor. All these sources of interference usually show up when the interfering channel is strong in comparison with the received channel.

Chart 3, use of which is demonstrated in the key at the right-hand bottom corner, will help in tracking down possible interfering channels for any chosen i.f. and oscillator frequency combination. As represented by the arrow heads showing direction of reference, b is the received channel. (In this particular set the oscillator frequency is below r.f. carrier frequency.) Oscillator frequency is found by connecting with a straightedge the vision carrier in the received channel on the scale at the extreme left of the chart with the i.f. in the section marked OSC. LOW, and interpolating on the OSCILLATOR FUNDAMENTAL scale. The second-channel (image) frequency is indicated at a on the key, using the same i.f. in the section marked OSC. HIGH. Second and 3rd harmonics are located on their respective scales by aligning the zero at the bottom of the TELEVISION CHANNELS scale at the left, with the oscillator frequency already interpolated. From these points, reference through the same i.f. value on the other I.F. REF. scales, as indicated on the key, will show at points **c**, **e**, **f** and **h** possible channels that can interfere.

For example, interference may be received on channel 4. The receiver i.f. is the familiar 25.25 mc, with the oscillator working on the high side of the fundamental. Drawing a line from channel 4 through OSC. HIGH intersects the fundamental scale just above 90. A line is drawn from zero on the TELEVISION CHANNELS scale through this point, intersecting the 2nd and 3rd harmonic scales. From these latter points lines are drawn through both high and low 25.25 of the I.F. REF. (interference can

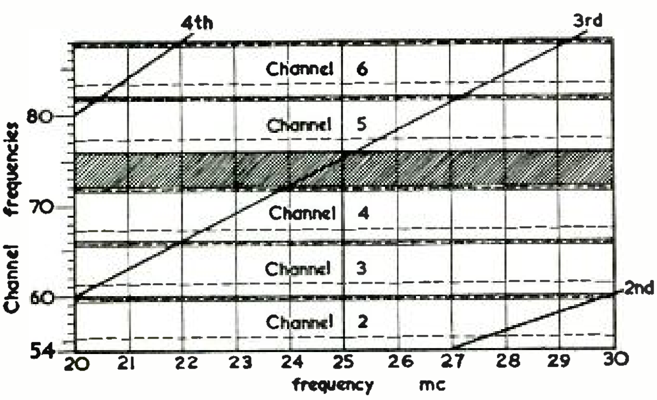


Chart 1—I.f. harmonic interference chart for low-band TV.

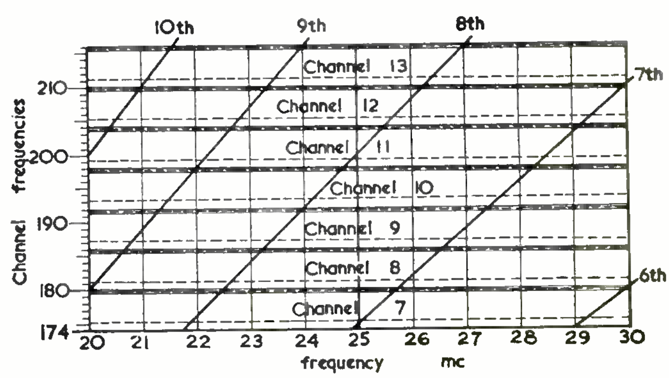


Chart 2—High-band i.f. harmonic interference chart.

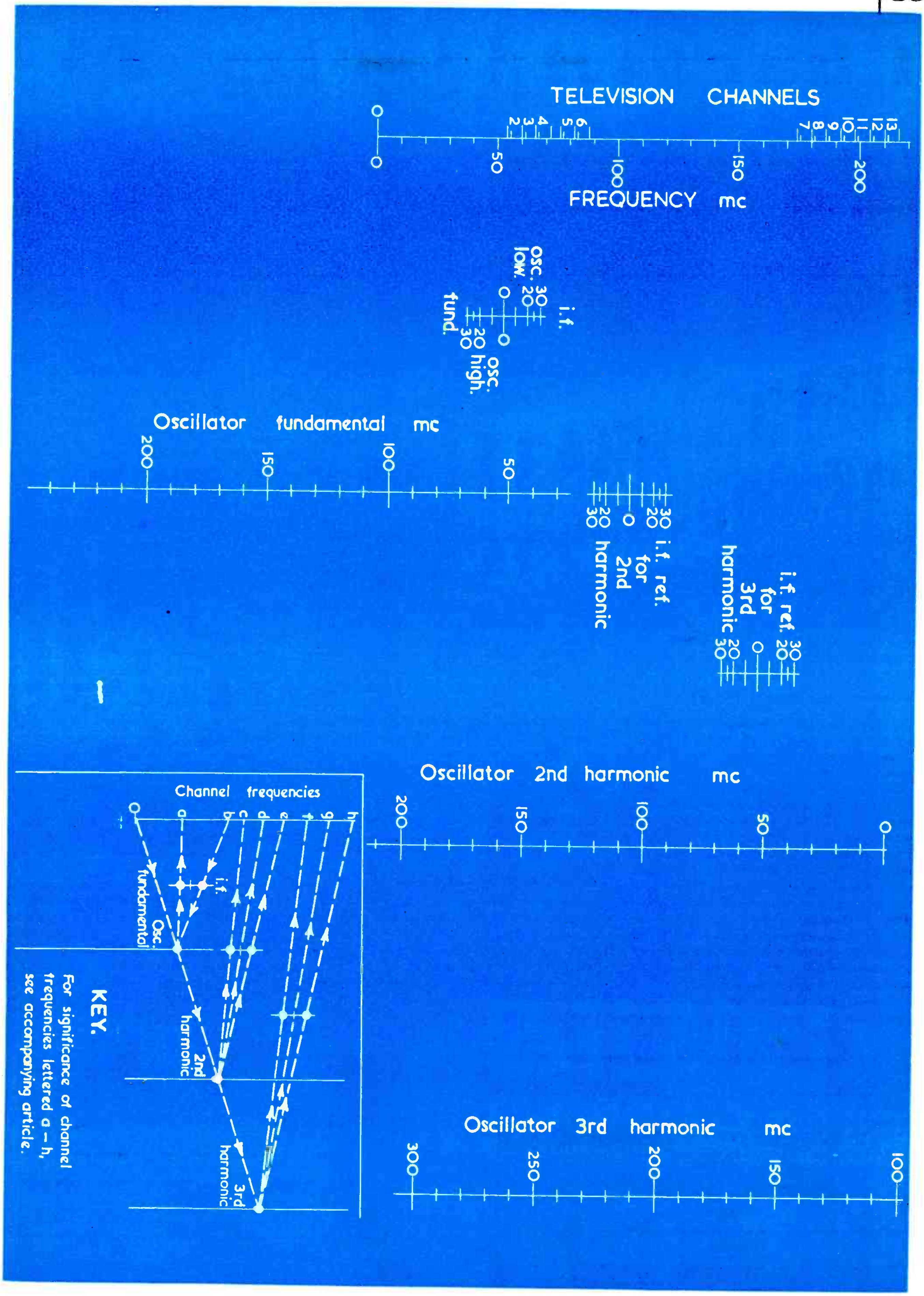


Chart 3—Nomograph for tracking down interference with any combination of intermediate and oscillator frequency.

be produced when the oscillator harmonic is either 25.25 mc above or below another station) to the TELEVISION CHANNELS scale. Point c is found to be between the television bands, but point e falls directly on channel 13. Points f and h fall above the television bands. The 2nd harmonic of the oscillator is 25.25 mc below channel 13, and this channel is the probable source of interference. Note that an image of the fundamental (drawn from the fundamental scale through OSC. LOW) would fall between the television bands, and could also be ruled out as a cause of interference.

If the oscillator is on the high side of the video carrier frequency, then the direction of reference indicated on the key will be reversed—a might be the received channel and b the second-channel frequency.

Oscillator radiation interference

Finally, in Group 2 comes the interference radiated by the local oscillator in another receiver set for reception of another channel. Chart 3 may be used for working out such possibilities, using the zero points on the I.F. REF. scales for 2nd and 3rd harmonics. As shown on the key, b or a might be the channel to which the interfering receiver is set, using the oscillator fundamental common to both, and possible channels where interference could be caused on another receiver are indicated by points d and g.

Starting from the interference received, the construction is shown by Chart 4. The channel where interference is picked up is at a. Reference through the zero points on the I.F. REF. scales to their respective harmonic scales, and back to the zero on the TELEVISION CHANNELS scale, gives two possible oscillator frequencies on the OSCILLATOR FUNDAMENTAL scale. Reference through the I.F. FUND. scale will show four possible points on the frequency spectrum, represented in Chart 4 by b, c, d and e, for the channel received by the interfering receiver. Generally two or three of these will be eliminated as being outside TV channels or having no service in the area.

Suppose, for example, that interference is being received on channel 12, and a receiver with a 25.25-mc i.f. is suspected. Let channel 12 be a and draw lines through the 2nd and 3rd harmonic zeros to intersect the 2nd and 3rd harmonic scales, then back to zero on the TELEVISION CHANNELS scale. The two possible oscillator frequencies intersected are a little above 102 and 68 mc. Drawing lines from these points of intersection through OSC. HIGH 25.25, we find that the receiver could cause such interference by 2nd harmonic radiation when tuned to channel 5, represented by d in Chart 4. Point e is below the television band.

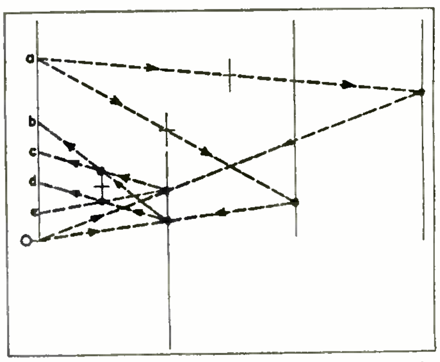


Chart 4—Example of the nomograph's use.

The author received considerable information and assistance from the August and September, 1950, copies of *Philco Service Merchandiser* and *RCA Data Sheet 1950 T11* (Supplementary information on Models T100, etc.) and wishes to express his appreciation to the publishers of these issues and to the compilers of the television interference articles contained in them.

K-C Technicians Organize For TV

Over 20,000 receivers were in operation within seven weeks after television came to Kansas City, Mo. (the highest count in any area in the same period). This debut was unmarred by unruly technical problems or discontent among the set owners.

Video owes its smooth introduction to Kansas City largely to the foresight of four men who saw the service problems which confronted service companies in other cities and prepared the way for TV by forming a plan to mold a nucleus of qualified technicians to make installations and do service work.

These men are: Robert Samson, executive secretary of the Electrical Association of Kansas City; C. W. Donaldson, president of the Donaldson Radio and Electric Co.; Avery Fouts, service manager of the Jenkins Music Co.; and C. L. Foster, vice president of the Central Radio and Television School. Under their guidance and with the cooperation of other dealers and distributors, a new organization called the Television and Radio Technicians was formed.

Functioning under the wing of the Electrical Association, the primary objectives of this new organization are:

1. To improve the status of the radio service industry through education and association.
2. To prepare for television with an approved course of study.
3. To operate an employment agency for dealers and distributors seeking reliable technicians.
4. To keep membership in TRT open to industry members who measure up to its technical and ethical standards.

A special arrangement was made with the Central Radio and Television School to train 60 selected radio repairmen in a streamlined 42-week night course. Stripped of all nonessentials, the course included basic electronic and television principles with lectures and study assignments, and laboratory work geared to prepare the student for working with television receivers.

The course is divided into three semesters which cover both lectures and workshop activity. Students go to school two nights a week, with one night devoted to lectures and the other to the laboratory work. Before graduating, each student must demonstrate his fitness in practical work and prove his knowledge before an examining board.

Distributor aid was enlisted to help cover the cost of the course, and 11 of the 14 wholesalers in the area underwrote the course by contributing $125 apiece. The small balance in tuition is paid by the students.

Believing that one's education is never complete, TRT also runs a weekly clinic for practicing technicians as well as students in the school. Meeting each Thursday night from 6:30 to 9:30, the technicians bring in their tough problems, discuss them, and exchange suggestions. If a problem is too difficult for the clinic to cope with, one of the school's engineers is called in to help.

Regular once-monthly meetings are held for all members of TRT. At these sessions the executive committee sounds out the members on how the organization can improve its program, especially academically. Meetings also include at least one talk by experts in the field.

Publicity is another part of its program. Promotional tie-ups with electrical shows are arranged. A monthly newsletter, decals for shop windows, leaflets, display ads, lapel pins, and tool box emblems help to bring the setup to the public's attention.—*Grier Lowry*

Joe W. Allen receives first television training diploma from instructor Foster.

Servicing Picture Tube Circuits

By CARL J. QUIRK*

THE most expensive single item in a television receiver is usually the cathode-ray tube. This—plus the current shortage of these tubes—discourages the average service shop from carrying spares. The many different types used in postwar television receivers further complicate the situation.

Therefore it is very important that the television service technician know how to isolate troubles that might be caused by a defective picture tube. He must know the various picture tube circuits currently in use. He also must understand the adjustments that directly affect the cathode-ray tube and know how to make these adjustments.

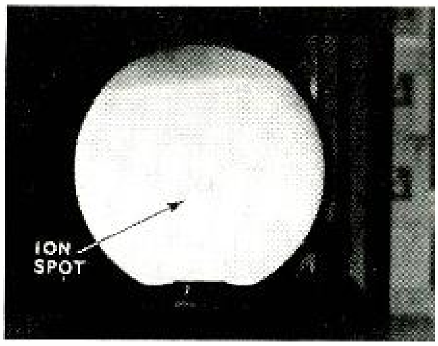


Fig. 1—An ion burn appears as a small round spot at the center of the raster.

The technician who does not have the "know-how" to diagnose picture tube troubles is at a distinct disadvantage if, for example, he is called upon to service a 19- or 20-inch set located in a difficult position (on a wall) in some public place, as a wrong guess that the picture tube is defective will result in a great deal of unnecessary work without fixing the receiver.

In one case an apparently inexperienced service technician diagnosed a condition as a faulty picture tube. The set owner (unimpressed by his apparent ability) called in another and more experienced serviceman. The second technician found a defect in the cable supplying filament power to the cathode-ray tube.

Since the magnetically deflected and focused tube is most common today, this article will deal primarily with defects of this type tube. There will be a few references to electrostatic tubes and certain interesting defects that could exist only in sets with these tubes.

Some of the following troubles are obviously caused by picture tube failure of one sort or another. There are, however, several conditions that could be the fault of some other component or circuit in the receiver. The important thing is to determine whether the picture tube is at fault or a contributing factor.

Ion spots

The round dark spot that appears in the center of the raster in Fig. 1 is an ion burn or ion spot. Such a spot can exist in any electromagnetic-type tube that does not use some means for preventing it.

As shown in the figure, the spot is at the center of the screen and is about the size of a fifty-cent piece. These ion spots—or ion burns as they are sometimes called—are a result of gas ions forming a cluster on the screen of the cathode-ray tube. With magnetic deflection the amount of deflection is inversely proportional to the mass of the object deflected. Ions are many times heavier than electrons and so are not normally deflected. Thus they form the cluster at the cathode-ray tube face, with the resultant ion spot.

A certain amount of misinformation concerning ion spots has found its way into the field. The following presentation of facts concerning ion spots may help to offset some of it.

Ion spots do not occur in electrostatic deflection tubes. (In electrostatic tubes the ions and electrons are deflected equally.)

Ion spots do not occur in metal-backed (aluminized) tubes. Due to the low velocity at which ions travel as compared to electrons, they do not penetrate the metallic layer as do electrons.

Ion spots *do not* result from the afterglow that occurs on many sets immediately after they are turned off. (In many cases technicians have advised their customers to turn the brightness to maximum before shutting off the set. This eliminates the bright spot at the center of the screen which was thought to produce the ion burn.)

The ion spot is more noticeable if the high accelerating voltage is lower than normal. (This reduces the velocity of the electrons and keeps them from penetrating the ion cluster.) In other words, if the ion spot is visible at 8 kv and the high voltage is raised to 12 kv, it may no longer be present. However, this is not practical, since the higher voltage reduces picture size.

An ion burn is visible only when a raster is present. Thus, if the screen is actually burned due to a sweep failure, the burn is visible whether or not the raster is present.

Ion burns do not normally exist in tubes using ion traps. However, there have been a few cases of ion burns in such tubes.

A correct conclusion that the reader will undoubtedly come to from the above information is that in an electromagnetic tube that does not use an ion trap, nothing can be done to prevent the condition from occurring. If the condition is annoying, the only cure is to replace the picture tube. Picture tubes using a straight gun with no means for trapping the ions are no longer manufactured. Instead a replacement tube with provision for ion trapping is used. For example, the 12RP4, which has a bent gun, replaced the 12JP4 that used a straight gun. The bent-gun-type 15DP4 replaced the 15AP4, a straight-gun tube.

Ion traps

Ion spots may be eliminated by one of two methods. (This applies to the design of the tubes since there is no field cure other than a tube replacement.)

Use a tube with a metal-backed screen. These tubes, the 12KP4 for example, have a phosphor screen with a very thin aluminum coating on the back surface. As long as the accelerating voltage is high enough, the electrons will pass through this very thin metallic backing. The ions, however, because of their mass, travel much slower and cannot penetrate the metallic backing; consequently no ion spot occurs.

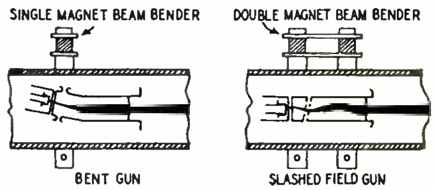


Fig. 2—Two types of electron gun that use magnetic traps to prevent ion burn.

The second and more popular method of overcoming the ion-burn problem is to use either a bent electron gun or what is known as a slashed-field gun.

Fig. 2 illustrates what is meant by a bent gun and a slashed-field gun. From a service technician's viewpoint the important difference between them is that the bent gun, as normally used, requires a single magnet for proper beam bending, while the slashed-field gun, as normally used, requires a double magnet for beam bending.

Cathode-ray tubes with slashed-field guns often use a double electromagnet. The magnet has a large coil and a small coil. The small coil should go forward on the neck of the tube, and the large coil toward the rear. If the

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magnets are reversed, the raster, if any, will be very weak.

If a double permanent magnet is used, the weakest magnet is toward the front of the tube.

Ion trap adjustment

Adjustment of the ion trap magnet (or beam bender, as it is sometimes called), although simple, is exacting. Follow the procedure exactly as outlined below. In some cases, even though the procedure is followed carefully, the desired results may not be obtained. Factors that may account for this condition are listed after the procedure. Originally established for adjustment of single-magnet beam benders, this procedure may be used equally as well with the double-magnet beam benders.

Make all initial ion trap adjustments at the lowest possible setting of the brightness control. The correct position for the ion trap magnet is shown in Fig. 3. With the base end of the gun pointing up as shown, slide the magnet over the neck. The north pole should be to the left adjacent to pin No. 12 and the south pole to the right adjacent to pin No. 6. The magnet should be placed about ¼ inch in back of the bend in the gun for the first adjustment.

Rotate the ion trap magnet about an eighth of a turn each way and slide it

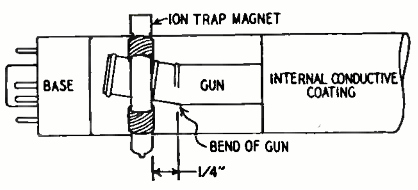


Fig. 3—The correct starting position for the trap magnet when adjusting it is about ¼ inch behind the gun's bend.

back and forth along the neck, stopping at the point of maximum brightness. Keep reducing the brightness as the system is brought into line to avoid damage to the tube. After alignment at low brightness, make a final adjustment with the brightness control set to where the raster just starts to "bloom". At this point the raster begins to expand rapidly or to defocus.

If no raster appears and all other conditions are normal, the magnet polarity may be reversed. Rotate the magnet through half a turn around the neck. Then make adjustments as before; if there is still no raster, try another magnet.

Do not leave the tube on any longer than necessary when making preliminary adjustments. If the electron beam is operated at high intensity before being brought into line with the ion trap magnet, it may damage the internal structure of the tube. For the same reason, it is important that the final adjustment of the magnet be made for maximum screen brightness. Failure to do this may result in burning the limiting aperture or the release of gas into the tube.

Sometimes it is possible to get two brightness maximums when moving the ion trap magnet back and forth along the neck. The correct position is the one closer to the base of the tube. The second maximum is usually found when the magnet is close to the case of the focus coil. The magnetic shunting effect of the focus coil case on the ion trap magnet changes the field strength so that a brightness maximum is obtained in this incorrect location. Tubes should not be operated at the second maximum since spot centering is disturbed and there is a possibility of tube damage.

If the above procedure does not produce the desired results, investigate these possibilities:

The magnet may be bad. If it has been dropped, it may be completely demagnetized. To check, simply bring the magnet into contact with some magnetic metal and note if there is any attraction.

If the magnet has some magnetism, it may not be strong enough. If this is the case, a very dim raster will be present, accompanied by a bluish or greenish glow from within the electron gun. This glow indicates the electron beam is striking the limiting aperture disc instead of passing completely through the aperture. This condition may damage the tube.

The magnet may be too strong. This is not meant to imply that a magnet increases in strength with age. Recently Du Mont redesigned the bent gun used in their Teletrons to obtain better over-all focus. This redesign reduced the magnetic strength necessary for proper beam bending. All Du Mont Teletrons using the new design gun bear the letter X, Y, or Z immediately following the serial number.

Using an accelerating voltage of 12 kv in each case, the magnet strength necessary for the old tube was 58 gauss compared to 42 gauss for the new tube. Thus, if a 58-gauss magnet is used with a new tube, it is necessary to move the

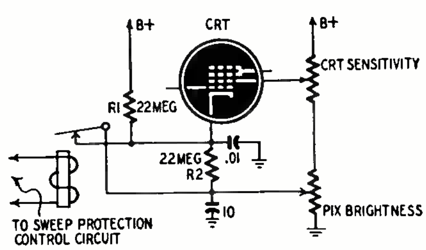


Fig. 4—A protection circuit for the picture tube that prevents the screen from burning in case the sweeps fail.

magnet back toward the base of the tube until the raster appears. In some cases it may be necessary to place the magnet on the base of the tube. If necessary, a magnetic shunt (a paper clip in an emergency) may be used to reduce the magnet strength so it can be put on the neck of the tube instead of the base.

No raster, normal sound

When this occurs, the owner of the television receiver invariably wants to know if his picture tube has gone bad.

Check to see if the filament of the picture tube is lit. If not, the cause may be one of the following:

The cable connector attached to the base of the CRT may be defective. Press the cable socket against the tube base to make sure that the connection is good. Carefully jiggle the leads in the cable that supply the filament power.

Check the filament continuity of the picture tube. Obviously, an open filament means that a new cathode-ray tube is necessary.

If these two checks reveal no defects, measure the voltage at the cable terminals. If the picture tube is operated in parallel with the other tubes in the receiver and they are all lit, then the trouble must be due to defective wiring. In some receivers a separate transformer or a separate winding on the power transformer is used for the cathode-ray tube filament. In these sets the trouble could be due to the separate transformer or the winding of the power transformer being defective.

Check for the presence of adequate high voltage. The best method, of course, is actually to measure the high voltage with a meter. Certain electronic-type voltmeters have high-voltage probes that can be used for measurements up to 30 kv. If a meter is not available, the presence of high voltage can be checked by drawing an arc from the high-voltage lead with a pencil or a well-insulated screwdriver. The high-voltage lead should not be shorted to ground as it may damage the power supply. Simply bringing the insulated screwdriver in light contact will cause arcing if high voltage is present. Obviously, if there is no high voltage or if the high voltage is very low, the picture tube is immediately eliminated as the cause of the trouble, as it is very seldom that two troubles occur simultaneously.

Check the ion trap adjustment. This possibility, of course, depends upon the conditions under which the receiver is being checked. If the receiver is being operated for the first time in the field or if it has been moved from one place to another, then the ion trap could be at fault.

Check for leaky sweep coupling capacitors in receivers with electrostatic tubes. It is possible that a coupling capacitor between the sweep amplifiers (vertical or horizontal) and the deflection plates in the cathode-ray tube is leaky. This puts excessive d.c. on the deflection plates and positions the beam so far off center that it strikes the side of the tube and produces no raster. The range of the centering circuits is usually insufficient to return the beam to its normal path. This condition may easily be mistaken as being caused by a bad cathode-ray tube.

Measure the d.c. voltage between the grid and the cathode of the cathode-ray tube. Most cathode-ray tubes will cut off if the difference in potential between grid and cathode of the cathode-ray tube is 50 volts or more (grid negative with respect to cathode).

If the difference in potenial between the grid and cathode is more than −50 volts and cannot be lowered by the brightness control adjustment, obviously something is wrong with the circuit and not the picture tube.

Such a condition could possibly occur in some of the early post-war TV receivers. Among the many features found in these sets is a sweep protection circuit. The function of the protection circuit is to prevent the possibility of burning the screen if either horizontal or vertical sweep circuits should fail. If one or both sweeps should fail, the voltage at the cathode is raised so that the beam is cut off.

The portion of the circuit at the picture tube is shown in Fig. 4. A voltage-divider circuit consisting of R1 and R2 is connected from B-plus to the cathode and through the brightness control to ground. With the receiver operating normally, the relay is energized and shorts out R2. The brightness of the tube is then adjusted as usual by the brightness control.

If, however, one of the sweeps fails, the relay coil is de-energized and R2 is re-inserted into the circuit. Under this condition the voltage at the cathode rises to a high value. Since the resistance of the brightness control is so much lower than R2, it has little effect.

If the service technician is not aware of the sweep protection circuit and does not check the grid-cathode voltage, he might think the picture tube is bad.

Distorted raster

Distortion of the raster as shown in Fig. 5 is caused by a tube defect often mentioned in the literature but seldom found in the field.

The photograph is of a 19AP4 metal-cone tube, a portion of which was magnetized. The raster is pulled up in the left corner at point A and to the side at point B. Points A and B constitute the poles of a bar magnet, the bar consisting of a section of the metal cone.

This magnetization of the metal cone is a result of close contact with a strong magnetic field. The most likely strong magnet to be encountered is the magnet of a PM speaker. Obviously, if a metal-cone tube is placed on a workbench, it should not come in contact with a speaker field or any other source of magnetization.

If this condition occurs, the cone may be demagnetized by placing the magnetized portion in a strong a.c. field. The magnetized part can be located with a compass.

An a.c. field capable of demagnetizing the cone may be produced with a focus coil. Remove the case of the focus coil and apply a.c. to it through a Variac. The Variac is used to prevent excessive current flow through the focus coil with resultant overheating of the coil.

To demagnetize the cone, energize the coil and move its flat side over the magnetized area. Do not interrupt the a.c. while the coil is near the cone. The cone should be well out of the field of the coil before the coil is de-energized.

Unstable sync

Indications of unstable sync vary according to the type of sync circuits used. If the horizontal sync circuit is a simple blocking oscillator, the picture will tear horizontally. Strips of the picture will tear out to the right. This condition is characteristic of the blocking oscillator circuit when no special a.f.c. circuit is used to control its frequency. It is also possible that the picture will jump vertically, indicating loss of vertical sync.

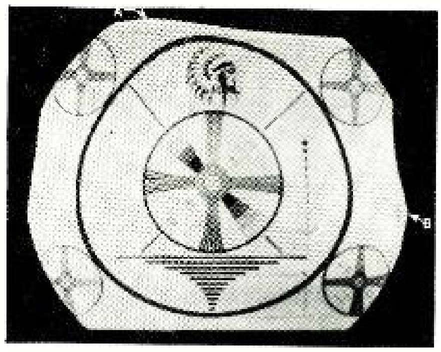


Fig. 5—A metal tube may distort the picture if its envelope is magnetized.

On sets using a horizontal a.f.c. circuit, the picture will try to pull out of sync horizontally, but the effect will not be the same as that for the simple blocking oscillator. The vertical sync will also be affected.

If this condition is a result of grid-cathode leakage in the picture tube, advancing of the brightness control will eliminate the sync instability. The reason for this will be explained later.

In some of the troubles listed previously, the visual indications were such that the picture tube was thought to be at fault before any checks were made. With this trouble, the cathode-ray tube is usually the last thing considered and even then the technician may not be certain exactly how the cathode-ray tube affected the sync.

Fig. 6 is a circuit of the type in which the above-mentioned symptoms would be caused by the C-R tube.

The sync take-off point is at the picture tube grid. The 6AL5 functions both as the d.c. restorer and sync take-off tube. The composite video signal is applied to the 6AL5 cathode, and at this point the video signal is black negative; that is, the portion of the signal that corresponds to black in the picture extends in a negative direction. The sync pulses also extend in the negative direction.

In normal operation, this black negative signal drives the cathode negative and permits the diode to conduct. However, this tube conducts only during the most negative portion of the signal; i.e. during the sync pulses. In this manner the sync signals are removed.

Let us assume that leakage exists between the grid and cathode of the picture tube. When adjusted for beam cutoff, the brightness control is so adjusted that the potential of the cathode is about +50 volts. However, with the leakage path between the grid and the cathode, some of this voltage appears at the 6AL5 cathode. In some cases this voltage may be as high as +30. This voltage biases the 6AL5 so that the applied signal must overcome this voltage before the tube will conduct. Thus, most of the sync is lost and the horizontal and vertical sweeps are unstable.

Advancing the brightness control will restore the sync to a stable condition, but this will result in very poor contrast due to excessive brightness. Increasing the brightness results in running the cathode toward ground and thus reduces the voltage at the cathode. If the cathode voltage is zero, the 6AL5 will have no bias due to the grid-cathode leakage.

The circuit shown here was used in the Du Mont RA-103D Teleset. A number of other receivers in the field use a similar circuit arrangement. Similar indications can be expected in any other receiver if there is a d.c. circuit between the grid of the picture tube and the sync separator tube.

No brightness control

If the brightness control fails to affect brightness there may be a heater-cathode short or leakage in the picture tube. In many receivers, the brightness control is located in the cathode circuit and one side of the filament goes to ground. For this reason, a heater-cathode short will short out the brightness control. Fig. 6 shows such a circuit.

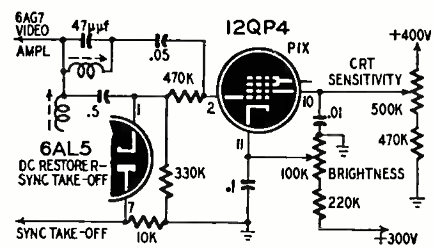


Fig. 6—Grid-cathode leakage may cause sync instability in circuits like this.

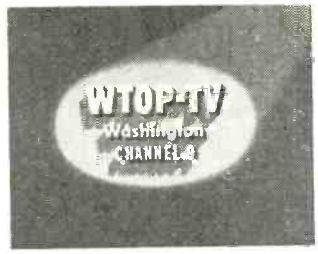
This condition sometimes can be cleared by lightly tapping the base of the cathode-ray tube. It is also possible to burn out the short by applying d.c. between the heater and cathode.

A positive solution (other than replacing the tube) is to use a separate filament transformer to supply the cathode-ray tube heater.

Disconnect the filament circuit from ground and its usual filament supply and connect it to the secondary of a 6.3-volt, 0.6-amp transformer. The transformer will permit tying the heater to the cathode. With the filament isolated from ground, the brightness control functions normally.

These troubles do not include all the possibilities involved in picture tube circuits. The service technician should acquaint himself with other possibilities that might exist. Often a little brainwork will save the cost of a new picture tube.

TV Station List



ALABAMA

Birmingham	WAFM-TV	13
Birmingham	WBRC-TV	4

ARIZONA

Phoenix	KPHO-TV	5

CALIFORNIA

Los Angeles	KECA-TV	7
Los Angeles	KFI-TV	9
Los Angeles	KLAC-TV	13
Los Angeles	KNBH	4
Los Angeles	KTLA	5
Los Angeles	KTSL	2
Los Angeles	KTTV	11
San Diego	KFMB-TV	8
San Francisco	KGO-TV	7
San Francisco	KPIX	5
San Francisco	KRON-TV	4

CONNECTICUT

New Haven	WNHC-TV	6

DELAWARE

Wilmington	WDEL-TV	7

DISTRICT OF COLUMBIA

Washington	WMAL-TV	7
Washington	WNBW	4
Washington	WTOP-TV	9
Washington	WTTG	5

FLORIDA

Jacksonville	WMBR-TV	4
Miami	WTVJ	4

GEORGIA

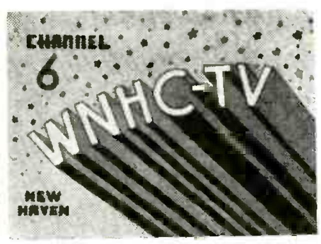
Atlanta	WAGA-TV	5
Atlanta	WSB-TV	2

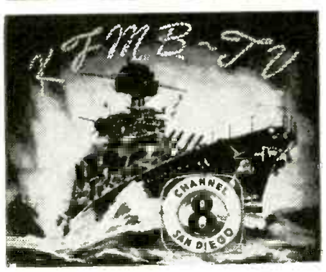
ILLINOIS

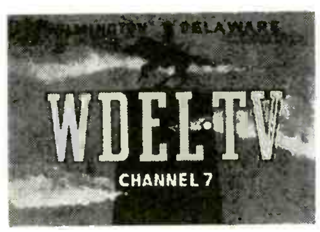
Chicago	WBKB	4
Chicago	WENR-TV	7
Chicago	WGN-TV	9
Chicago	WNBQ	5
Rock Island	WHBF-TV	4

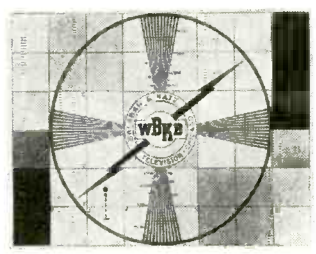
INDIANA

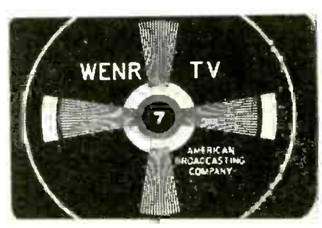
Bloomington	WTTV	10
Indianapolis	WFBM-TV	6



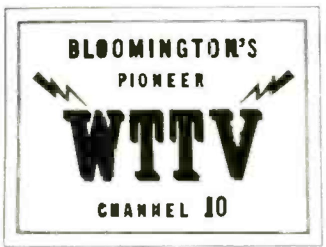


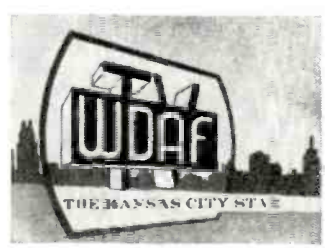


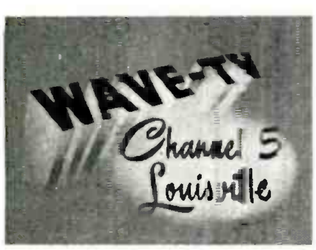


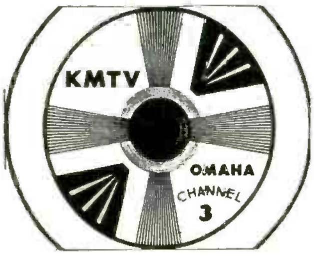


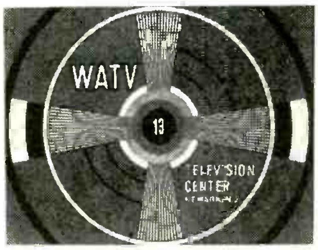
IOWA		
Ames	WOI-TV	4
Davenport	WOC-TV	5
KENTUCKY		
Louisville	WAVE-TV	5
Louisville	WHAS-TV	9
LOUISIANA		
New Orleans	WDSU-TV	6
MARYLAND		
Baltimore	WAAM	13
Baltimore	WBAL-TV	11
Baltimore	WMAR-TV	2
MASSACHUSETTS		
Boston	WBZ-TV	2
Boston	WNAC-TV	7
MICHIGAN		
Detroit	WJBK-TV	2
Detroit	WWJ-TV	4
Detroit	WXYZ-TV	7
Grand Rapids	WLAV-TV	7
Kalamazoo	WKZO-TV	3
Lansing	WJIM-TV	6
MINNESOTA		
Minneapolis	KSTP-TV	5
Minneapolis	WTCN-TV	4
MISSOURI		
Kansas City	WDAF-TV	4
St. Louis	KSD-TV	5
NEBRASKA		
Omaha	KMTV	3
Omaha	WOW-TV	6
NEW JERSEY		
Newark	WATV	13
NEW MEXICO		
Albuquerque	KOB-TV	4
NEW YORK		
Binghamton	WNBF-TV	12
Buffalo	WBEN-TV	4
New York	WABD	5
New York	WCBS-TV	2
New York	WJZ-TV	7
New York	WNBT	4
New York	WOR-TV	9
New York	WPIX	11
Rochester	WHAM-TV	6
Schenectady	WRGB	4
Syracuse	WHEN	8
Syracuse	WSYR-TV	5
Utica	WKTV	13

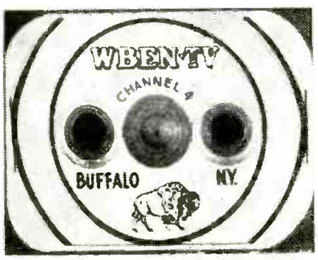


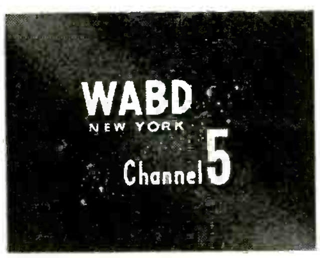


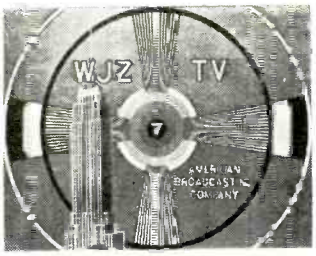


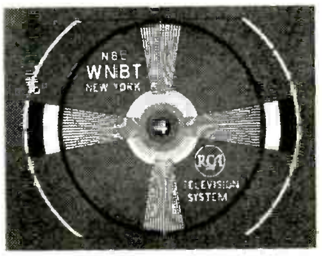


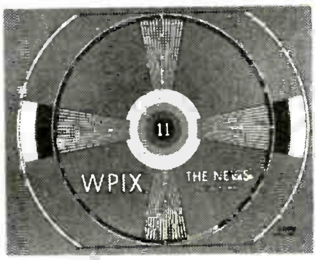


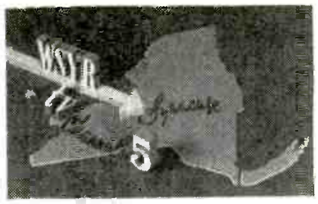


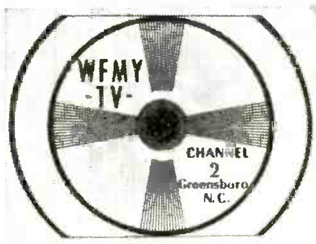












NORTH CAROLINA

Charlotte	WBTV	3
Greensboro	WFMY-TV	2

OHIO

Cincinnati	WCPO-TV	7
Cincinnati	WKRC-TV	11
Cincinnati	WLW-T	4
Cleveland	WEWS	5
Cleveland	WNBK	4
Cleveland	WXEL	9
Columbus	WBNS-TV	10
Columbus	WLW-C	3
Columbus	WTVN	6
Dayton	WHIO-TV	13
Dayton	WLW-D	5
Toledo	WSPD-TV	13

OKLAHOMA

Oklahoma City	WKY-TV	4
Tulsa	KOTV	6

PENNSYLVANIA

Erie	WICU	12
Johnstown	WJAC-TV	13
Lancaster	WGAL-TV	4
Philadelphia	WCAU-TV	10
Philadelphia	WFIL-TV	6
Philadelphia	WPTZ	3
Pittsburgh	WDTV	3

RHODE ISLAND

Providence	WJAR-TV	11

TENNESSEE

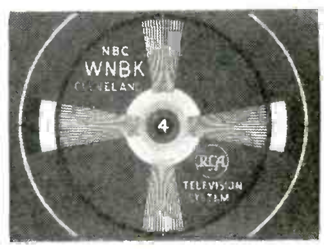
Memphis	WMCT	4
Nashville	WSM-TV	4

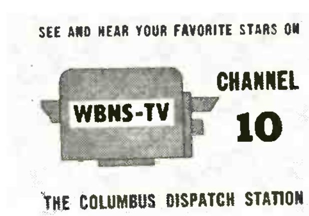
TEXAS

Dallas	KRLD-TV	4
Dallas	WFAA-TV	8
Fort Worth	WBAP-TV	5
Houston	KPRC-TV	2
San Antonio	KEYL	5
San Antonio	WOAI-TV	4

UTAH

Salt Lake City	KDYL-TV	4
Salt Lake City	KSL-TV	5





VIRGINIA

Norfolk	WTAR-TV	4
Richmond	WTVR	6

WASHINGTON

Seattle	KING-TV	5

WEST VIRGINIA

Huntington	WSAZ-TV	5

WISCONSIN

Milwaukee	WTMJ-TV	3

OTHER AMERICAN STATIONS

BRAZIL

*Rio de Janeiro	PRG-3 TV	6
Sao Paulo	PRF-3 TV	3

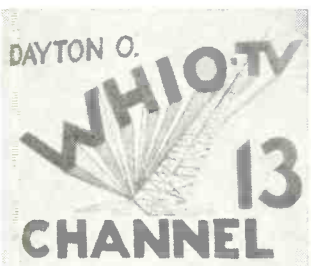
CUBA

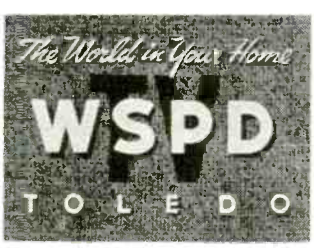
Havana	CMUR-TV	4
*Havana	CMQ-TV	6

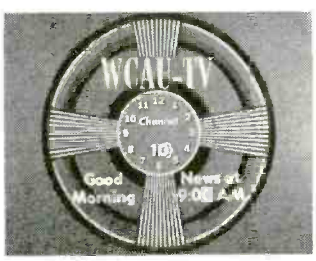
MEXICO

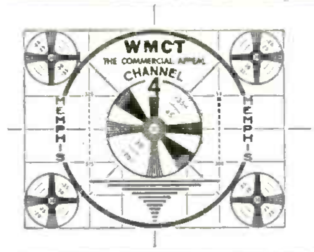
*Mexico City	XEW	
Mexico City	XHTV	4

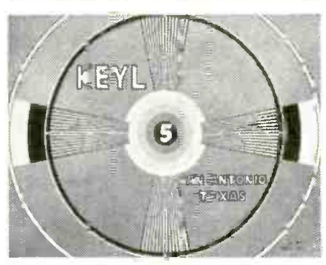
**Stations not operating at time list was compiled.*

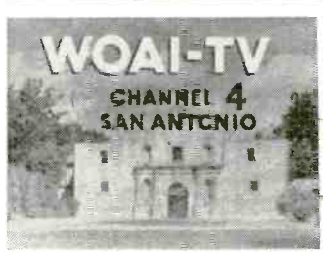


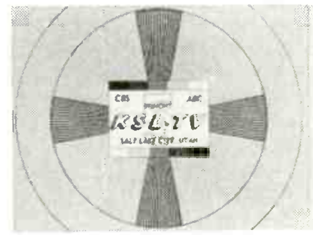


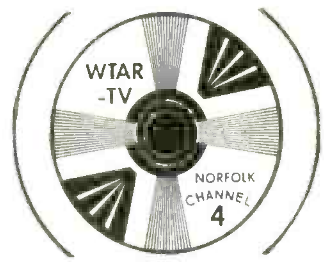


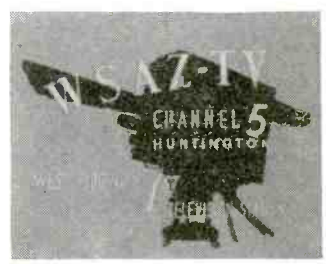


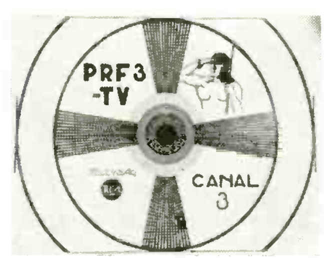












Trends in Television I.F.'s

By EDWARD M. NOLL

THE television receiver i.f. system must receive and amplify the desired television signal while closing the door on all undesired signals. Two types of i.f. systems are used in today's receivers—intercarrier and dual channel, (Fig. 1). Dual-channel systems have separate i.f. sections for picture and sound, which are segregated at the mixer output or in first and second following i.f. stages. Picture and sound intermediate frequencies are, respectively, local oscillator minus received picture carrier frequency and local oscillator minus received sound carrier frequency.

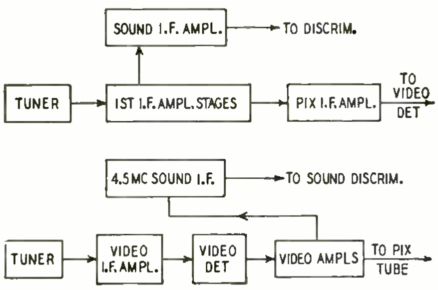


Fig. 1—The two i.f. types compared.

In the intercarrier system, the amplifier tubes that follow the mixer amplify and pass both picture and sound i.f. signals—building up the picture carrier to a higher level than the sound carrier. The picture carrier dominates at the video detector and the sound signal appears to it as a sideband of 4.5 mc. The video detector interprets this intercarrier beat between two carriers. The sound component of 4.5 mc is pulled from the composite video signal at the video detector or first video amplifier output and goes to a 4.5-mc i.f. strip.

Intercarrier system

The intercarrier system has a number of potential advantages:

1. Oscillator drift problems are minimized. Thus oscillator tuning should not be critical because the sound frequency in the 4.5-mc i.f. strip cannot vary with local oscillator tuning but is fixed at the original frequency separation of picture and sound carrier frequencies at transmitters. Thus tuning can have as its major objective—a good picture. Correct sound follows along with this adjustment for best picture.

2. The i.f. system can be simpler, less expensive, and (in some respects) easier to align. For example, sound-channel trap is not needed as sound is not blocked from the i.f. circuit. Absence of traps reduces the susceptibility of the system to phase distortion.

However, intercarrier units have been plagued by high noise levels in sound output. This *intercarrier buzz* level is so much a function of correct alignment, tuning, and even contrast setting that the good possibilities of the intercarrier method are obscured. The major source of intercarrier noise is the interaction, in fact, the modulation of the sound by picture information. This noise can be minimized (usually it cannot be eliminated) with a superior limiter circuit or gated beam limiter-discriminator, and very careful alignment (particularly the secondary of the discriminator transformer). Note that signal interference in an FM system (the source of interference is picture signal and its relative levels with respect to 4.5-mc FM sound) *not only introduces amplitude modulation of sound but FM and phase-modulated noise components.* Thus a good limiter is not the complete answer. Response patterns of typical dual-channel and intercarrier systems are presented in Fig. 2.

Note that in the intercarrier stages of many models there are no adjacent-channel picture or sound traps. As a result interchannel spillover is very prevalent in those areas where adjacent channels have been allocated or in fringe areas where stations come in from various directions and levels.

Alignment of the typical intercarrier circuit is critical, because position of the picture carrier at 50% level is important from the standpoint of resolution and low-frequency response. Likewise it is very important to position the sound carrier down in the shelf to obtain a high sound level as well as low buzz.

In a video i.f. system, gain is a function of bandwidth and the number of stages. If to economize we reduce the number of stages, the necessary gain is obtainable only with a sacrifice in bandwidth. Speaking generally, resolution up to 4 mc can be obtained with four i.f. stages; 3 to 3.5 mc with three stages; and 2.5 mc with two stages. It is ironic that a few of those manufacturers who criticized the CBS color system because it is limited in geometric or horizontal resolution, market a black-white receiver decidedly inferior to the color resolution. Certainly there is no excuse, economic or otherwise, for an i.f. response down 6 db only 2.5 mc away from picture carrier frequency.

Interstage coupling circuits

Several basic interstage coupling circuits are used in the late model television receivers — stagger single- or double-tuned transformer, overcoupled, and bandpass (Fig. 3). Stagger-tuned types are still the most common, although the bifilar type of winding is widely applied. More gain per stage can be obtained with the double-tuned type of transformer although alignment is slightly more difficult.

The bifilar type of stagger-tuned transformer has a number of advantages over simple stagger-tuning.

1. There is more effective isolation between output of one stage and input of next. No coupling capacitor is needed and a leakage problem is eliminated.

2. The grid time-constant is very short (no coupling capacitor) and strong noise bursts cannot charge the capacitor. This means that the signals have an open path and noise does not block or lower gain of the i.f. stages for an interval after each noise burst.

A bifilar winding consists of two separate windings positioned very near to each other and wound in the same direction. The usual form of bifilar winding in i.f. strips is a primary and secondary interwound (turn of primary, turn of secondary, turn of primary, etc., down the coil form). Turns are close-wound and often use thin triple insulation to prevent any d.c. leakage. Very close proximity produces almost perfect 1:1 coupling. Thus windings act as single inductor with the same resonant characteristics as a single-winding stagger-tuned stage—only one resonant adjustment is necessary.

The most important advantages of the stagger-tuned type of i.f. circuit are simple alignment procedure and far less trouble with regeneration, as each resonant circuit is tuned to a different frequency. A few receivers use two or three stagger-tuned i.f. stages and a single overcoupled stage. This expedient helps in obtaining a wider and more uniform response curve when just a few i.f. stages are employed.

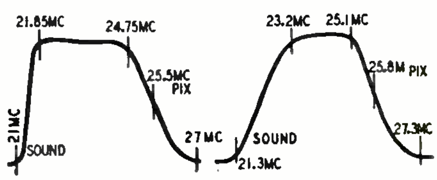


Fig. 2—Response curves of both systems.

There is a definite trend toward higher-frequency i.f. systems to minimize some of the more trying tuner problems. Wider frequency spacing between signal carriers and local oscillator means better tuner selectivity. Consequently, there is weaker oscillator feedback to the antenna system, a better image rejection ratio, and no local oscillator interference is caused on other channels. Although local oscillator frequencies are moved outside of the television band with the higher intermediate frequencies, radiation can still cause interference to other services. The FCC feels this radiation can be held down to 15 microvolts per meter at 100 feet. RMA believes receiver manufacturers can hold it down to 50 microvolts without too high a cost factor. In spite of these opinions, our present receivers often radiate signals in the *thousands* of microvolts per meter at 100 feet.

Mixer to i.f. amplifier coupling

On the modern TV chassis there is always a substantial physical spacing between the mixer output of tuner and the first i.f. amplifier tube. An appreciable length of line must span the gap. This line is subject to capacitive losses to ground and stray pickup unless it is a low-impedance link. Low-impedance links, as typified by RCA and Zenith in Fig. 4, also minimize feed-through of spurious signals from the tuner as only resonant signals will be transferred. Only a resonant signal sees a low impedance via the link.

Any capacitance added by the link, although this might be rather high on long links, has an insignificant effect on the low-impedance connection. The added capacitance does not cause loss of signal, merely reducing somewhat the impedance of the link. It lowers reactance of the mutual element that controls coupling between the two tuned circuits. This can be compensated for in the design of the coupling arrangement.

A.g.c. system

In the modern receiver an a.g.c. system becomes an integral part of the i.f. unit, maintaining close control over the gain of the i.f. system. This control is fast acting and sets the bias level according to the strength of incoming signal. Thus a constant-level signal reaches the video amplifier. For reasonable differences in station signal levels it should not be necessary to change brightness-contrast settings when switching channels. However, the tuned circuits of the various stages are influenced by the biasing of the various i.f. tubes. Input capacitance of these tubes —because of the influence of Miller effect—varies with stage gain, which in turn is a function of biasing and a.g.c. As the receiver is switched from station to station, bias levels change according to signal strength. This changes resonant frequencies of tuned circuits (shift in input capacitance) and i.f. amplifier response becomes a function of received signal strengths.

Miller effect

Miller effect in an i.f. stage causes a change in input capacitance whenever the operating bias and gain of that stage is changed. As bias is decreased and stage gain increases, input capacitance of the tube also increases. Thus the resonant frequency of the tuned circuit with which this capacitance is associated also decreases, (Fig. 5-a). Resonant frequency increases with an increase in stage bias.

An opposite frequency-bias relation can be set up by using an unbypassed cathode. In such an arrangement effective input capacitance decreases with a decrease in bias and increases with more bias. For example, if bias is increased, gain of stage falls and there is a weaker signal across the cathode resistor. Under this condition, the ratio of signals e_g to e_k is increased and the input capacitance has influence over a greater percentage of the total applied signal e_{sig} (the sum of e_g and e_k must always equal applied signal votage). This means effective input capacitance has increased. See Fig. 5-b.

Since our original bias has been increased, the higher input capacitance causes a decrease in the resonant frequency of tuned circuit—an opposite effect to Miller effect. With a bias decrease a greater percentage of the applied signal appears across R_k and input capacitance becomes less influential. Resonant frequency will then increase.

It is reasonable to expect that if we choose a proper value of R_k and insert a modifying capacitor from grid to cathode, as in Fig. 5-c (reduced capacitance change due to Miller effect) two opposite influences could be repressed and the resonant frequency changed very little with a shift in bias.

We can carry this idea a step further and expect that, with proper control of R_k and C_g, frequency could be made to shift in either way with bias change.

Philco controlled i.f. system

Philco has employed these vacuum-tube input relations to improve their i.f. system (RADIO-ELECTRONICS, Sept. 1950, page 74). It is a fact that in normal signal areas a good picture and good sound occur at the same setting of the fine tuning control with a properly aligned receiver. However, in a weak signal area and with a properly aligned receiver, best picture and best sound do not occur at the same setting. This is because the signal is weak and the picture carrier sets down 40-50% on the response curve. If fine tuning is varied until the picture carrier is up on the flat-top of the response curve, picture synchronization is improved and the picture has better contrast. At this setting, however, sound is lost because the sound carrier frequency has been raised above the frequency of the sound i.f. or, in the case of intercarrier, is off the response curve entirely.

In the Philco compensated i.f. amplifier a special resonant shift is incorporated (Fig. 6) to raise the level of the picture carrier when a weak signal is received while leaving it at normal amplitude level for strong signals. This is done automatically without any shift whatsoever in the basic i.f. carrier frequencies, and therefore, no loss of sound when the receiver is tuned for the best picture on a weak signal.

A modifying capacitor is used to obtain a controlled amount of frequency shift due to Miller effect. In addition, an unbypassed cathode resistor of the proper value to dominate the Miller effect change by a definite amount is used. Thus when bias along the a.g.c. line decreases upon reception of a weak signal, cathode circuit action causes input capacitance to decrease and raises the tuned-circuit resonant frequency to a value higher than 25.5 mc. This boosts the amplitude level of the picture i.f. carrier frequency of 26.6 mc. In fact the relative amplitude level of picture carrier when a weak signal is received is roughly double that on a weak signal.

In the same i.f. unit Miller effect is accentuated by grounding the cathode of a few of the i.f. amplifier tubes. In these cases it was found helpful to decrease the resonant frequences of some of the higher-frequency tuned circuits to raise picture and sound carrier levels when weak signals are received, dropping the 27.-mc tuned circuit lower to raise picture carrier level and dropping the 23-mc lower to improve sound carrier level at 22.1 mc.

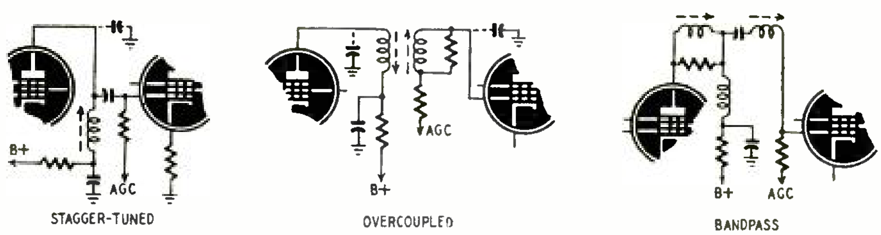


Fig. 3—Above, the three chief types of coupling in television i.f. amplifiers.

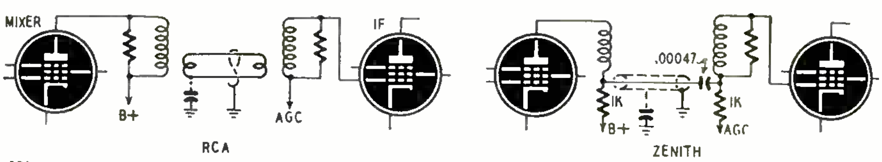
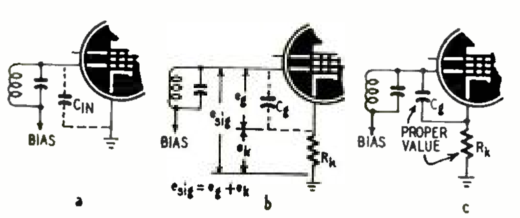


Fig. 4—Open-wire or coaxial links are used to couple mixer and i.f. stages.



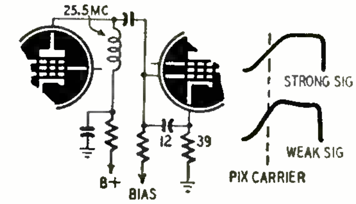
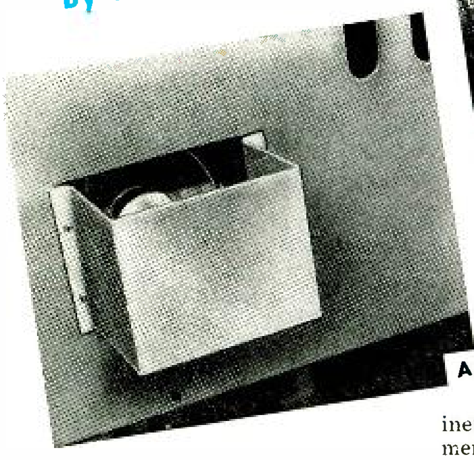


Fig. 5—How Miller effect is controlled. Fig. 6—This i.f. chases the signal.

Big-Tube Conversions are Profitable

Replacing small TV tubes with big ones makes money for the skilled technician

By MATTHEW MANDL*



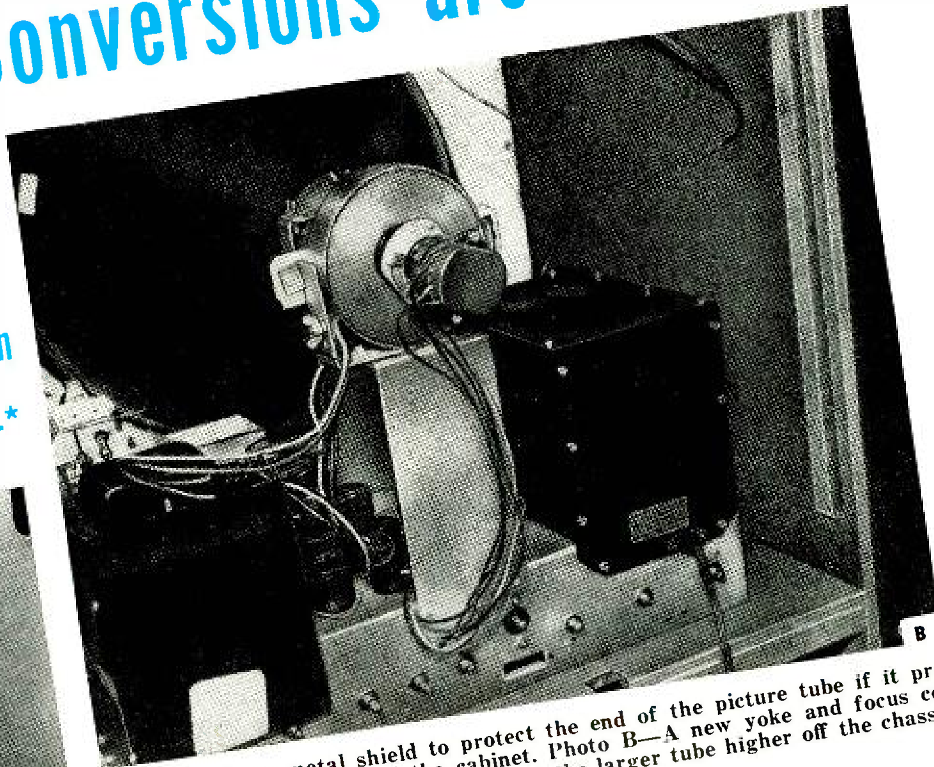


Photo A—Use a metal shield to protect the end of the picture tube if it protrudes through the back of the cabinet. Photo B—A new yoke and focus coil assembly bracket may be needed to raise the larger tube higher off the chassis.

MANY small set owners cannot afford the larger receivers. This means there is a ready market for the competent technician who can install a larger picture tube and make the necessary circuit changes for good performance. In fact, many alert service organizations are already busy with this profitable venture. The cost, compared with the price of a new set, is low enough to attract customers, yet affords a good margin of profit for the technician.

Three factors must be considered for any conversion: the cabinet size, the tube type, the necessary circuit changes. The size of the present cabinet and of the desired screen are very important, for any circuit can be modified to accommodate tubes from the 12- to 19-inch or larger size. If the existing cabinet must be used, then the tube size will be limited to the next larger one unless the cabinet is exceptionally roomy. If, however, the customer is willing to pay for a larger cabinet, tube size is no problem.

Of course some receivers have a very crowded cabinet which would not accommodate *any* larger tube. In such cases a new cabinet or installing the larger tube in a separate cabinet are the only alternatives. A separate cabinet for the tube alone is not recommended because it leaves a dead screen on the original receiver and requires interconnecting cables. A new cabinet is preferable—one that will hold both the old chassis and the new tube.

Cabinet changes

The technician must estimate the maximum usable tube size. The front dimensions of the cabinet will generally set the limit. Most 10-inch tubes have a face diameter of 10½ inches and a length of about 17½ inches. Some of the

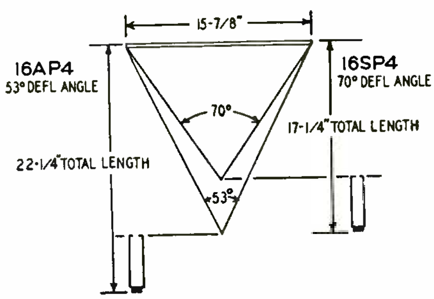


Fig. 1—Using a large deflection angle reduces the length of the picture tube.

old cabinets will take 12-inch tubes easily, for the difference in width is only a couple of inches and some types (such as the 12KP4 and the 12QP4) have the same length as the 10-inch types.

The 14-inch rectangular tubes can also be used, because they are actually about an inch shorter than the 10-inch types. They are shorter because they have a greater deflection angle. If the beam is swept over a wider angle, the tube can be made much shorter for a given screen size. This is shown in Fig. 1, which compares the 16AP4 and the 16SP4.

Both tubes have a face diameter of 15⅞ inches, but the 16AP4, which has a deflection angle of 53 degrees, has an overall length of 22¼ inches. The 16SP4, however, is only 17¼ inches long because the larger deflection angle (70 degrees) allows shorter construction. (Fig. 1 is for comparison only, since deflection starts at the gun and not the tube base.) Thus, the 16SP4 is actually shorter in over-all length than most of the 10-inch types!

If the new tube is longer than the original tube, it may protrude through the back of the cabinet if the extended part is protected by a metal shield. Make this shield from heavy gauge tin or sheet metal. Cut a hole in the back

Fig. 2—Basing diagrams for kinescopes

*Technical Institute—Temple University

panel of the cabinet to fit the neck of the tube, and bolt the shield on to prevent tube damage as shown in Photo A. This is a sensible procedure, for it is a waste of space to use a deeper cabinet merely for the tube neck alone. Several commercial receivers use this arrangement to decrease cabinet size.

The front of the cabinet will have to be cut out more to provide sufficient opening for the tube face. Some of the older receivers have a removable mask and this simplifies the procedure. With others, a larger opening must be cut and a new mask fitted over it. Panel masks to accommodate all tube sizes (both rounded edge and rectangular) are available from wholesale houses at low cost.

Since the larger tube will set the neck higher above the chassis, a new yoke and focus coil assembly bracket must be installed in place of the small one. These are also available from various wholesale houses, and come in several heights for the type tube used. An assembly bracket for a 16-inch picture tube is shown in Photo B.

The tube type

Tubes with deflection angles up to 65 degrees can usually be interchanged without changing the deflection yoke. If the new tube has a greater deflection angle and it is to replace one having a smaller deflection angle, a wide-angle deflection yoke must be used. This is important to consider for it means that some tubes not only require circuit changes, but parts replacement as well.

All 10- and 12-inch picture tubes have deflection angles of 50 to 56 degrees and can be replaced with larger tubes without yoke change if the larger tubes do not have deflection angles in excess of 65 degrees. Table I lists a representative group of these tubes. This list does not contain any rectangular types, for these all have a 70-degree deflection angle.

Table II lists tubes with deflection angles greater than 65-degrees and this includes the 19- and the 22-inch rectangular types. *All* tubes (both Tables I and II) have socket connections as shown in Fig. 2-c except the 10DP4, the 10MP4, and the 12VP4 which are shown in Fig. 2-a and 2-b. The 10DP4 uses electrostatic focus.

The new tube should have the same type ion trap magnet (beam bender) as the old tube, particularly if the coil type is used. Replacing the double field coil type with a tube requiring a single magnet means the old beam bender must be fastened to the chassis and a single-magnet type purchased for the new tube.

Another consideration is the outer conductive coating which, with the inner graphite coating and the glass dielectric, acts as the second filter capacitor of the high-voltage system. If the new tube has no outer conductive coating, a 500-μμf high-voltage filter capacitor must be wired into the high-voltage power supply circuit to avoid ripple.

With some tube types being scarce, however, it may be necessary to use one requiring the beam-bender change and capacitor addition. While these units are not costly, they do involve a little more time for the conversion process.

Tubes with gray filter face plates reduce ambient light reflections. This may be an added selling feature, but is not of prime importance in tube conversion. If all other factors fall into convenient replacement and availability, the gray filter face plate is of secondary importance.

Circuit changes

As a rule, 10,000 volts will operate 12-inch tubes; 12,000 volts is enough for 16-inch tubes; and 14,000 volts is adequate for the 19-inch tubes. Since most 10-inch receivers have high-voltage supplies which furnish about 9,000 volts, few changes are necessary when these are replaced with 12-inch tubes.

Often a 9,000- or 10,000-volt supply can be boosted by slight circuit changes to operate 16-inch tubes such as the 16AP4 or the 16CP4 which have low deflection angles. A number of such changes are possible with the kick-back-type high-voltage system as shown in Fig. 3 without having to replace the horizontal output transformer.

Measure the potential with a high-range v.t.v.m. (or one with a high-voltage probe) to determine what voltage is

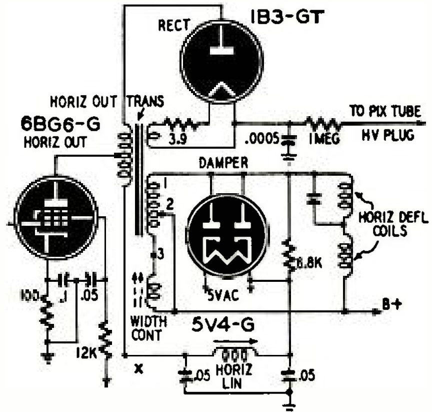


Fig. 3—The kickback type of high-voltage supply used on older 10-inch sets.

available. If it is only about 7,000 volts, a voltage-boost doubler system will be necessary. If 9,000 volts or more are available, two or three thousand more can usually be secured by the proce-

Table I—Small-Angle Tubes

Type	Length (Inches)	Face Diameter (Inches)	Defl. Angle (Degrees)	Envelope	Type Beam Bender
12LP4	18¾	12-7/16	54	Glass	Double
12QP4	17½	12-7/16	55	Glass[1]	Single
12TP4	18¾	12-7/16	54	Glass[1]	Double
12UP4	18⅝	12-7/16	54	Metal[1]	Double
12VP4	18	12-7/16	55	Glass[1]	Double
15CP4	21½	15½	57	Glass[1]	Double
15DP4	20½	15½	57	Glass[1]	Single
16AP4	22¼	15⅞	53	Metal[1]	Double
16CP4	21½	15⅞	52	Glass[1]	Double
16DP4	20¾	15⅞	60	Glass[1]	Double
16EP4	19⅝	15⅞	60	Metal[1]	Double
16FP4	20¼	16⅛	62	Glass[1]	Single
16HP4	21¼	15⅞	60	Glass	Double
16JP4	20¾	16⅛	60	Glass	Double
16LP4	22¼	15⅞	52	Glass	Double
16MP4	21¾	16⅛	60	Glass	Double

[1] Require second high-voltage filter capacitor. Glass types have no outer conductive coating.

Table II—Large-Angle Tubes

Type	Length (Inches)	Face Size (Inches)	Defl. Angle (Degrees)	Envelope	Type Beam Bender
14BP4[1]	16-13/16	9-11/16 x 12½	70	Glass	Double
14CP4[1]	16¾	9-23/32 x 12-17/32	70	Glass	Single
14DP4[1]	16¾	9-23/32 x 12-17/32	70	Glass[2]	Double
14FP4[1]	16⅛	9-11/16 x 12½	70	Glass[2]	Single
16GP4	17-11/16	15⅞	70	Metal[2]	Single
16KP4[1]	18¾	11½ x 14¾	70	Glass	Single
16QP4[1]	19	11½ x 14¾	70	Glass[2]	Double
16RP4[1]	18¾	11½ x 14¾	70	G ass	Double
16SP4	17-5/16	15⅞	70	Glass	Double
16TP4[1]	18⅛	11½ x 14¾	70	Glass	Single
16UP4[1]	18⅛	11½ x 14¾	70	Glass[2]	Single
16VP4	17-3/16	15⅞	70	Glass[2]	Single
16WP4	17¾	15⅞	70	Glass[2]	Double
16XP4[1]	18¾	11½ x 14¾	70	Glass[2]	Double
16YP4	17-5/16	15⅛	70	Glass	Single
17AP4[1]	18⅝	12¼ x 15⅜	70	Glass[2]	Single
17BP4[1]	19¼	15-21/64 x 12-9/64	70	Glass	Single
17CP4[1]	19	16-1/16 x 12⅜	70	Metal[2]	Single
19AP4	21½	18⅝	66	Metal[2]	Single
19DP4	21½	18⅞	66	Glass	Double
19EP4[1]	21⅛	17 x 13-3/32	70	Glass	Double
19FP4	22	18⅞	66	Glass[2]	Double
19GP4	21¼	18⅞	66	Glass[2]	Single
20BP4	28¾	20	54	Glass[2]	None
22AP4	22⅞	21-11/16	70	Metal	Single

[1] Rectangular types—deflection measured diagonally.
[2] Require second high-voltage filter capacitor. Glass types have no outer conductive coating.
Letter A added to the above type denotes gray filter face plate, except for 16GP4 and rectangular types, which all have filter face plates.

dures detailed in the following paragraphs. Try a new 6BG6-G and a new 1B3-GT tube, because low emission from either type in an old set could drop the high voltage below normal.

One method which gives increased sweep and voltage is to place a capacitor across the secondary of the horizontal output transformer. Try values from .01 to .035 µf, for some values work better than others in different circuits. Put the capacitor across points marked 1 and 2 in Fig. 3, or across 2 and 3. The width coil can be removed entirely, and the tap at 2 removed and placed at point

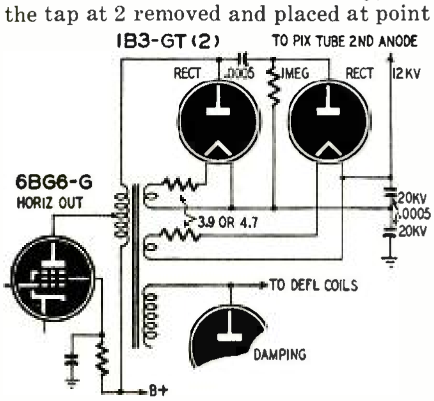


Fig. 4—A high-voltage doubler circuit. This supply delivers as much as 13 kv.

3. Try a capacitor of about .035 µf between these new points (1 and 3). This often increases sweep over 1 inch and raises the voltage more than a thousand. There is usually sufficient latitude in vertical and horizontal sweep (height and width controls) to blow the picture out to proper size for the 12- or 15-inch tubes (and occasionally for the 16-inch also).

A smaller value of screen dropping resistor in the 6BG6-G horizontal output tube will give additional sweep and high voltage. However, if the regulation of the low-voltage supply is poor, the added screen current may drop the plate voltage and actually drop the output. Experiment with different values for the screen resistor to get the desired amount of increase in the high voltage.

Returning the negative side of the 500-µµf high-voltage filter capacitor to terminal 1 of the horizontal output transformer in Fig. 3 instead of to ground will increase the high voltage a little, too. Another way to increase both sweep and high voltage is to return the plate of the horizontal discharge or oscillator tube to the boosted B-plus (X in Fig. 3) through a decoupling and dropping R-C circuit. Returning the plate of the vertical output tube to this point will increase the vertical drive if more is needed. Decreasing the value of the plate resistor of the horizontal discharge tube will also help.

The 6BG6-G can be replaced with a type 6CD6-G for more sweep and higher voltage. These tubes are interchangeable as far as socket connections and operating voltages are concerned. However, the 6CD6-G takes a 2.5-amp filament current compared to 0.9 amp for the 6BG6-G. When making the change, be sure the power transformer can take the added drain, or else install an additional heater transformer.

If the original high-voltage system delivers only 7,000 volts, it must be rebuilt. Fig. 4 shows a voltage doubler circuit with a horizontal output transformer having two filament windings for the rectifier tubes. This system does not actually deliver double the original voltage, but a lesser amount depending on the load. With 7,000 volts initially, however, 12,000 or 13,000 volts will be available for tubes as large as the 19-inch variety. With good emission 1B3-GT tubes, and a 6CD6-G horizontal output tube, the high voltage will be enough for the 19-inch tubes.

For 16-inch tubes, which need only 12,000 volts for high brilliancy, the voltage of the doubler can be reduced by using 250-µµf capacitors in place of the 500-µµf units. This will decrease the regulation somewhat and drop the potential. A bleeder consisting of ten 10-megohm resistors in series can also be placed across the high-voltage output for a slight reduction if the voltage is a little too high for the 16-inch tubes. Using ten resistors assures smaller voltages across the individual units, with less danger of flashover.

Another way to increase the high voltage as well as the horizontal sweep is to use a combination horizontal deflection-output and high-voltage transformer, such as the RCA 223T1, in the circuit shown in Fig. 5. Autotransformer action supplies high voltage to the rectifier tube, and the transformer has a separate winding for the rectifier filament.

This circuit, when used with deflecting yokes such as the RCA 209D1, provides ample deflection for 70-degree tubes and it has a high-voltage output of about 14,000.

Excessive high voltage will prevent full deflection and will result in a smaller picture. It also increases the electron beam velocity and the deflection coils cannot sweep the beam fully. For this reason it is important that the high voltage be measured to make sure it does not exceed the nominal value for the tube used.

Some kits on the market furnish complete hardware and other components necessary for conversion. A complete doubler kit runs less than $15 and many dealers stock these for conversion from 10- to 16-inch tubes. When converting from 10 to 12 inches, however, the yoke and horizontal output transformer need not be changed, and only a few minor alterations are necessary to get satisfactory results.

Wide-angle 70-degree deflection yokes and other components such as larger horizontal output transformers are sold separately and come in a variety of makes and prices. A knowledge of the parts available on the market coupled with conversion know-how is a sure avenue to greater profits for the technician.

Ion trap and focus coil

When installing some types of tubes, it may be necessary to make changes in the focus circuit to provide more or less current through the focus coil. If more current is required, install a bleeder resistor between the low-voltage side of the coil and ground. Adjust the resistance of the bleeder so the sum of the focus and bleeder currents equals the focusing current required for the new tube. When the tube requires less current, a suitable resistor should be connected in parallel with the coil. The resistor is adjusted so the excess current flows through it instead of through the coil.

Adjust the ion trap or beam bender as soon as the new tube is installed. Turn down the brightness so the picture is barely visible. Move the trap back and forth while rotating it slightly from side to side. Position it for the brightest raster. Turn up the brightness to average and adjust the focus coil for sharpest lines. Touch-up the position of the ion trap for brightest raster.

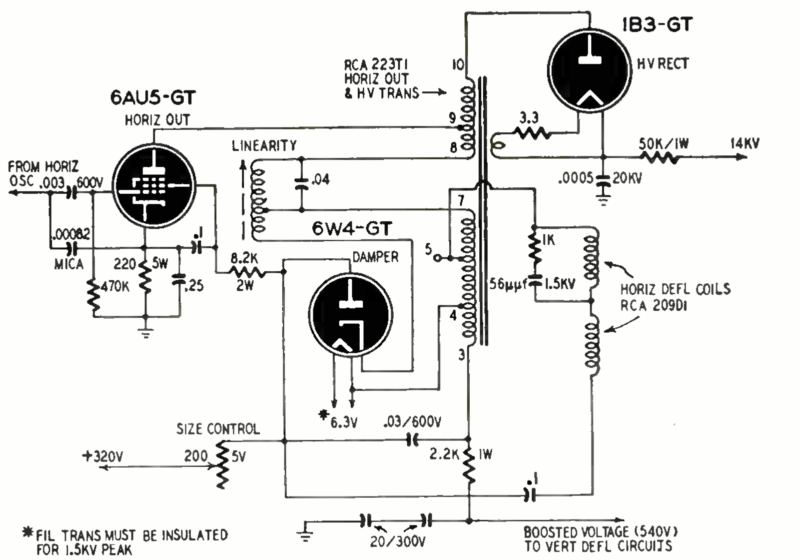


Fig. 5—High-voltage circuit for tubes with large-angle deflection and using up to 14 kv. This supply uses as specially-designed ferrite core transformer.

TV Progress Abroad

By E. AISBERG*

OLD Europe's 10 millions of square kilometers are divided among more than two dozen countries, inhabited by a total of 500 million people. With an area only 20% smaller, the United States forms a single country of 150 million inhabitants.

Here lies the fundamental difference between the development of television on the two sides of the Atlantic. In the United States, a single standard has been adopted over the whole vast territory. We have seen the magnificent advance of television which has resulted from the possibility of producing great numbers of television receivers at a moderate price.

The situation is far different in Europe. There are four principal standards, without counting variations. Television, from a practical point of view, exists only in two countries, France and Great Britain, which already had television service before World War II.

Great Britain maintains its standard of 405 lines. Its programs are transmitted from Alexandra Palace at London and from the newly inaugurated Sutton Coldfield station near Birmingham, which is connected with London by radio relays. A third transmitter is being erected at Holme Mass (near Huddersfield) and will probably be completed by the middle of 1951. The number of television receivers is now greater than 400,000, and they cannot be manufactured fast enough to satisfy the increasing public demand. The success of English television is due to the excellent quality of the programs and relatively low cost of receivers.

In France, after the liberation, television transmissions were resumed from Paris, using 455 lines. Later, after numerous discussions, the definite standard of 819 lines was adopted. Owners of television receivers were reassured by a law guaranteeing 455-line transmissions till 1958. Meanwhile, high-definition 819-line transmissions have commenced from Paris as well as from the new transmitter at Lille, which is linked to Paris by radio relays working on 30-centimeter waves. Another transmitter is being assembled at Lyons.

The number of televiewers increases very slowly in France, chiefly because of the high price of receivers—a price which puts them out of reach of the medium-income portion of the population. In addition, the programs are not always interesting. They are composed largely of film—too often old and of mediocre quality.

The total budget devoted to television in France is very small. The technicians and actors are performing veritable prodigies and making real sacrifices to assure regular and more or less satisfactory television service. Remember that in France (as in England) no advertising is permitted on television or radio, and its resources come entirely from taxes.

It is difficult to estimate the number of French television viewers exactly. A large number of them prefer not to declare their equipment officially, thus avoiding the tax of 2,500 francs per annum. The closest guess is about 20,000 viewers.

There are as yet no regular television programs in European countries other than England and France (and possibly Russia). These countries had been marking time pending the adoption of a European standard. Studies to that end have been made by a commission of the Consultative Committee of Radiocommunications and comprising 60 delegates representing 15 countries. At the final meeting held in London May 8, 1950, the following stage had been reached:

"Systems based on 405, 525, 625, and 819 lines were examined. The delegates of France, the United Kingdom, and the United States have confirmed that their countries will continue to use their present standards.

"France and the United Kingdom maintain their previous proposition envisaging the unification of the standards used by the Paris and London transmitters.

"Austria, Belgium, Denmark, Italy, the Netherlands, Sweden and Switzerland have declared themselves in favor of the 625-line system and have addressed an appeal to their colleagues inviting them to reconsider their position."

Why does 625 lines appear to be the future European television standard? It is, to all intents and purposes, the same as the American standard. In Europe, all the electric power systems operate at 50 cycles. To avoid interference from the 50-cycle hum, all European television systems use 25 images per second, each composed of two interlaced fields.

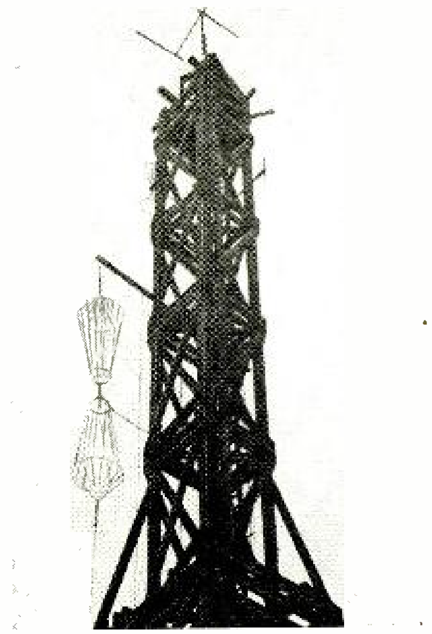
Thus, the number of lines traced per second in the European standard is:

$625 \times 25 = 15{,}625$ lines per second.

The U. S. standard, with 525 lines 30 times per second, is:

$525 \times 30 = 15{,}750$ lines per second.

We see that the two standards are practically identical. With the same bandpass the European system will have a little better vertical and the same horizontal definition as the American.



View of the 819-line transmitter tower.

Now that the new European standard's close at hand, several countries are thinking of installing television transmitters. In the forefront are Belgium, Switzerland, and Italy. The situation in Belgium is especially peculiar. In that bilingual country every problem takes on a political aspect. The normally technical question of standards has aroused partisan passions; the Walloons favor the French standard of 819 lines, while the Flemings defend resolutely that of 625!

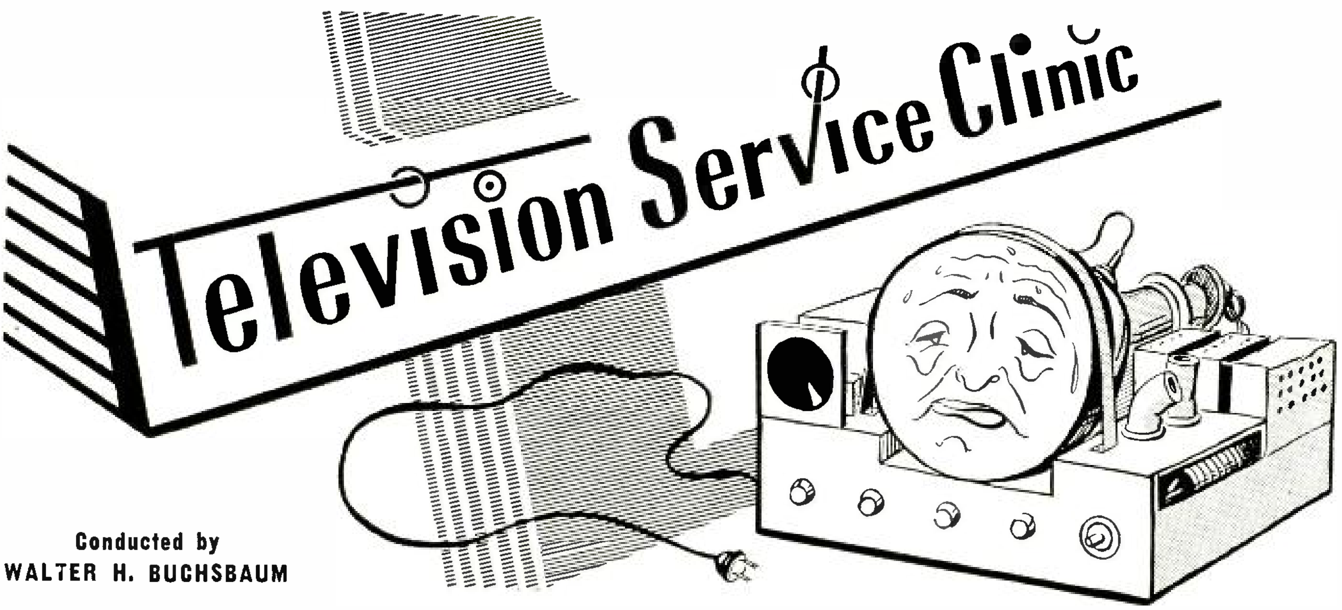
It is probable that the first European 625-line transmitter will be installed in the Grand Duchy of Luxembourg. Because of its privileged geographical situation, Luxembourg is a sort of European radio center.

Like the transmitters of Monaco and Andorra, two tiny principalities on the frontiers of France, Radio Luxembourg is a private station supported by advertising. Now it is proposed to add to Radio Luxembourg a 625-line television transmitter, with an antenna supported by towers 300 meters high, which will radiate 50 kw of power.

What will be the range of such a transmitter? Only the future can tell. Meanwhile, it appears—as the result of an inquiry we have conducted in several European countries—that the range of television transmitters often exceeds the theoretical range determined by the height of the transmitting and receiving antennas. Instances where the range reaches 150 or even 300 kilometers are not rare. Numerous Belgians receive the programs from Paris as well as those from London.

One cannot count on such exceptional ranges under normal conditions of wave propagation. But, before all Europe is served by a tight network of television transmitters, no doubt plenty of water will have flowed beneath the bridges of the Seine!

*Publisher, *Toute la Radio*, Paris, France



Conducted by
WALTER H. BUCHSBAUM

FIRST of all we want to wish all our readers a very Happy and Prosperous New Year. We are greatly flattered by the numerous inquiries regarding our book *Television Servicing*, as well as by the increasing stream of letters to this column. All letters are answered directly and those of general interest are answered on this page as well.

Because of the steel shortage many TV manufacturers are turning away from power transformers to use a circuit with two selenium rectifiers in a voltage-doubler arrangement. While this circuit has been used for several years in less expensive, small-screen receivers, it is now in use for 16- and 17-inch rectangular picture tubes. Operating the horizontal flyback circuit from such a source means that only 250 volts B-plus are available where previously 360 to 400 volts were used. Special flyback transformers, invariably the ceramic-core type, are used to provide sufficient high voltage and deflection.

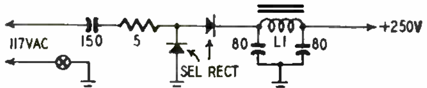


Fig. 1—Voltage doubler cricuit of the type used in transformerless receivers.

The circuit in Fig. 1 shows a typical selenium doubler circuit. The output at the filter is 250 volts with 117 volts a.c. input. If the line voltage is low, the output may drop to 230 or even 210. The low line voltage will cause a reduction in width and high voltage, or brightness. Unfortunately many homes suffer from low line voltage in the evening hours when the load on the power generators is greatest. In some locations a.c. line voltage as low as 95. While most transformer types of receiver have some leeway, the majority of selenium-type TV sets will not perform properly at such low values.

One solution is to install a constant-voltage type of transformer or a suitable variable transformer and run the receiver from that source. The cost of either runs from above $20 to $50 and many set owners object to this additional expense. But if you have any old power transformers around, a simple and effective arrangement can be made. Any power transformer having a 117-volt primary and a 6.3-, 5- or 12-volt filament winding can be used.

Connect the a.c. power line to the 117-volt primary winding as shown in Fig. 2. Now make a temporary connection of the filament winding and measure the voltage across 1 and 3. If it is less than the voltage across 1 and 2, reverse the filament winding. Where a 6.3- and a 5-volt winding are used, connect them in series, checking to make sure their voltages add. Mount this auxiliary transformer in the TV cabinet away from the picture tube, possibly in some corner or in the bottom section of a console. Solder all leads and tape them securely before mounting the transformer.

If low line voltage occurs only at certain times of the day, a simple toggle switch can be mounted on the back of the cabinet as shown in Fig. 2. When the picture gets small and dim, the owner throws the switch to connect his set to the higher tap on this autotransformer. The switch must be returned to the normal position when the set is turned off or when the line voltage goes up.

Almost any transformer can be used, but the windings not used should be disconnected and their leads securely taped. Since the secondaries are not drawing rated current, the primary current can be higher than in other applications and any transformer designed for several amperes of filament current and about 100-ma secondary current will be suitable as an autotransformer.

Negative picture

Turning the brightness control up on a Bradford (Du Mont) TV set produces a negative picture. Also, I use a lazy-X-type antenna and would like to know if a Yagi will give me more gain on channel 6.—J. F. S., Marion, Ohio.

Replace the 1B3-GT in the high-voltage supply. Check the high voltage,

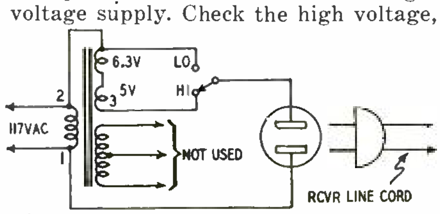


Fig. 2—Simple hookup for stepping up line voltage with a power transformer.

which should be 12 kv with an average picture. Replace the picture i.f. amplifiers and the r.f. amplifier. It is also possible that the 19AP4 tube has become weak. Before replacing it, try readjusting the ion trap or using a new ion trap.

Any Yagi, if tuned for a single channel, will give more signal on that channel than a dipole and reflector (lazy X). Orienting the Yagi is rather critical since it has a narrow beam in one direction only.

Unsteady picture

The picture on a 630 TS receiver is unsteady and shifts to the sides and goes out of sync completely. I have tried adjusting the synchrolock, but with no success.—J. G., Philadelphia, Pa.

I suggest you replace the 6AL5 and the 6K6 horizontal oscillator tubes in the high-voltage cage, or the 6AC7. Any of these would cause your trouble. The synchrolock adjustment may fail if the capacitors shunting either winding are defective.

No vertical sweep

Except for a bright horizontal line, the screen of an Admiral 16-inch 16R12 receiver is blank.—C. P., Jr., Auburn, Me.

The defect must be in the vertical sweep section, as there is no vertical deflection at all. A defective tube or capacitor is the most likely cause, although a defect in the vertical deflection coil in the yoke or in the leads running to the yoke will also cause this trouble. Replace the vertical output and oscillator tubes, and measure plate voltages and check the continuity of the windings of the vertical output transformer.

Big-Tube Conversions

We receive numerous queries on converting small-tube television receivers to use bigger tubes. Since each set has its peculiarities, a general answer covering a large number of models is usually insufficient. We have therefore prepared a number of brochures, each describing in detail the conversion of one of the more common models. Send us the name and model number of the set to be converted, *plus a stamped, self-addressed envelope,* for the brochure desired. If we have none for your particular job, an individual reply will be sent. Address:

Walter H. Buchsbaum
Television Clinic
RADIO-ELECTRONICS
25 West Broadway
New York 7, N. Y.

Weak reception

I get very weak reception on the low band. The set is a 19-inch Du Mont and the antenna is an Amphenol 114-026. The lower half of the dipole is cut away because the antenna is for 300-ohm ribbon line and the set has a 72-ohm input.—W. B., Brooklyn, N. Y.

A folded dipole is intended for a 300-ohm line and your set is designed for 72-ohm input. You should use a single dipole.

Poor reception on the low band may be due to location, orientation, or height of the antenna. Misalignment of the Du Mont tuner, especially poor tracking on the low band, will cause weak pictures. Alignment may be done according to the manufacturer's instructions with an oscilloscope and a sweep generator.

The r.f. bandwidth of this set should be 6 mc and the picture i.f. bandwidth 3.8 to 4 mc.

No brightness

The brightness control on an Admiral 10-inch receiver gives me difficulty.—F. S. B., Jr., Chicago, Ill.

Insufficient brightness may be caused by:

1. Low high voltage. Replace the 1B3-GT, check the 1-megohm resistor on the 1B3-GT socket, replace the high-voltage capacitor.

2. Brightness control shorted. Disconnect the capacitor from the control arm to ground to check. A misadjusted ion trap will also cause lack of brightness.

3. Weak picture tube. Although this is the least pleasant trouble, this is what I suspect. 10BP4's usually get weak after about 18 months of service. If all the above tests fail, I suggest you replace the 10PB4 as the next step in checking the receiver.

Simple Master Antennas

By WILBUR J. HANTZ

Many problems arise in large apartment houses where each TV receiver requires a separate antenna. Two of the more prominent problems are reluctant landlords and inadequate roof space. The landlord who will allow a number of stacked arrays on the roof is still rare. However most landlords can be persuaded to permit the installation of at least one master antenna system.

An efficient master antenna system is a challenging problem. Some of its most important requirements are:

1. A constant impedance match to the receivers;
2. Adequate isolation between receivers to prevent interaction and oscillator radiation;
3. Prevention of reflections and standing waves;
4. Not too much signal attenuation.

If the signal strength is high in the immediate area, all these conditions can be met by using a simple resistive network between the receivers and the antenna as shown in Fig. 1. Some dealers use this system for their TV showroom. The input impedance of most receivers being 300 ohms, the resistor values are so chosen that a constant impedance of 300 ohms is always

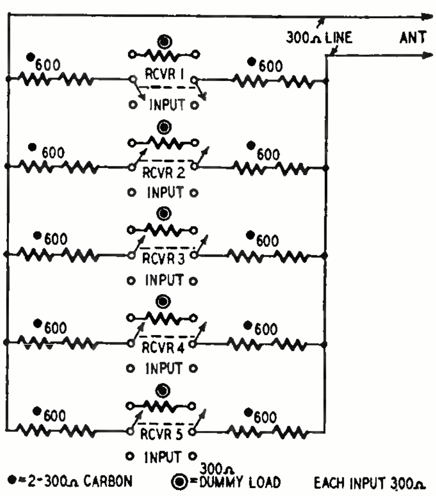


Fig. 1—Hookup for strong-signal areas.

presented even though some of the receivers are turned off. If the five receivers of the figures were connected directly to the transmission line minus the matching resistors, the total impedance presented to the line would be 1/5 of 300 ohms or 60 ohms, which would cause all kind of headaches. In Fig. 1, d.p.d.t. toggle switches are used to switch in either the receiver or a dummy load. Each branch presents a constant impedance of 1500 ohms to the antenna.

The resistive pad inserts quite a loss and cannot be used where the signal strength is too low. Here, the proper approach to the problem is to use a booster amplifier between the network and the antenna. Commercial boosters generally provide outputs of either 75 or 300 ohms which will match most TV receivers. In Fig. 2, the matching sys-

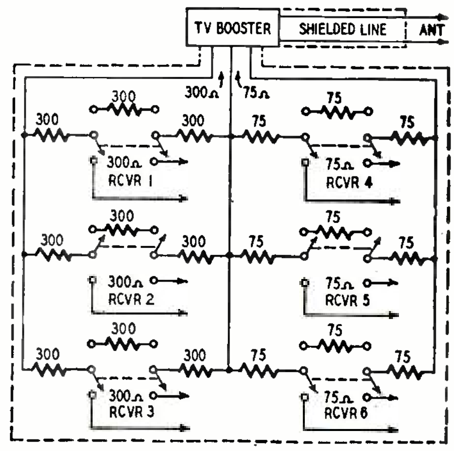


Fig. 2—A more sensitive system. Two boosters or a special booster permits matching both 75- and 300-ohm lines.

tem provides either 75 or 300 ohm outputs. Carbon resistors of the ¼-watt variety are used. In this installation, shielded line should be used both from the antenna to the booster and the receivers. The matching network can be located at the booster if desired.

If other impedance values are needed than indicated, it is just a matter of using Ohm's law for parallel impedances because most TV receiver inputs can be considered as resistive.

FILTERS AID TV FILMING

Improved picture quality from televised motion picture films has been made possible by a new filter technique developed at the Eastman Kodak Company. The filters prevent the red and infra-red radiation of the projection beam from falling on the iconoscope mosaic.

One filter recommended by the Eastman company consists of a 6 mm layer of Pittsburgh heat-absorbing glass No. 2043 plus a 3 mm layer of Corning No. 9780 or 9788. This combination reduces light with wavelengths greater than 590 millimicrons to less than 10% on the iconsoscope mosaic.

The improvements in the reproduced TV pictures are: reduced overall haze or veil; better contrast and resolution and increased brightness or tone range; reduced edge flare; reduced high light saturation; and increased video signal. When the filters are used, the light on the mosaic is reduced by 30%, but the master monitor shows a 20% increase in video signal.

TV ANTENNA EQUIPMENT

Directory of antennas, boosters, towers, and other pre-front-end equipment

Airflyte Electronics Co.
22 Evergreen St.
Bayonne, N. J.
Complete line of TV antennas, chimney mounts and brackets.

All Channel Antenna Corp.
70-07 Queens Blvd.
Woodside, N. Y.
Wide and narrow band arrays, biconicals, superdirectional fans, folded high, straight low, folded low, Yagis, window antennas, indoor antennas, folded in-line and double V antennas. Thirty models.

Alliance Mfg. Co.
Lake Park Blvd.
Alliance, Ohio
Booster matched with antenna rotator. One model. Antenna rotating devices. Three models.

A'par Mfg. Co.
496 St. Francis St.
Redwood City, Cal.
Small aluminum TV tower.

Alprodco, Inc.
Mineral Wells, Tex.
Kempton, Ind.
Aluminum towers for TV. Four models.

American Phenolic Corp.
1830 S. 54th Ave.
Chicago 50, Ill.
Broadband inline and piggy-back folded dipoles, indoor fixed dipoles. Eleven models. Extension masts, matching transformers, lightning arresters, standoff insulators, transmission lines, twinlead connectors and an automatic antenna rotator.

Anchor Radio Corp.
2215 South St. Louis Ave.
Chicago 23, Ill.
TV preamplifiers. Two models.

Antenna Products
1809 N. Ashland Ave.
Chicago 22, Ill.
Biconical antenna, dual rotation and uni-rotation arrays, Yagi antennas, chimney and wall mounts. Eleven models.

Astatic Corp.
Harbor & Jackson Sts.
Conneaut, Ohio
All-channel, two-stage TV boosters. Two models. Single-stage TV and FM booster. Two models.

Baker Mfg. Co.
Evansville, Wis.
Antenna towers and masts. Five models each in varying heights.

Barb City Industries
4150 S. 4th Ave.
DeKalb, Ill.
Uni-directional and bi-directional arrays, indoor collapsible array, attic antennas, foot mounts (universal and conventional), foot mounts for conduit tubing.

Blonder-Tongue Labs.
20 Gunther Ave.
Yonkers, N. Y.
Wide-band, all channel automatically tuned booster amplifying all 12 TV channels simultaneously.

David Bogen Co.
663 Broadway
New York, N. Y.
TV Boosters. Two models.

Brach Mfg. Corp.
200 Central Ave.
Newark, N. J.
Broadband antennas, bow tie, V, biconical superdirectional fans, T-bar inline, indoor antennas; twelve models. Masts, brackets and installation accessories. Non-amplified master antenna systems for 4 to 16 sets; six models. TVI matching transformers with highpass filter; one model. Two-set couplers; one model.

Bud Radio, Inc.
2118 E. 55th St.
Cleveland 3, Ohio
TV tower in 8-foot sections. One model.

Camburn, Inc.
32-40 57th St.
Woodside, N. Y.
Straight and folded dipoles with and without reflectors, stacked conicals, 4- and 5-element Yagis, straight line single and double stacked arrays, window and indoor antennas. Mast mounting brackets, screw eyes, lead-in clamps, guy wire, lightning arrestors, standoffs, miscellaneous accessories. 120 models.

Camburn Sales and Mfg. Corp.
302 W. Michigan Ave.
P.O. Box 408
Battle Creek, Mich.
Telescoping 3-sectional 51-foot tower. Guy ring for rotating antenna. Antenna mount for roof or wall. Universal mount.

Channel Master Corp.
Ellenville, N. Y.
Folded and straight dipole combinations, conventional conical combinations, broad-band fan combinations, Yagis, Hi-lo combinations, V antennas. All antennas preassembled. Masting and accessories. 50 models.

Circle-X Antenna Corp.
500 Market St.
Perth Amboy, N. J.
All-purpose circular antennas, masts, ground rods, guy wires, mast clamps, chimney mounts.

Clear Beam Television Antennas
618 N. La Brea Ave.
Los Angeles 36, Cal.
V-cones, arrows, Hi-lo dipoles, Yagis, clover leafs, pre-assembled kits. Ten models.

Cornell-Dubilier Electric Corp.
South Plainfield, N. J.
Various types of antennas, rotators, and mounting accessories.

Crown Controls Co.
124 So. Washington St.
New Bremen, Ohio
Compass-indicating rotator.

DeciMeter, Inc.
1430 Market St.
Denver 2, Colo.
Balanced circuit preamplifiers; two models. TVI wave traps for FM, diathermy, 10-meter amateur, and spurious Ff. in three ranges: 20-26, 25-35, and 88-108 mc.

Delson Mfg. Corp.
126 11th Ave.
New York 11, N. Y.
Window antennas, high and low band folded telescoping tunable dipoles, conical, open dipole, stacked arrays. Chimney and wall mounts and masts.

R. L. Drake Co.
11 Longworth St.
Dayton, Ohio
TVI filters.

East Coast Electronics
40 St. Francis St.
Newark 5, N. J.
Yagi beams, wide and narrow band arrays, biconical antennas and masts. Twenty-two models. Transmission line, coaxial cable, chimney mounts, wall brackets, accessories.

Easy-up Tower Co.
427 Romayne Ave.
Racine, Wis.
TV towers. Six models. Mast mountings, guy wire clamps, thimbles, pole rings.

Electro-Voice, Inc.
Buchanan, Mich.
TV Booster.

Energy Farm Equipment Co.
Monticello, Ia.
Hydraulic TV mast.

Gadgets, Inc.
3629 N. Dixie Drive
Dayton 4, Ohio
Indoor circular dipole.

General Cement Mfg. Co.
919 Taylor Ave.
Rockford, Ill.
Telescoping indoor dipole, single, double and 4-stack conicals.

Don Good, Inc.
1014 Fair Oaks Ave.
S. Pasadena, Cal.
Low-loss 300-ohm television lead-in wire line, television highpass filters, TVI traps. Three models.

Haugen Co.
412 S. Front St.
Mankato, Minn.
Antenna mast hoist and roof mount.

Hi-Lo TV Antenna Corp.
3540 N. Ravenswood Ave.
Chicago 13, Ill.
Spiral antenna for high and low bands. Indoor and outdoor models.

Hy-Lite Antenna, Inc.
242 E. 137th St.
New York 51, N. Y.
Single and stacked folded dipoles, Yagis, and V antennas.

Industrial Television, Inc.
359 Lexington Ave.
Clifton, N. J.
Untuned booster.

Insuline Corp. of America
36-03 35th Ave.
Long Island City, N. Y.
Wide-band antenna systems, including bi-conical single, double and quadruple arrays in standard and heavy duty models; folded dipole antennas and arrays; window antennas; indoor dipoles and indoor-outdoor folded dipoles. Twenty models.

Jerrold Electronics Corp.
121 N. Broad St.
Philadelphia 7, Pa.
Multiple TV systems with separate 3-element Yagi for each channel, master control unit, amplifier strips for each of 12 channels, and power supply. Antenna distribution outlets, four models. Wall outlets, three models. FM filter traps, two models. Solderless coax fittings, five types. Terminating resistor unit.

JFD Mfg. Co.
6101 Sixteenth Ave.
Brooklyn, N. Y.
Multi-element and multibay dipoles, folded dipoles and conicals with special modifications; Yagi beams; window and indoor antennas. Fifty-one antenna models. Masts, extensions, brackets, arresters, and other accessories.

Knepper Aircraft Service Co.
Aero Tower Div.
1016 Linden St.
Allentown, Pa.
Welded tubular aluminum towers and tower sections to 120 feet. Three models. Also poles and pole kits with hardware and mounting accessories.

H. L. Koenig Eng. Co.
735 Southwest Blvd.
Kansas City 3, Kan.
Antenna rotators. Two models.

La Pointe-Plascomold Corp.
Windsor Locks, Conn.
Antennas, masts, towers, mounts, guy cables, guy rings and collars, turnbuckles, cable clamps, lightning arresters, transmission line. Approximately 200 different items.

Louis Bros.
3543 E. 10th St.
Los Angeles 16, Cal.
High and low folded dipoles, inline, conicals, Yagis, and V antennas. Nine models.

Lyman Electronic Corp.
12 Cass St.
Springfield, Mass.
Yagi, folded dipole, single and double stacked.

Lyte Products, Inc.
46 Lawrence St.
Newark, N. J.
Antenna rotators. Conicals, stacked phased h. f. antennas, folded high and low band dipoles, telescopic aluminum mast. Folded dipole with triple reflector. Nineteen models.

Metalace Corp.
2191 Grand Concourse
Bronx 53, N. Y.
Antenna mounting devices. Chimney mounts, 5 types; wall mounts, 4 sizes; eave mounts, 4 sizes; miscellaneous mounts and accessories.

Milner Mfg. Co.
Box 4465, Fondren Station
Jackson, Miss.
All aluminum masts for 30 to 100-foot installations.

National Co.
61 Sherman St.
Malden, Mass.
TV boosters.

Network Mfg. Corp.
213 W. 5th St.
Bayonne 7, N. J.
Narrow beam and wide band antennas, yagi, conical, folded hi-lo assemblies. Parabolic dishes and wire mesh 400 mc for land the development service. Eight models excluding high models.

Oak Ridge Products
Div. of Video Television, Inc.
37-01 Vernon Blvd.
Long Island City 1, N. Y.
High and low band antennas, biconicals, indoor dipoles and window antennas. Fourteen models.

Ohio Aerial Co.
4553 Lewis Ave.
Toledo 12, Ohio
All-wave conicals basic suspension for 4 types of antenna.

Walter E. Peek, Inc.
2842 W. 30th St.
Indianapolis 22, Ind.
Six-element single-channel arrays, 12-element single-band stacked arrays for low channel operation; 16-element high channel arrays. Quadrature phase stacked broad band channels 7 to 13; double stacked closed dipole conicals. Six models.

Peerless Products Industries
812 N. Pulaski Rd.
Chicago 51, Ill.
Indoor dipoles. Two models.

Penn Boiler & Burner Mfg. Co.
Lancaster, Pa.
TV towers in 10-foot sections, tubular construction. Roof mountings, guy rings and collars.

A. A. Peters
231 N. Seventh St.
Allentown, Pa.
Antenna towers and portable tower rigs.

Philco Corp.
Philadelphia 34, Pa.
Fan and V antennas. Five models.

Philson Mfg. Co.
60-66 Sackett St.
Brooklyn 31, N. Y.
Narrow band (Yagi type) indoor dipoles, folded dipoles, single dipole, stacked arrays of all types. Masts.

Phoenix Electronics, Inc.
50 Island St.
Lawrence, Mass.
Dipole, inline, conical, Yagi. Seventeen models.

Plymouth Electronic Corp.
68 High St.
Worcester, Mass.
Three-channel transfer switches; 6-strand guy wire, chimney mounts, ten models; roof mounts, three models; wall mounts, two models.

Premax Products Div.
Chisholm-Ryder Co.
Highland & College Aves.
Niagara Falls, N. Y.
Ground rods and fastenings.

Twenty-two types and sizes. Antenna mountings and accessories.

Price Tenna-Trailer Co.
660 E. Walnut St.
Watseka, Ill.
Portable TV demonstrating unit. TV masts.

Radiart Mfg. Co.
7580 Garfield Blvd.
Cleveland 25, Ohio
Wide and narrow-band arrays including high-low, in-line, high gain conical and Yagi dipoles; indoor dipoles. Eighteen models.

Radiart Corp.
3571 W. 62nd St.
Cleveland 2, Ohio
Folded dipoles and reflectors; turnstile folded dipoles; hi-lo all-channel; straight line all channel, single and double stacked conical all-channel, single, double and 4-stacked Yagi cut-to-channel, 5-element, single and double stacked super V end-fire, single double and 4-stacked. Indoor two and three-section telescoping masts, and indoor loaded X.

Radio Corporation of America
RCA Victor Div.
Harrison, N. J.
Single lobe antenna, reversible beam array, FM folded-dipole antenna, mast mounting bracket, transmission line, lightning arrester. Three models.

Radio Merchandise Sales, Inc.
1165 Southern Blvd.
New York 59, N. Y.
Conicals, Yagis, folded dipoles, straight dipoles, window antennas and indoor antennas.

Radion Corp.
1137 Milwaukee Ave.
Chicago, Ill.
Indoor dipole, indoor antenna in shape of photo album, conical window antennas. Three models.

Ramsey Radio & Television Co.
Box 291
Ramsey, Ill.
Welded steel TV antenna towers in 10-foot sections, with built-in rotor mounts, hinged feet, and lead-in insulators.

Ray Mfg. Co.
441 Summit
Toledo, Ohio
Conical arrays, folded dipoles, special single and double-stacked Yagis cut to any channel. Twenty-three models. Chimney mounts, roof saddles, mounting bases, mast connectors and guy rings.

Regency Div.
I.D.E.A., Inc.
55 North New Jersey St.
Indianapolis, Ind.
Television and FM boosters. Three models.

Rostan Corp.
202 E. 44th St.
New York 17, N. Y.
Self-supporting and guyed aluminum towers.

Walter L. Schott Co.
9306 Santa Monica Blvd.
Beverly Hills, Cal.
Wideband conical arrays with and without masts, Yagis.

Mark Simpson Co.
32-28 Forty-ninth St.
Long Island City 3, N. Y.
All-channel TV booster.

Snyder Mfg. Co.
22nd and Ontario Sts.
Philadelphia, Pa.
Conicals, folded and straight dipoles, hi-lo, portable indoor, double V type, straight bay, biconical, and window antennas.

Sperling Products Co.
62 Grand St.
New York, N. Y.
No information supplied.

Square Root Mfg. Co.
391 Saw Mill River Road
Yonkers, N. Y.
Built-in quadrature phased antennas, three models; rotating rooftop antenna; indoor and window antennas.

Standard Coil Products Co.
2311-29 North Pulaski Road
Chicago 39, Ill.
TV booster.

Tabet Mfg. Co.
254 W. Tazewell St.
Norfolk 10, Va.
Wide-band conicals, single and stacked arrays, window antennas, five models. Aluminum towers, three models.

Taylor Mfg. Co.
Lima, Ohio
Aluminum and steel chimney mounts and antenna bases, aluminum wall mounts, steel saddle and roof mounts. Seven models.

Tech-Master Products Co.
443 Broadway
New York, N. Y.
TV booster kit.

Technical Appliance Corp.
Sherburne, N. Y.
Twin-driven Yagi arrays, in-line and piggy back antennas, conicals, fifty models. Antenna amplifier distribution systems, lightning arresters, mast bases and accessories.

Tel-A-Ray Enterprises, Inc.
335 Clay St.
Henderson, Ky.
Wide-spaced Yagi arrays, broadband butterfly, antenna-mounted preamplifier. Twenty-eight models.

Telematic Industries, Inc.
One Joralemon St.
Brooklyn 2, N. Y.
Conicals, folded and straight dipoles, 16 models. Masts, mast couplers, ribbon-line wire strippers, detent replacement. Stacking bars, conical element stabilizers, and high gain signal spurs.

Television Equipment Corp.
238 William St.
New York 7, N. Y.
Untuned booster, multiple dwelling coupler and booster networks, color adapters and converters.

Telrex, Inc.
Asbury Park, N. J.
Conical V beams, all channel arrays, outdoor and indoor antennas. Twenty-four models. Accessories.

TELvision Labs., Inc.
5045 W. Lake St.
Chicago 44, Ill.
Built-in and under-the-rug printed circuit antennas. Five models.

Tower Corp.
3332 E. 55th St.
Cleveland 4, Ohio
Five-foot steel mast extensions.

Tricraft Products Co.
1535 N. Ashland Ave.
Chicago 22, Ill.
Seven-element all-wave array, single, double or 4-stacked; loaded dipoles, loaded dipoles with triple reflector; hi-lo folded dipole and reflector; conical, single, double and 4-stacked; single and double stacked 5-element Yagi; loaded window and indoor dipoles; masts (kits and preassembled units. Twenty-three models.

Trio Mfg. Co.
Griggsville, Ill.
Yagis, attic antennas, wide-band arrays, two-channel Yagis, phase control and masts. Fifteen models.

The Turner Co.
Cedar Rapids, Ia.
TV Booster. One model.

VeriBest Television Products
233 Spring St.
New York, N. Y.
All-band outdoor antennas, Yagis, stacks of all kinds, conicals. Ten models.

Victoria Sales Co.
619 N. Michigan Ave.
Chicago 11, Ill.
Telescoping indoor dipole, under-the-rug antenna.

Wabash Mfg. Co.
2300-18 S. Western Ave.
Chicago 8, Ill.
Under-the-rug antennas. Two models.

Walco Products, Inc.
50 Franklin St.
E. Orange, N. J.
Two-speed 370-degree antenna rotator, with or without indicator. Two models.

Ward Products Corp.
1523 E. 45th St.
Cleveland 3, Ohio
Folded dipoles, Yagis, stacked arrays.

Warren Mfg. Co.
250 East St.
New Haven, Conn.
Complete line of TV antennas, hardware and brackets.

Western Coil & Electrical Co.
216 State St.
Racine, Wis.
Semi-telescoping steel masts, 10 to 40 feet; self-supporting aluminum towers, 33 to 55 feet; guyed aluminum towers; steel lattice type and triangular type towers and tower sections to 100 feet. Fourteen models.

Wincharger Corp.
East 7th at Division
Sioux City 6, Iowa
Guyed and self-supporting roof-mounted towers. Six models.

Wind Turbine Co.
266 E. Market St.
West Chester, Pa.
Towers and masts, tripods, antenna support brackets. Ten models.

Workshop Associates
135 Crescent Rd.
Needham Heights 94, Mass.
Double V and cut-to-channel Yagis. Matching transformers, coax switches, connectors, and other accessories.

Directory of TV Receiver Characteristics

1 Manufacturer	2 Model	3 Chassis number	4 Cabinet or chassis type	5 AM-FM-SW	6 C-R tube type	7 C-R tube anode kilovolts	8 Number of tubes	9 Intercarrier sound	10 Type of AGC	11 Video i.f. stages	12 Video i.f. megacycles	13 Built-in antenna	14 AF output watts 5% distortion	15 Speaker size inches	16 Accessories
Admiral Corp. 3800 West Cortland St. Chicago, Ill.	12X11	20Z1	T	No	12LD4	9	19	Yes	Ord	3	25.75	NT		5	No
	16R12	21B1	T	No	16KP4[1]	12.5	21	No	Ord	3	25.75	NT		5	No
	26R12	21B1	C	No	16KP4[1]	12.5	21	No	Ord	3	25.75	NT		5	No
	26X55, 26X56, 26X57, 26X65, 26X66, 26X67, 26X75[2], 26X76[2]	24D1	C	No	16GP4	13	24	No	Key	3	25.75	NT		10	No
	29X17, 29X26	24F1	C	No	19AP4	13	24	No	Key	3	25.75	NT		12	No
	34R16	20V1	C	AM	14CP4	12	23	No	Ord	3	25.75	NT		10	P
	36R37	21C1	C	AM-FM	16KP4[1]	12.5	26	No	Ord	3	25.75	NT		12	No
	39X17, 39X25, 39X26	24G1	C	AM-FM	19AP4	13.5	29	No	Key	3	25.75	NT		12	P
	39X35, 39X36	21J1	C	AM	19AP4		24	No	Ord	3	25.75	NT		12	P
Affiliated Retailers, Inc. (Artone) Empire State Bldg. New York, N. Y.	16CD		C	No	16″		19	Yes				TU		6	No
	16CD3DR		C	AM-FM	16″		19	Yes				TU		6	P3
	16CR		C	No	16″[3]		19	Yes				TU		6	No
	16RD		T	No	16″[3]		19	Yes				TU		6	No
	19CD		C	No	19″		19	Yes				TU		6	No
	819		C	No	19″		19	Yes				TU		6	No
Air King Products Co., Inc. 170 53rd St. Brooklyn, N. Y.	12C1	700	C	No	12LP4	9	21	Yes	Ord	3	25.75	NT	2.4	5	No
	12T1, 12T2	700	T	No	12LP4	9	21	Yes	Ord	3	25.75	NT	2.4	5	No
	14T1	700–3	T	No	14RP4	9	21	Yes	Ord	3	25.75	NT	2.4	5	No
	16C1, 16C2, 718	700–10, 700–70	C	No	16RP4	12	21	Yes	Ord	3	25.75	NT	2.4	10	No
	16C3, 16C5	700–10, 700–70	C	No	16RP4	12	21	Yes	Ord	3	25.75	NT	2.4	5	No
	16K1	700–50, 700–72	C	AM-FM	16RP4	12	26	Yes	Ord	3	25.75	NT	2.4	8	P3
	16M1, 16T1, 16T1B	700–10, 700–70	T	No	16RP4	12	21	Yes	Ord	3	25.75	NT	2.4	5	No
	19C1	700–40	C	No	19DP4	13	21	Yes	Ord	3	25.75	NT	2.4	10	No
	20C1	700–40	C	No	20RP4	13	21	Yes	Ord	3	25.75	NT	2.4	10	No
Andrea Radio Corp. 27-01 Bridge Plaza North Long Island City 1, N. Y.	Caronia 19	VL19	C	AM-FM	19AP4	13.5	28	No	Key	3	26.2	NT	3.5	12	No
	Fleetwood, Sutton	VL16	C	FM	16GP4	13	25	No	No	3	26.2	NT	3.5	10	No
	Mayfield	VL16	T	FM	16GP4	13	25	No	No	3	26.2	NT	3.5	8	No
	Normandy	VK19	C	AM-FM	19AP4	13.5	31	No	No	4	26.2	NT	4	12	No
	Saybrooke	VL12	T	FM	12QP4	10.5	23	No	No	3	26.2	NT	3.5	5½	No
Ansley Radio & Television, Inc. 41 St. Joes Ave. Trenton, N. J.	706	703, 604	C	AM-FM	16″[13]	13	43	No	Key	4	25.75	No	8	12[4]	P3
	724	703, 604	C	No	16″[13]	13	30	No	Key	4	25.75	No	2.5	12	No
	726	703, 604	C	No	19″[13]	13	30	No	Key	4	25.75	No	2.5	12	No
	727	703, 604	C	AM-FM	19″	13	43	No	Key	4	25.75	No	8	12[4]	P3
	729	703, 604	C	No	16″[13]	13	30	No	Key	4	25.75	No	2.5	12	No
	730	703, 604	C	No	19″	13	30	No	Key	4	25.75	No	2.5	12	No
	731	703, 604	C	AM-FM	17″[3]	13	42	No	Key	4	25.75	No	8	12	P3
	732	605	C	No	17″[3]	13	21	No	Ord	4	25.75	No	2.5	12	No
	733	703, 604	C	AM-FM	20″[3]	13	42	No	Key	4	25.75	No	8	12	P3
	734	605	C	No	20″[3]	13	21	No	Ord	4	25.75	No	2.5	12	No

Arvin Industries, Inc. Columbus, Ind.	2120CM, 2126CM	TE-289-2	C	No	12LP4A	10	19	Yes	Ord	4	45.75	NT	0.6	5½	PLD
	2121TM, 2123 TM	TE-289-2	T	No	12LP4A	10	19	Yes	Ord	4	45.75	NT	0.6	5½	PLD
	2124CCM	TE-289-2	C	AM-FM	12LP4A	10	19	Yes	Ord	4	45.75	NT	0.6	8	P3LD
	2160CM, -CB, 2164CM, -CB	TE-290	C	No	16AP4A	12	20	Yes	Ord	4	45.75	NT	0.6	8	PLD
	2161TM	TE-290	T	No	16AP4A	12	20	Yes	Ord	4	45.75	NT	0.6	5½	PLD
	2162CCM	TE-290	C	AM	16AP4A	12	20	Yes	Ord	4	45.75	NT	0.6	6x9	P3LD
	4080T	TE-282	T	No	8AP4A	8.5	18	Yes	Ord	3	45.75	No	0.5	4½	No
	4162CB, 4162CM	TE-286	C	No	16AP4A	12	26	Yes	Key	4	45.75	NT	1.3	10	PLDT
Atwater Television Co. 360 Furman St. Brooklyn, N. Y.	No information supplied														
Automatic Radio Mfg. Co., Inc. 122 Brookline Ave. Boston 15, Mass.	TV-5019	TV-5019	C	No	19BP4	11-13	21	Yes	Ord	3	25.75	No	4	12	No
	TV-5116R, TV-5061	TV-5116R	C	No	17BP4A[5]	11-13	21	Yes	Ord	3	25.75	No	3	8	No
Bace Television Corp. Green and Lenning Sts. South Hackensack, N. J.	170C, 170HD, 170FD	630	C	No	17"[3]	13.5	30	No	Key	4	25.75	TU	3	12	PJ
	170TM	630	T	No	17"[3]	13.5	30	No	Key	4	25.75	TU	3	5x7	PJ
	20C	630	C	No	20"[3]	13.5	28	No	Key	4	25.75	TU	3	12	PJ
	20RCH	630	C	No	20"[3]	13.5	28	No	Key	4	25.75	TU	3	12	PRC
Bell Television, Inc. 552 W. 53rd St. New York 19, N. Y.	16C3, 16D3, 1603		C	No	16AP4	12	31	No	Ord	4	25.75	No	4	12	No
	16T3		T	No	16AP4	12	31	No	Ord	4	25.75	No	4	8	No
	19C4, 19D4, 1901		C	No	19AP4	13	31	No	Ord	4	25.75	No	4	12	No
	19T4		T	No	19AP4	13	31	No	Ord	4	25.75	No	4	8	No
	1604		MR	No	16AP4	13	32	No	Ord	4	25.75	No	4	8	RC
	1902		MR	No	19AP4	13	32	No	Ord	4	25.75	No	4	12	RC
Belmont Radio Corp. 5921 W. Dickens Ave. Chicago 39, Ill.	The Adams (RC-2005)	20AY21 & 8AF210	C	AM-FM	20CP4	16	32	Yes	Key	4	26.75	TU	3.0	12	P3
	The Catalina (C-2002), The Clayton (C-2001)	20AY21	C	No	20CP4	16	24	Yes	Key	4	26.75	TU	3.0	10	No
	The Marquis (C-1714), The Mayfair (C-1715), The Mozart (C-1716)	17AY21	C	No	17BP4	12	22	Yes	Key	4	26.75	TU	3.0	10	No
	The Rancho (M-1712), The Revere (M-1713), The Rocket (M-1711)	17AY21	T	No	17BP4	12	22	Yes	Key	4	26.75	TU	3.0	6	No
	The Santung (RC-1719), The Savoy (RC-1718)	17AY21	C	AM	17BP4	12	27	Yes	Key	4	26.75	TU	3.0	12	P3
Bendix Radio, Television and Broadcast Receiver Division Baltimore 4, Md.	2051	T5-4	T	No	14BP4[6]	12	18	Yes	Ord	2	25.75	NT	1.75	4x6	No
	2060	T5-3	T	No	16RP4[1]	12	18	Yes	Ord	2	25.75	NT	1.75	4x6	No
	3051	T5-4	C	No	14BP4[6]	12	18	Yes	Ord	2	25.75	NT	1.75	10	No
	6001, 6003	T5-3	C	No	16KP4[1]	12	18	Yes	Ord	2	25.75	NT	1.75	10	No
	6100	T5-2	C	AM-FM	16KP4[1]	12	18	Yes	Ord	2	25.75	NT	1.75	10	P3
Bowers Television Co. Box 1262, Reading, Penna.	TC270K-17	270K	C	FM	17AP4	14-15	24	Yes	Key	4	26.25	TU	2.5	12	PJ
Capehart-Farnsworth Corp. 3702 E. Pontiac Ave. Ft. Wayne, Ind.	Bedford, Nantucket	CX-33	T	No	160AR[7]	11	23	Yes	Ord	3	26.25	TU	4	8	No
	Chicagoan, Wm. Penn	CX-33F	C	No	16GP4	11	23	Yes	Ord	3	26.25	TU	4	12	No
	Georgetown	CX-33	C	No	160AR[7]	11	23	Yes	Ord	3	26.25	TU	4	6x9	No
	Monmouth, New Englander	CX-33	C	No	160AR[7]	11	23	Yes	Ord	3	26.25	TU	4	12	No
	New Amsterdam	CX-33	C	AM-FM	19AP4	11	38	Yes	Ord	3	26.25	TU	4[8]	12[9]	P3
	Saratoga	CX-33	C	AM-FM	170AR[7]	11	38	Yes	Ord	3	26.25	TU	4[8]	12	P3
	Spinet	CX-33	C	No	170AR[7]	11	23	Yes	Ord	3	26.25	TU	4	8	No
	Ticonderoga	CX-33	C	AM	160AR[7]	11	37	Yes	Ord	3	26.25	TU	4[8]	12	P3
	Virginian	CX-33	C	No	170AR[7]	11	23	Yes	Ord	3	26.25	TU	4	12	No
Cascade Television Co., Inc. 153 Chestnut Ave. Irvington 11, N. J.	F36-4X3	630		No	5TP4[10]	27	40	No	Key	4	26.25	No	15	12	RC
	LD17	630	C	No	17RP4	14.5	30	No	Key	4	26.25	No	4	12	No
	LD20	630	C	No	20RP4	14.5	30	No	Key	4	26.25	No	4	12	No
	LD119	630		No	20RP4	14.5	30	No	Key	4	26.25	No	4	12	RC

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Certified Radio Laboratories	4920	4920	K-WC	No	10BP4[11]	10	20	Yes	Ord	4	25.75	No	2.5	4x6	No
5507-13 Avenue	4920-12	4920	T	No	12LP4	10	20	Yes	Ord	4	25.75	No	2.5	4x6	No
Brooklyn 19, N. Y.	5020-16	5020	C	No	16DP4	12	20	Yes	Ord	4	25.75	No	2.5	12	No
Commander Television Corp.	1701	1700	C	No	17BP4A	12	22	Yes	Ord	4	26.1	No	3	12	No
280 9 Ave.	1901	1900	C	No	19AP4A	13.5	22	Yes	Ord	4	26.1	No	3	12	No
New York 1, N. Y.															
Concord Radio Corp.	1-167		T	No	16RP4	14	19	Yes	Ord	3	24.6	NT	2	8	No
901 W. Jackson Blvd.	1-168		C	No	16RP4	14	19	Yes	Ord	3	24.6	NT	2	5	No
Chicago 7, Ill.															
Conrac, Inc.	14M36, 14W36, 15P36, 16B36	36	C	No	16GP4	13	24	No	Ord	4	25.75	No	5	12	No
649 W. Foothill Blvd.	17P39, 20M39, 21B39	39	C	No	19AP4A	14	24	No	Ord	4	25.75	No	5	12	No
Glendora, Calif.															
Covideo, Inc.	T-1400		T	No	14BP4	11	20	Yes	Ord	3	25.75	No	3.5	5	CO
212 Broadway															
New York 7, N. Y.															
Crosley Division, Avco Mfg. Corp.	11-441MU, 11-461WU, 11-471BU	320	C	No	12LP4A	8	20	Yes	Key	4	26.4	NT	1	10	No
1329 Arlington St.,	11-442MIU, 11-472BIU	331	T	No	17BP4	12.3	24	Yes	Key	4	26.4	NT	1	5¼	No
Cincinnati 25, Ohio	11-443MU, 11-454MU, 11-458MU, 11-473BU, 11-484BU	323	C	No	19AP4A	14.5	24	Yes	Key	4	26.4	NT	1	10	No
	11-444MU, 11-474BU	331	C	AM	17BP4	12.3	32	Yes	Key	4	26.4	NT	1	10	P3
	11-445MU, 11-447BU, 11-465WU, 11-475BU, 11-477BU	321	C	No	16TP4	12.3	24	Yes	Key	4	26.4	NT	1	10	No
	11-446MU, 11-476BU	325	C	No	16GP4	12	24	Yes	Key	4	26.4	NT	1	10	No
	11-453MU, 11-460MU, 11-470BU, 11-483BU	323	C	No	19AP4	14.5	24	Yes	Key	4	26.4	NT	1	10	No
	11-459MU	321	T	No	16TP4	12.3	24	Yes	Key	4	26.4	NT	1	5¼	No
DeWald Radio Mfg. Corp.	DT162		T	No	16GP4[12]	12	23	Yes	Ord	4	25.75	NT	3.3	6½	No
35-15 37 Ave.	DT163		C	No	16GP4[12]	12	23	Yes	Ord	4	25.75	NT	3.3	10	No
Long Island City 1, N. Y.	DT190		C	No	19"[13]	12	22	Yes	Ord	4	25.75	NT	3.3	10	No
	DT1020, DT1030		T	No	10BP4	9	23	Yes	Ord	4	25.75	NT	3.3	6½	No
	ET140		T	No	14CP4	11	22	Yes	Ord	4	25.75	NT	3.3	6½	No
	ET141		C	No	14CP4	11	22	Yes	Ord	4	25.75	NT	3.3	10	No
	ET170		T	No	17BP4	12	20	Yes	Ord	3	25.75	NT	3.3	6½	No
	ET171		C	AM	17BP4	12	20	Yes	Ord	3	25.75	NT	3.3	5–10[9]	P3
Allen B. Du Mont Laboratories, Inc.	Andover, Park Lane, Strathmore	RA-117	C	No	17BP4	9	24	No	Ord	4	26.25	No	1[14]	10	No
35 Market St.	Ardmore, Mt. Vernon, Westerly	RA-112	C	FM	19AP4A	13	26	No	Ord	4	26.25	No	1[14]	10	No
E. Paterson, N. J.	Brookville, Burlingame, Revere	RA-113	C	FM	17BP4	13	26	No	Ord	4	26.25	No	1[14]	10	No
	Carlton, Sumter, Ventura	RA-117	T	No	17BP4	9	24	No	Ord	4	26.25	No	1[14]	5	No
	Hanover, Winslow	RA-109	C	FM	19AP4A	15	35	No	Ord	4	26.25	No	3[14]	10	No
	Sherbrooke	RA-109	C	AM-FM	19AP4A	15	39	No	Ord	4	26.25	No	3[14]	12	P
	Tarrytown	RA-113	C	AM-FM	19AP4A	13	32	No	Ord	4	26.25	No	1[14]	12	P
	Westminster II	RA-116	C	AM-FM	19AP4A	15	48	No	Ord	4	26.25	No	6	3–12[9]	PTRM
Electro-Technical Industries	12B	12B	K	No	12KP4	9	18	No	No	3	25.75	No	4	6	No
1432 N. Broad St.	14BR	14BR	K	No	14BP4	10	18	No	No	3	25.75	No	4	6	No
Philadelphia 21, Penna.	16BR	16BR	K	No	16RP4	13	19	No	No	3	25.75	No	4	6	No
Emerson Radio and Phonograph Corp.	660[52], 673[52]	120133B	T	No	12LP4A	10	17	Yes	Ord	3	25.75	NT	2	6	No
111 8 Ave.	661	120134B,-G	T	No	16GP4	12.5	22	Yes	Ord	4	25.75	NT	3	6	No
New York 11, N. Y.	662	120127B	T	No	14BP4	12	21	Yes	Ord	3	25.75	NT	3	5	No
	663	120128B	T	No	16RP4	12	21	Yes	Ord	3	25.75	NT	3	5	No
	664[52]	120133B	C	No	12LP4A	10	20	Yes	Ord	3	25.75	NT	2	12	No
	665[52]	120131B[15]	C	AM	12LP4A	10	24	Yes	Ord	3	25.75	NT	2	12	P3
	666	120135B[16]	C	AM-FM	16GP4	12.5	30	Yes	Ord	4	25.75	NT	3	12	P3
	667, 668	120134B,-G	C	No	16GP4	12.5	22	Yes	Ord	4	25.75	NT	3	12	No
	669	120129G	C	No	19AP4	13.5	22	Yes	Ord	4	25.75	NT	5	12	No
Fada Radio and Electric Co., Inc.	R1025		C	No	16GP4	12.5	27	No	Key	4	25.75	NT	2.2	10	No
525 Main St.	R1045		T	No	12LP4A	9.5	25	No	Key	4	25.75	NT	1.5	6	No
Belleville 9, N. J.	R1050		T	No	16GP4	12.5	27	No	Key	4	25.75	NT	2.2	6	No
	S4C20, S4C40		C	No	14BP4	11.5	22	Yes	Ord	3	26.1	NT	1.5	10	No

Fada Radio & Electric (contd.)	S4T15, S4T30		T	No	14BP4	11.5	22	Yes	Ord	3	26.1	NT	1.5	6	No
	S7T65		T	No	17BP4A	13.5	22	Yes	Ord	3	26.1	NT	1.5	6	No
	S9C10		C	No	19AP4	14.5	22	Yes	Ord	3	26.1	NT	1.5	10	No
	S1055		C	No	16RP4	13.5	22	Yes	Ord	3	26.1	NT	1.5	10	No
	S1055X		C	No	16GP4	13.5	22	Yes	Ord	3	26.1	NT	1.5	10	No
	S1060, S6T65		T	No	16RP4	13.5	22	Yes	Ord	3	26.1	NT	1.5	6	No
	S20C10		C	No	20CP4	14.5	22	Yes	Ord	3	26.1	NT	1.5	10	No
Federal Television Corp.	Commodore	1600C	C	AM-FM	16DP4	12.5	31	No	Ord	4	25.75	NT	4	12	P
139 Duane St.	Dover	1200D	C	FM	12LP4	9	26	No	Ord	4	25.75	NT	4	12	PS
New York 3, N. Y.	Essex	1600E	C	FM	16DP4	12.5	28	No	Ord	4	25.75	NT	4	12	PS
	Manhattan	1600M	T	FM	16DP4	12.5	28	No	Ord	4	25.75	No	4	5x7	PS
	Mohawk	1600M	T	No	16DP4	12.5	27	No	Ord	4	25.75	No	4	5x7	No
	New Yorker	1200N	T	FM	12LP4	9	26	No	Ord	4	25.75	No	4	5x7	PS
	Pacemaker	1600P	C	No	16DP4	12.5	27	No	Ord	4	25.75	NT	4	12	No
Firestone Tire & Rubber Co., The	13-G-44	-9123A[17]	T	No	14BP4[6]	13	26	Yes	Key	4		TU	2	6	No
1200 Firestone Pkwy.	13-G-45	-9123B[17]	C	No	14BP4[6]	13	26	Yes	Key	4		TU	2	6x9	No
Akron, Ohio	13-G-46	-9120G[17]	T	No	16TP4[1]	13.5	26	Yes	Key	4		TU	2	6	No
	13-G-47	-9120H[17]	C	No	16TP4[1]	13.5	26	Yes	Key	4		TU	2	6x9	No
	13-G-48	-9121C[17]	C	AM-FM	16TP4[1]	13.5	31	Yes	Key	4		TU	2	6x9	P
Freed Radio Corp.	54, 55, 56, 68	CHT-1620	C	No	16GP4	12	28	No	Key	4	25.75	No	4	12	PJ
200 Hudson St. New York 13, N. Y.	101, 103, 104	CHT-1900	C	FM	19AP4A	14	30	No	Key	4	25.75	TU	4	12	PJ
General Electric Co.	14C102, 14C103	A[52]	C	No	14"[3]	11.5	21	Yes	Ord	3	45.75	NT	1	10	No
Electronics Park	14T2, 14T3	A[52]	T	No	14"[3]	11.5	21	Yes	Ord	3	45.75	NT	1	5½	No
Syracuse, N. Y.	16C103, 16C104, 16C113, 16C116	A[52]	C	No	16"[3]	11.5	21	Yes	Ord	3	45.75	NT	1	12	No
	16K1, 16K2	A[52]	C	AM-FM	16"[3]	11.5	29	Yes	Ord	3	45.75	NT	1[18]	12	P3
	16T5	A[52]	T	No	16"[3]	11.5	21	Yes	Ord	3	45.75	NT	1	5¼	No
	17C101, 17C102	A[52]	C	No	17"[3]	11.5	21	Yes	Ord	3	45.75	NT	1	12	No
	19C105, 19C106	C	C	No	19"	14	21	Yes	Key	4	45.75	NT	5	12	No
Hallicrafters Co., The	805, 806	M800S	C	No	16TP4[1]	13	16	Yes	Ord	2	26.25	NT	1	8	PJ
4401 W. 5 Ave.	810	M800S	T	No	16TP4[1]	13	16	Yes	Ord	2	26.25	NT	1	5	PJ
Chicago 24, Ill.	811	E800D	T	AM	16TP4[1]	13	24	Yes	Ord	3	26.25	NT	2	5	PJ
	815	D800D	T	No	16TP4[1]	13	21	Yes	Ord	3	26.25	NT	2	5	PJ
	818	K800D	C	AM	16GP4	13	24	Yes	Ord	3	26.25	NT	2	8	PJ
	820, 821	E800D	C	AM	16TP4[1]	13	24	Yes	Ord	3	26.25	NT	2	8	PJ
	822	F800D	C	No	16GP4	13	21	Yes	Ord	3	26.25	NT	2	8	PJ
	860, 861	E800D	C	AM	16TP4[1]	13	24	Yes	Ord	3	26.25	NT	2	12	P
	870, 871	D800D	C	No	16TP4[1]	13	21	Yes	Ord	3	26.25	NT	2	8	PJ
	880	H800D	C	No	19AP4	13	21	Yes	Ord	3	26.25	NT	2	10	PJ
	890	J800D	C	AM	20CP4	13	24	Yes	Ord	3	26.25	NT	2	12	P
Hertner Electric Co., The 12690 Elmwood Ave. Cleveland 11, Ohio	L-10	L-10	C	No	5TP4	27	39	No	Ord	5	25.75	No	20	12	RC
Hoffman Radio Corp.	630, 631	170	T	No	14CP4	11	21	No	Key	3	26.1	TU	3	8	No
3761 S. Hill St.	634, 635	171	T	No	16TP4	13.5	21	No	Key	3	26.1	TU	3	12x6	No
Los Angeles 7, Calif.	866, 867, 868, 876, 877, 878	171	C	No	16TP4	13.5	21	No	Key	3	26.1	TU	3	12	No
	870, 871, 872	170	C	No	14CP4	11	21	No	Key	3	26.1	TU	3	12	No
	890, 891, 892	175	C	No	19AP4	13.5	21	No	Key	3	26.1	TU	3	12	No
	950, 951, 952	172	C	AM-FM	16TP4	13.5	24	No	Key	3	26.1	TU	3	12	P
	960, 961	176	C	AM-FM	19AP4	13.5	27	No	Key	3	26.1	TU	8	12	P
Industrial Television, Inc.	248		C	No	16JP4	13	33	No	No	4	25.75	NT	8	12	RC
359 Lexington Ave.	348		C	No	19AP4	15	33	No	No	4	25.75	NT	8	12	RC
Clifton, N. J.	761		T	No	16TP4	12	19	Yes	Ord	3	25.75	NT	3	8	PJ
	1161, 1261		C	No	16TP4	12	19	Yes	Ord	3	25.75	NT	3	12	PJ
	1361		C	No	19GP4	14	19	Yes	Ord	3	25.75	NT	3	12	PJ
International Television Corp.	1651	F-16	T	No	16RP4A	11	20	Yes	Ord	3	25.75	NT	4	4x6	No
238 William St. New York 7, N. Y.	1652, 1653, 1653F	F-16	C	No	16RP4A	11	20	Yes	Ord	3	25.75	NT	4	12	No

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Jackson Industries, Inc. 500 E. 40 St. Chicago, Ill.	14T		T	No	14BP4	14	20	Yes	Yes[23]	3	25.75	NT	1.5	6	No
	16C	E	C	No	16RP4	14	20	Yes	Yes[23]	3	25.75	NT	1.5	8	No
	16T	E	T	No	16RP4	14	20	Yes	Yes[23]	3	25.75	NT	1.5	6	No
	29C		C	No	19AP4A	14	20	Yes	Yes[23]	3	25.75	NT	1.5	10	No
	316	E	C	AM	16RP4	14	27	Yes	Yes[23]	3	25.75	NT	1.5	10	P
Kaye-Halbert Corp. 3555 Hayden Ave. Culver City, Calif.	233B, 233M, 233W	242	C	No	16YP4[22]	12	24	Yes	Key	3		No	2	12	No
	234B, 234M, 234W	242	C	No	16YP4[19]	12	24	Yes	Key	3		No	2	12	No
	235, 236	242	C	No	16YP4[20]	12	24	Yes	Key	3		No	2	12	No
	237	242	C	No	16YP4[21]	12	24	Yes	Key	3		No	2	12	No
	238B, 238M, 238W	242	C	No	19AP4	12	24	Yes	Key	3		No	2	12	No
	240, 241	242	C	No	19AP4	12	24	Yes	Key	3		No	2	12	No
	731	242	C	No	17BP4	12	24	Yes	Key	3		No	2	12	No
Magnovox Co., The Buenter Road Ft. Wayne, Ind.	American Modern (MV64), American Traditional (MV79), French Provincial (MV67)	103	C	AM-FM	17BP4	13	36	No	Ord	4	25.75	TU	13	15[26]	P
	Biltmore (MV31)	102	C	No	16TP4	12.5	20	Yes	Ord	3	25.75	NT	2.4	12	No
	Contemporary (MV78)	102	C	AM-FM	17BP4[24]	12.5	29	Yes	Ord	3	25.75	TU	2.5	12	P
	Cosmopolitan (MV41)	102	C	No	17BP4[25]	12.5	20	Yes	Ord	3	25.75	TU	2.4	12	No
	Embassy (MV63)	103	C	All	17BP4	13	40	No	Ord	4	25.75	TU	17	15[27]	P
	Hampshire (MV7)	102	T	No	14BP4	12.5	20	Yes	Ord	3	25.75	NT	2.4	8	No
	Hepplewhite (MV36)	103	C	No	17BP4	13	27	No	Ord	4	25.75	TU	4	12	PJ
	Metropolitan (MV21)	102	T	No	16TP4	12.5	20	Yes	Ord	3	25.75	NT	2.4	8	No
	Normandy (MV37)	103	C	No	17BP4	13	27	No	Ord	4	25.75	TU	4	12	PJ
	Playhouse (MV33)	102	C	No	17BP4[24]	12.5	20	Yes	Ord	3	25.75	TU	2.4	12	No
	Provincial (MV77), Wedgewood (MV72)	102	C	AM-FM	16TP4	12.5	31	Yes	Ord	3	25.75	TU	6.5	12	P
	Modern Theater (MV40), Shoreham (MV30)	103	C	No	19AP4	13	27	No	Ord	4	25.75	TU	4	12	PJ
Majestic Radio and Television Div. of Wilcox Gay Corp. 170 Washington St. Brooklyn 1, N. Y.	120, 121	99	T	No	12LP4A	9.5	19	Yes	Ord	3	24.75	NT	3	5	No
	141, 142	100	T	No	14DP4	9.5	19	Yes	Ord	3	24.75	NT	3	5	No
	160, 162	101	T	No	16KP4	12	19	Yes	Ord	3	24.75	NT	3	5	PJ
	7P1, 7P2, 7P3, 7P10, 7P11	101A	C	No	17AP4	12	19	Yes	Ord	3	24.75	TU	3	10	P3
	7PR12, 7PR13	101C	C	AM-FM	17AP4	12	27	Yes	Ord	3	24.75	TU	3	10	P3
	9PR4, 9PR5	103	C	No	19AP4A	12	19	Yes	Ord	3	24.75	TU	3	10	P3
	9PR8, 9PR9	103A	C	AM-FM	19AP4A	12	27	Yes	Ord	3	24.75	TU	3	10	P3
	902, 903, 910, 911	103	C	No	19AP4A	12	19	Yes	Ord	3	24.75	TU	3	10	PJ
	1400	100	C	No	14DP4	12	19	Yes	Ord	3	24.75	NT	3	10	No
	1600	101	C	No	16KP4	12	19	Yes	Ord	3	24.75	TU	3	10	PJ
	1605, 1610	102	C	No	16GP4	12	19	Yes	Ord	3	24.75	TU	3	10	PJ
	1710	101A	C	No	17AP4	12	19	Yes	Ord	3	24.75	TU	3	10	PJ
Marathon Radio & Television, Inc. 495 Kent Ave. Brooklyn 11, N. Y.	Brighton, Imperial, Winslow	630	C	No	16-19″[28]	12-13	30	No	Key	4	25.75	No	2.5	12	No
	Kent	630	C	No	16-19″[28]	12-13	30	No	Key	4	25.75	No	2.5	12	No
Mars Television, Inc. 112-33 Colonial Ave. Corona, L. I., N. Y.	Dartmouth	630	C	AM-FM	19AP4A	15	45	No	Key	4	22.3	No	10	12	P3
	Hampton, Oriental, Regent, Versailles, Warwick	630	C	No	16DP4A	13	31	No	Key	4	22.3	No	4	10	No
Mattison Television and Radio Corp. 893 Broadway New York 3, N. Y.	Aristocrat, Carolyn, Quadrille	630-4[29]	C	No	20DP4A	16	30	No	Key	4	25.7	NT	5	12	No
	Cathay, Continental, Diplomat	630-4[29]	C	No	17XP4A	15	30	No	Key	4	25.7	NT	5	12	No
	Challenger	630-4[29]	C	No	16DP4A	14.5	30	No	Key	4	25.7	NT	4	12	No
John Meck Industries, Inc. 4541 N. Ravenswood Chicago 40, Ill.	MM-614C	9018	C	No	14CP4	13	18	Yes	Ord	3	25.6	NT	2.5	8	No
	MM-614T	9018	T	No	14CP4	13	18	Yes	Ord	3	25.6	NT	2.5	8	No
	MM-616C	9018	C	No	16TP4	13	18	Yes	Ord	3	25.6	NT	2.5	10	No
	MM-616T	9018	T	No	16DP4	13	18	Yes	Ord	3	25.6	NT	2.5	8	No
	MM-919C	9018	C	No	19FP4	13	20	Yes	Ord	3	25.6	NT	2.5	10	No
	XSB	9018	C	No	16DP4	13	19	Yes	Ord	3	25.6	NT	2.5	10	No

Meissner Mfg. Div. Maguire Industries, Inc. Mt. Carmel, Ill.	25TV		WC	No	12KP4	12	25	No	No	3	26.4	No	4	5	No
Mercury Radio & Television Corp. 839 S. Wabash Ave. Chicago 5, Ill.	No information supplied														
Midwest Radio & Television Corp. 901-11 Broaway Cincinnati, Ohio	Adaptor (PXA-16) Constellation (KX-19) Constellation (PX-16) Constellation Adaptor (KXA-19) Video Grand (KR-19) Video Grand (PR-16)	DMA-16 DX-19 DM-16 DXA-19 DJ-19 DR-16	C[30] C[30] C[30] C[30] C[30] C[30]	No No No No AM-FM AM-FM	16GP4 19AP4A 16GP4 19AP4A 19AP4A 16GP4	12 12.5 12 12.5 12.5 12	24 25 25 24 32 32	Yes Yes Yes Yes Yes Yes	Key Key Key Key Key Key	4 4 4 4 4 4	25.75 25.75 25.75 25.75 25.75 25.75	NT NT NT NT NT NT	No 4 4 No 4 4	No 12 12 No 12 12	No No No No P3 P3
Mitchell Mfg. Co. 2525 N. Clybourn Ave. Chicago, Ill.	T16-B, T16-M		C	No	16TP4	12.5	20	Yes	Ord	3	26.1	NT	2	8	PJ
Montgomery Ward and Co. 619 W. Chicago Ave. Chicago, Ill.	Airline 3020 Airline 3032 Airline 3034 Airline 3036, 3039 Airline 3038 Airline 3040 Airline 3041		T T T C C C C	No No No No AM-FM AM No	16TP4 16TP4 14BP4 16EP4 16TP4 16TP4 16TP4	12.5 12.5 11 12.5 12.5 12.5 12.5	21 25 22 25 29 27 22	Yes No Yes No No Yes Yes	Ord Key Ord Key Key Key Key	3 3 4 3 3 4 4	25.5 26.2 26.75 26.2 26.2 26.75 26.75	TU NT TU NT NT TU TU	2.2 2.2 2.2 2.2 2.2 2.2 2.2	4x6 6 6 12 12 12 10	No No No No P3 P3 No
Motorola, Inc. 4545 Augusta Blvd. Chicago, Ill.	No information supplied														
Multiple Television Mfg. Co. 987 Hegeman Ave. Brooklyn 8, N. Y.	L-16W, LFD-16 L-19, LFD-19, TT7-19 19″ Remote	630-type 630-type 630-type	C C T	No No No	16DP4A 19DP4A 19DP4A	14 16 16	31 31 33	No No No	Key Key Key	4 4 4	25.75 25.75 25.75	No No No	3.5 3.5 5	12 12 12	No No RC
National Co., Inc. 61 Sherman St. Malden, Mass.	1601, 1602 1625, 1627, 1628, 1629 16C	279-292 279-292	T C WC	No No No	16RP4 16RP4 16RP4	12 12 12	23 23 23	Yes Yes Yes	Ord Ord Ord	4 4 4	25.75 25.75 25.75	TU TU No	2 2 2	4x6[9] 10 4x6[9]	No No No
North American Philips Co., Inc. 100 E. 42 St. New York 17, N. Y.	Irvington (PT200) Mt. Vernon (PT300) } Jumbo Vue-588, Jumbo Vue-1200	PC50 PC75P, PC75T	C CC	No No	3NP4[31] 3NP4[31]	25 25	22 29	Yes No	Ord Ord	3 4		No No	3 5.3	8 12	No RC
Olympic Radio & Television, Inc. Olympic Building Long Island City, N. Y.	752, 752CB, 755, 755CB 753 764, 767 766 769, DX621, DX621C DX931, DX932		T[32] C T C C C	No No No AM-FM AM-FM No	17″ 16″[3] 17″ 19″[3] 16″ 19	12.5 12.5 12.5 12.5 12.5 12.5	20 20 20 30 30 20	No No No No No No	Ord Ord Ord Ord Ord Ord	3 3 3 3 3 3	25.75 25.75 25.75 25.75 25.75 25.75	NT NT NT NT NT NT	3 3 3 3[37] 3[37] 3	5 10 10 12 12 10	No No PLD P3 P3 PJ
Packard-Bell Co., Inc. 12333 W. Olympic Blvd. Los Angeles 64, Calif.	2001-TV 2002-TV 2101 2102 2105 2105A 2202-TV 2204-TV 2301 2601-TV 2602 2801-TV 2803	2001-2 2001-2 2101-2 2101-2 2101-2 2101-2 2201-4 2201-4 2301 2601 2602 2801 2803	T C T C C C T C C C C C C	No No No No No No No No No No AM-FM AM-FM AM-FM	12LP4[33] 12LP4[33] 17BP4A[34] 17BP4A[34] 17BP4A[34] 16TP4[1] 16TP4[1] 16TP4[1] 20CP4[35] 16AP4[1] 16JP4[36] 16TP4[25] 20CP4[35]	9 9 13 13 13 13 13 13 14 13 13 14 14	20 20 21 21 21 21 21 21 23 26 26 28 28	Yes Yes Yes Yes Yes Yes Yes Yes Yes No Yes Yes Yes	Ord Ord Ord Ord Ord Ord Ord Ord Ord Ord Ord Ord Ord	3 3 3 3 3 3 3 3 3 4 3 3 3	25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0 25.0	NT NT NT NT NT NT NT NT NT NT NT NT NT	1.1[14] 1.1[14] 1.1[14] 1.1[14] 1.1[14] 1.1[14] 1.1[14] 1.1[14] 1.25[14] 2.5[14] 1.1[14] 1.25[14] 1.25[14]	6½ 10 6¼ 10 6½ 6½ 6½ 10 12 10 10 12 12	No No No No No No No No No No P3 P3 P3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Pathe Television Corp. 250 W. 57 St. New York 19, N. Y.	12-2	700	T	No	12LP4	9	21	Yes	Ord	3	25.75	NT	2.4	5	No
	16-21, 16-25	700-10,-70	C	No	16RP4	12	21	Yes	Ord	3	25.75	NT	2.4	10	No
Philco Corp. Tioga and C Streets Philadelphia 34, Penna.	1207[52]		T	No	12WP4	9	18	Yes	Ord	3	26.6	TU	1	4	No
	1208[52]		T	No	12WP4	9	18	Yes	Ord	3	26.6	TU	1	5¼	No
	1234[52]		C	No	12WP4	9	18	Yes	Ord	3	26.6	TU	1	8	No
	1282[52]		C	No	12WP4	9	18	Yes	Ord	3	26.6	TU	3	6x9	P3
	1443B, L, M		T	No	14CP4	9	22	Yes	Ord	4	26.6	TU	3	6	No
	1443PL, PM, PW		C	AM	14CP4	9	25	Yes	Ord	4	26.6	TU	5	6x9	P3
	1443X, XL		C	No	14CP4	9	22	Yes	Ord	4	26.6	TU	3	10	No
	1601, 1601T, 1602, 1607		T	No	16WP4A	13	23	Yes	Ord	4	26.6	TU[28]	3	6	No
	1604L, 1604M, 1606		T	No	16ZP4	12	25	Yes	Ord	4	26.6	TU	3	6[38]	No
	1634L, 1634M		C	No	16ZP4	12	25	Yes	Ord	4	26.6	TU	3	10	No
	1836L		C	No	17BP4A	13.5	23	Yes	Ord	4	26.6	TU	3	12	No
	1836M		C	No	17BP4A	13.5	23	Yes	Ord	4	26.6	TU	3	12	No
	1870L		C	No	17BP4A	13.5	23	Yes	Ord	4	26.6	TU	5	6x11	P3
	1872		C	AM	17BP4A	13.5	23	Yes	Ord	4	26.6	TU	5	6x11	P3
	1874L, 1874M		C	AM	17BP4A	13.5	26	Yes	Ord	4	26.6	TU	5	6x11	P3
	1875		C	AM-FM	17BP4A	13.5	28	Yes	Ord	4	26.6	TU	5	6x11[9]	P3
	1876		C	AM-FM	17BP4A	13.5	28	Yes	Ord	4	26.6	TU	5	6x11[9]	P3RC
	2134, 2136		C	No	20DP4A	15	23	Yes	Ord	4	26.6	TU	5	12	No
	2138		C	No	20DP4A	15	23	Yes	Ord	4	26.6	TU	5	12	RC
	2175		C	AM-FM	20DP4A	15	28	Yes	Ord	4	26.6	TU	5	12	P3
	2176		C	AM-FM	20DP4A	15	28	Yes	Ord	4	26.6	TU	5	12	P3RC
Philharmonic Radio Corp. 119 W. 57 St. New York, N. Y.	616		T	No	16XP4	13.5	19	Yes	Ord	3		NT	2	5	No
	1116, 6161		C	No	16XP4	13.5	19	Yes	Ord	3		NT	2	10	No
Philmore Mfg. Co. 113 University Place New York, N. Y.	Belvedere	CP731D	T	No	16"[3], [28]	14	31	No	Key	4	25.75	TU[4]	2.5	5x7	No
	Commodore 16	CP731D	C	No	16"[3], [28]	14	31	No	Key	4	25.75	TU[4]	2.5	12	No
	Commodore 19	CP731D	C	No	19"[31]	16	31	No	Key	4	25.75	TU[4]	2.5	12	No
Pilot Radio Corp. 36-07 36 St. Long Island City, N. Y.	TV164	TV164	T	FM	16TP4	13.5	28	Yes	Ord	4		NT	2.5	8	PJ
	TV167A	TV167A	C	FM	16GP4	13.5	28	Yes	Ord	4		NT	2.5	12	PJ
	TV191	TV191	C	FM	19AP4	13.5	28	Yes	Ord	4		NT	2.5	12	PJ
RCA Victor Division, Radio Corp. of America Camden, N. J.	Cumberland (2-T-60)	KCS45A	C	No	12LP4	9.7	21	No	Ord	4	25.5	NT	2.3[14]	8	PJ
	Fairfax (6-T-84)	KCS48-RK156	C	AM	16GP4	12	27	No	Ord	4	25.5	NT	5[14]	12	P3
	Fairfield (6-T-71), Highland (6-T-65), Modern (6-T-75)	KCS47A	C	No	16GP4	12	22	No	Ord	4	25.5	NT	1.8[14]	12	PJ
	Hartford (6-T-87), Rutland (6-T-86)	KCS48-RK158	C	AM-FM	16GP4	12	30	No	Ord	4	25.5	NT	10[14]	12	P3
	Hillsdale (9-T-77), Northampton (9-T-79)	KCS49A	C	No	19GP4A	14	22	No	Ord	4	25.5	NT	1.8[14]	12	PJ
	Kent (6-T-54)	KCS47	CB	No	16GP4	12	22	No	Ord	4	25.5	NT	1.8[14]	8	PJ
	Kingsbury (6-T-64)	KCS47A	C	No	16GP4	12	22	No	Ord	4	25.5	NT	1.8[14]	8	PJ
	Newport (6-T-53)	KCS47	T	No	16GP4	12	22	No	Ord	4	25.5	No	1.8[14]	8	PJ
	Provincial (6-T-76), Regency (96-T-74)	KCS47A	C	No	16GP4	12	22	No	Ord	4	25.5	NT	1.8[14]	12	PJ
	Sedgwick (9-T-89)	KCS60-RK158	C	AM-FM	19GP4A	14	30	No	Ord	4	25.5	NT	10[14]	12	P3
	Shelby (2-T-51)	KCS45	T	No	12LP4	9.7	21	No	Ord	4	25.5	NT	2.3[14]	7x5	PJ
	Somervell (2-T-81)	KCS46-RK156	C	AM	12LP4	9.7	22	No	Ord	4	25.5	NT	5[14]	12	P
	York (9-T-57)	KCS49	T	No	19GP4A	14	22	No	Ord	4	25.5	NT	1.8[14]	8	PJ
Radio Craftsmen, Inc., The 1617 S. Michigan Ave. Chicago 16, Ill.	RC101[54]	RC101	WC	No	16TP4[39]	13	25	No	Key	4	26.1	No	—	No	No
	RC200	RC200	WC	FM	16TP4[39]	13	29	No	Key	4	26.1	No	6	No	No

Radio and Television Inc.	616		T	No	16XP4[1]	14	19	Yes	Ord	3		NT	2	6	No
244 Madison Ave.	1116, 6161		C	No	16XP4[1]	14	19	Yes	Ord	3		NT	2	10	No
New York, N. Y.															
Regal Electronics Corp.	19C31, 19D31	1931	C	No	19AP4A	17	31	No	Key	4	25.75	No	2	12	No
603 W. 130 St.	19C36, 19D36	1936	C	AM-FM	19AP4A	17	36	No	Key	4	25.75	No	2	12	PJ
New York 27, N. Y.	22C17, 2217	2217	C	No	17BP4A	12	22	Yes	Ord	4	26.1	No	2	12	No
	17T22	2217	T	No	17BP4A	12	22	Yes	Ord	4	26.1	No	2	4x6	No
	17HD36	1736	C	AM-FM	17BP4A	14	36	No	Key	4	25.75	No	2	12	PJ
	1708	2217	C	No	17BP4A	12	22	Yes	Ord	4	26.1	No	2	12	No
	17HD31	1731	C	No	17BP4A	14	31	No	Key	4	25.75	No	2	12	No
	22D19, 2219	2219	C	No	19AP4A	17	22	Yes	Ord	4	26.1	No	2	12	No
Scott Radio Laboratories, Inc.	AC-16	710	C	No	16KP4	11.5	21	Yes	Ord	3	26.1	NT	2	10	No
4541 Ravenswood Ave.	AT-16	710	T	No	16KP4	11.5	21	Yes	Ord	3	26.1	NT	2	6	No
Chicago 40, Ill.	310TC	710 & 310	C	AM-FM	16KP4	11.5	33	Yes	Ord	3	26.1	NT	10	12	P
	510TC	710 & 510	C	AM-FM	16KP4	11.5	35	Yes	Ord	3	26.1	NT	18	12[4]	P
	710W	710	C	No	16KP4	11.5	26	Yes	Ord	3	26.1	NT	10	12[4]	PA
	800B-16	800B & 710	C	All	16KP4	11.5	45	Yes	Ord	3	26.1	NT	18	15[4]	RPRC
	800B-19	800B & 910	C	All	20DP4	11.5	45	Yes	Ord	3	26.1	NT	18	15[4]	RPRC
	910W	910	C	No	20DP4	11.5	26	Yes	Ord	3	26.1	NT	10	12[4]	PA
Sentinel Radio Corp.	420-TVB, 420-TVM	20E589	T	No	16TP4	12-13	21	Yes	Ord	3	25.5	TU	2.25	4x6	No
2100 Dempster	423-CVB, 423-CVM	20E644	C	No	16TP4[20]	12-13	21	Yes	Ord	3	25.5	TU	2.25	10	No
Evanston, Ill.	424-CVB, 424-CVM	20E644	C	No	16TP4[20]	12-13	21	Yes	Ord	3	25.5	TU	2.25	12	No
	425-CVB, 425-CVM	20E652	C	No	19AP4A	13	21	Yes	Ord	3	25.5	TU	2.25	12	No
	428-CVB, 428-CVM	20E667	C	No	19AP4A	13	21	Yes	Ord	3	25.5	TU	2.25	12	No
Setchell-Carlson, Inc.	2500	25	C	AM	17BP4A	14	24	Yes	Key	4	26.1	No	1.5	10	P3
New Brighton, Minn.	2500LP	25	C	AM	17BP4A	14	24	Yes	Key	4	26.1	No	1.5	10	No
Shevers, Inc., Harold	Barclay, Bryant, Chelsea, Classic,	031-A	C	No	16BP4A[35]	12	31	No	Key	4		No	3.2	12	No
123 W. 64 St.	Digby, Rector, Regency (all 031-A)														
New York, N. Y.	Visionaire (1261)[53]	126	T	No	12AP4A	10.5	26	Yes	Ord	4		NT	1.9	6	No
	Visionaire (1263)[53]	126	C	No	12LP4A	10.5	26	Yes	Ord	4		NT	1.9	10	No
	Visionaire (1265)[53]	12	C	No	12LP4A	10.5	26	Yes	Ord	4		NT	1.9	12	No
Sightmaster Television Corp.	16C51		C	FM[40]	16HP4	14	23	Note40	Ord	3	25.75	TU	3	8	RC[40]
111 Cedar St.	16E51		T	FM	17AP4	14	23	No	Ord	3	25.75	TU	3	8	RC[40]
New Rochelle, N. Y.	19C51		C	FM[40]	19DP4	14	23	Note40	Ord	3	25.75	TU	3	8	RC[40]
	20C51		C	FM[40]	20DP4	14	23	Note40	Ord	3	25.75	TU	3	8	RC[40]
S. M. A. Co.	CT-111-A	CTV221A	C	FM	16HP4[12]	10	21	No	No	3	25.75	TU	2	6x9	P3
4721 N. Kedzie Ave.	CT-120-A	CTV220A	C	FM	16XP4[1]	12	22	No	Ord	3	25.75	TU	2	6x9	P3
Chicago 35, Ill.	TV-116-A	CTV219A	C	FM	19AP4	11	22	No	No	3	25.75	TU	2	12	No
Snaider Television Corp.	Auditorium	P520	C	SW-FM	5TP4[31]	27	37	No	Ord	5	26.1	No	6.5	12	No
540 Bushwick Ave.	Champion	1230	T	SW-FM	12LP4	10	31	No	No	5	26.1	No	3.2	12	No
Brooklyn, N. Y.	Champion	1630	C	SW-FM	16RP4	10	31	No	No	5	26.1	No	3.2	12	No
	Champion	1930	C	SW-FM	19AP4	10	31	No	No	5	26.1	No	3.2	12	No
	Crusader	1221	T	No	12LP4	10	21	Yes	Ord	3	25.75	No	3.2	10	No
	Crusader	1621	C	No	16RP4	10	21	Yes	Ord	3	25.75	No	3.2	10	No
	Crusader	1921	C	No	19AP4	10	21	Yes	Ord	3	25.75	No	3.2	10	No
	Portojector	M-PJ-521	P	No	5TP4[31]	30	21								
Sonora Radio & Television Corp.	302		T	No	12LP4	9.5	19	Yes	Ord	3	26.1	NT	2	5	No
325 N. Hoyne Ave.	303		C	No	12LP4	9.5	19	Yes	Ord	3	26.1	NT	2	8	No
Chicago 12, Ill.	305		T	No	16TP4	12.5	20	Yes	Ord	3	26.1	NT	2	5	PJ
Sparton Radio-Television	5002, 5003	23TD10	T	No	10BP4	10	24	No	Ord	4	26.25	NT	2.5	4x6	No
2400 E. Ganson St.	5006, 5007	23TD10A	T	No	12LP4	10	24	No	Ord	4	26.25	NT	2.5	4x6	No
Jackson, Mich.	5006X, 5007X	25TK10A	T	No	12LP4A	10-12.5	26	No	Key	4	26.25	NT	2.5	5x7	No
	5010, 5011	19TS10	T	No	10BP4	8-9.5	21	Yes	Ord	3	26.25	NT	1.5	5	No
	5014, 5015	19TS10A	T	No	12LP4	8-9.5	21	Yes	Ord	3	26.25	NT	1.5	5x7	No
	5025, 5026	26SS160	T	No	16KP4[1]	12.5-14	26	Yes	Key	4	26.25	NT	2.5	5	No
	5025-B, 5026-B, 5101, 5102, 5103	26SS170	T	No	17KP4A	12.5-14	26	Yes	Key	4	26.25	NT	2.5	5	No
	5029, 5030	26SD160	T	No	16KP4[1]	12.5-14	26	Yes	Key	4	26.25	TU	2.5	5x7	No
	5035, 5036, 5037	26SS160L	T	No	16KP4[1]	12.5-14	26	Yes	Key	4	26.25	NT	2.5	5x7	No
	5052, 5053	24TR10	C	No	12LP4	9-10.5	27	No	Ord	4	26.25	No	2.5	10	No

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sparton Radio-Television (Contd.)	5056, 5057	19TW10A	C	No	12LP4	8-9.5	21	Yes	Ord	3	26.25	NT	1.5	10	No
	5064, 5065	23TB10	C	No	16AP4	10	27	No	Ord	4	26.25	No	2.5	10	No
	5068, 5069	24TV9C	C	No	12LP4	10	28	No	Ord	4	26.25	No	2.5	10	No
	5076, 5077	26SS160	C	No	16KP4[1]	12.5-14	26	Yes	Key	4	26.25	NT	2.5	10	No
	5076-BB, 5077-BB	26SS160B	C	No	16KP4[1]	12.5-14	26	Yes	Key	4	26.25	NT	2.5	10	No
	5079, 5080	26SD160	C	No	16KP4[1]	12.5-14	26	Yes	Key	4	26.25	TU	2.5	12	No
	5079-B, 5080-B	26SD170	C	No	17KP4A	12.5-14	26	Yes	Key	4	26.25	TU	2.5	12	No
	5082, 5083, 5182, 5183	26SD170	C	AM-FM	17KP4A	12.5-14	26	Yes	Key	4	26.25	TU	2.5	12	P
	5085, 5086	25RD190	C	No	19AP4A	13.25-15	27	Yes	Key	4	26.25	TU	2.5	12	No
	5088, 5089	26SD170	C	AM-FM	17KP4A	12.5-14	26	Yes	Key	4	26.25	TU	2.5	10	P
	5090	26SD170	C	No	17KP4A	12.5-14	26	Yes	Key	4	26.25	TU	2.5	10[9]	No
	5104, 5105	26SS170D	T	No	17KP4A	12.5-14	26	Yes	Key	4	26.25	NT	2.5	5	No
	5152, 5153, 5154	26SS170	C	No	17KP4A	12.5-14	26	Yes	Key	4	26.25	NT	2.5	10	No
	5155, 5156, 5157	26SD170	C	No	17KP4A	12.5-14	26	Yes	Key	4	26.25	TU	2.5	10	No
	5170, 5171	25SD201	C	No	20CP4A		27	Yes	Key	4	26.25	TU	2.5	10	No
Starrett Television Corp. 601 W. 26 St. New York 1, N. Y.	James Buchanan	17BM1	T	No	17BP4A	12.5	20	Yes	Ord	3	26.1	NT	2	5	PJ
	Peter Cooper	47BM1	C	AM	17BP4A	12.5	20	Yes	Ord	3	26.1	NT	2	8	P
	Patrick Henry	27BM1	C	No	17BP4A	12.5	20	Yes	Ord	3	26.1	NT	2	8	PJ
	Washington Irving	37BM1	C	No	17BP4A	12.5	20	Yes	Ord	3	26.1	NT	2	8	PJ
	James Madison	39AM1	C	No	19AP4	12.5	20	Yes	Ord	3	26.1	NT	2	8	PJ
	John Marshall	59AM1	C	AM	19″	12.5	20	Yes	Ord	3	26.1	NT	2	8	P
	Peter Stuyvesant	29AM1	C	No	19AP4	12.5	20	Yes	Ord	3	26.1	NT	2	8	PJ
	Eli Whitney	7BB1	C	No	17BP4A	12.5	20	Yes	Ord	3	26.1	NT	2	8	PJ
	Roger Williams	17BL1	T	No	17BP4A	12.5	20	Yes	Ord	3	26.1	NT	2	5	PJ
Stewart-Warner Electric 1826 Diversey Pkwy. Chicago 14, Ill.	9120-A	9120-A	T	No	16TP4[1]	13.5	26	Yes	Key	4		TU	2	6	No
	9120-B, -C, -D, -E, -F	Note 41	C	No	16TP4[1]	13.5	26	Yes	Key	4		TU	2	6x9	No
	9121-A	9121-A	C	AM-FM	16TP4[1]	13.5	31	Yes	Key	4		TU	2	6x9	P3
	9121-B	9121-B	C	AM-FM	16TP4[1]	13.5	31	Yes	Key	4		TU	2	12	P3
	9122-A	9122-A	C	AM-FM	19AP4	13.5	31	Yes	Key	4		TU	2	12	PJ
	9200-A	9200-A	T	No	14BP4[6]	13	19	Yes	Ord	3		No	1	6	No
Stolle Eng. and Mfg. Co. 3970 S. Grand Ave. Los Angeles, Calif.	Semco 22R51A	20,000	C	No	19AP4A	13	22	Yes	Ord	3		No	6	12	No
	Semco 2251R	10,000	T	No	16KP4	13	22	Yes	Ord	3		No	6	5	No
Stromberg-Carlson Co. 100 Carlson Rd. Rochester 3, N. Y.	Chinese Classic, 18th Century	119	C	AM-FM	19AP4	12-14	29	Yes	Key	4	26.2	NT	2.5	12	P
	Chippendale, Imperial, Provincial	17	C	No	17AP4	12-14	26	Yes	Key	4	26.2	NT	2.5	12	No
	Empire, Georgian	119	C	No	19AP4	12-14	29	Yes	Key	4	26.2	NT	2.5	12	No
	Kenwood	17	C	AM-FM	17AP4	12-14	26	Yes	Key	4	26.2	NT	2.5	12	P
	Mercury, Treasure Chest	17	T	No	17AP4	12-14	26	Yes	Key	4	26.2	NT	2.5	5½	No
	Stancliffe	24	C	AM-FM	24AP4	12-14	30	Yes	Key	4	26.2	NT	2.5	12	P
Sylvania Electric Products Inc. Colonial Radio & Television Div. Buffalo, N. Y.	090, 247	168	C	No	16LP4	13	24	Yes	Ord	4		TU	3	10	No
	128	108	C	AM-FM	12VP4	9.5	24	Yes	Ord	4		TU	3	12	P
	197, 245	227	C	No	12VP4A	9.5	23	Yes	Ord	4		TU	2	10	No
	246	139	T	No	12VP4A	9.5	24	Yes	Ord	4		TU	3	5¼	No
	1110X	329	T	No	16AP4	13	20	Yes	Ord	3		NT	2	5¼	No
	4120M	260	T	No	14CP4	13	21	Yes	Ord	4		TU	2	6½	P
	4130B, 4130M, 4130W	260	C	No	14CP4	13	21	Yes	Ord	4		TU	2	8	P
	5130B, 5130M, 5130W, 5140B, 5140M	290	C	No	19AP4A	13	21	Yes	Ord	4		TU	4	12	P
	5150M	274	C	AM-FM	19AP4A	13	21[48]	Yes	Ord	4		TU	4	12	P
	6110X, 6120B, 6120M, 6120W	261	T	No	16KP4	13	21	Yes	Ord	4		TU	2	6½	P
	6130B, 6130M, 6030W	261	C	No	16KP4	13	21	Yes	Ord	4		TU	2	10	P
	6140M, 6140W	271	C	No	16KP4	13	21	Yes	Ord	4		TU	4	12	P
	7110X	366	T	No	17BP4A	13	21	Yes	Ord	4		TU	2	6½	No
	7020B, 7020M, 7020W	366	T	No	17BP4A	13	21	Yes	Ord	4		TU	2	6½	P
	7130B, 7130M, 7130W	366	C	No	17BP4A	13	21	Yes	Ord	4		TU	2	10	P
	7140M, 7140W	356	C	No	17BP4A	13	21	Yes	Ord	4		TU	2	12	P
	7150M, 7160B	357	C	AM-FM	17BP4A	13	21	Yes	Ord	4		TU	4	12	P

Tech-Master Products Co. 443 Broadway New York, N. Y.	630C19, 630S19[49]	Note 41	K	No	Note 42	14	30	No	Key	4	25.75	No	2.5	12	No
	Blue-Ribbon (1223)	1223	K	No	10-12″	9	23	No	Key	4	25.75	No	2.5	5x7	No
	1630-1930	Note 41	WC	No	Note 42	14	30	No	Key	4	25.75	No	2.5	12	No
	1930D	1930D	WC	FM	Note 43	14	31	No	Key	4	25.75	No	2.5	12	PJ
	1930T	1930T	WC	No	Note 43	14	31	No	Key	4	25.75	No	2.5	12	PJ
	Universal (5016)[53]	5016	K	No	Note 44	9	17	Yes	Ord	3	27.75	No	2	4x6	No
Tele King Corp. 601 W. 26 St. New York, N. Y.	114	TVC	T	No	14BP4	14	19	Yes	Ord	3		TU	1.8		No
	117C, 117L	TVC	C	No	17BP4	14	19	Yes	Ord	3		TU	1.8	8	No
	117CA	TVC	C	AM	17BP4A	14	21	Yes	Ord	3		TU	1.8	8	P3
	162	TVC	T	No	16RP4A	14	19	Yes	Ord	3		TU	1.8	6	No
	201	TVC	T	No	20AP4A	14	19	Yes	Ord	3		TU	1.8		
	202C	TVC	C	No	20AP4A	14	19	Yes	Ord	3		TU	1.8		
	416CAF	TVC	C	AM-FM	16DP4A	14	27	Yes	Ord	3		TU	1.8	12	P3
	916C	TVC	C	No	16DP4A	14	19	Yes	Ord	3		TU	1.8	10	No
	916CAF	TVC	C	AM-FM	16DP4A	14	27	Yes	Ord	3		TU	1.8	10	P3
	919C	TVC	C	No	19DP4A	14	21	Yes	Ord	3		TU	1.8	10	
	919CAF	TVC	C	AM-FM	19DP4A	14	29	Yes	Ord	3		TU	1.8	10	P3
Telequip Radio Co. 2559 W. 21 St. Chicago 8, Ill.	CD514	14T	C	No	14BP4	11.5	19	Yes	Ord	3	24.0	NT	2	8	No
	CD516	16T	C	No	16KP4[1]	12.5	19	Yes	Ord	3	24.0	NT	2	8	No
	CD517	17T	C	No	17BP4	12.5	19	Yes	Ord	3	24.0	NT	2	8	No
	CD519, CD619	19T	C	No	19AP4A	12.5	19	Yes	Ord	3	24.0	NT	2	10	No
	TD414	14T	T	No	14BP4	11.5	19	Yes	Ord	3	24.0	NT	2	5	No
	TD416	16T	T	No	16KP4[1]	12.5	19	Yes	Ord	3	24.0	NT	2	5	No
	TD417	17T	T	No	17BP4	12.5	19	Yes	Ord	3	24.0	NT	2	5	No
Tele-Tone Radio Corp. 540 W. 58 St. New York 19, N. Y.	TV-310	TAO	C	AM-FM	16XP4[34]	11-12	27	Yes	Ord	3	37.3	NT	2.5	8	P3
	TV-314	TAJ	T	No	14DP4[6]	8	21	Yes	Ord	3	37.3	NT	2	5	No
	TV-316B	TAO	C	AM	16XP4[34]	11-12	26	Yes	Ord	3	37.3	NT	2.5	4x6	P3
	TV-318, -322, -323	TAM	T	No	14CP4	8	15	Yes	Ord	3	25.75	NT	1	4	No
	TV-324	TAP	T	No	16XP4[34]	11	15	Yes	Ord	3	25.75	NT	1	4x6	No
	TV-325, -326, -335	TAP	C	No	16XP4[34]	11	15	Yes	Ord	3	25.75	NT	1	10	No
	TV-325R, -326R	TAP	C	No	16XP4[34]	11	15	Yes	Ord	3	25.75	NT	1	10	RC
	TV-327	TAP	C	AM-FM	17AP4	11-12	23	Yes	Ord	3	25.75	NT	2	10	P3
	TV-328, -329	TAP	C	No	19DP4	11	15	Yes	Ord	3	25.75	NT	1	10	No
	TV-330	TAO	T	No	16XP4[34]	12	21	Yes	Ord	3	37.3	NT	2	4x6	No
	TV-331, -332, -333	TAO	C	No	16XP4[34]	12	21	Yes	Ord	3	37.3	NT	2	10	PJ
	TV-334	TAO	C	AM-FM	20DP4	11-12	27	Yes	Ord	3	37.3	NT	2.5	12	P3
	TV-336	TAP	T	No	17AP4	11	15	Yes	Ord	3	25.75	NT	1	4x6	No
Tele-Vogue, Inc. (Muntz TV) 1735 W. Belmont Ave. Chicago 13, Ill.	M31	TV17A2	T	No	16RP4A	12.5	17	Yes	Ord	3		NT	1.5	5	No
	M32	TV17A2	C	No	16RP4A	12.5	17	Yes	Ord	3		NT	1.5	10	No
	M33	TV17A4	C	No	19DP4A	12.5	17	Yes	Ord	3		NT	1.5	10	No
Trad Television Corp. 1001 First Ave. Asbury Park, N. J.	C1620, CFD1620	T-20	C	No	16KP4	11.5	21	No	Ord	3	25.75	NT	3	12	No
	C1920	T-20	C	No	19AP4	11.5	21	No	Ord	3	25.75	NT	3	12	No
	CD1630	TT-63-SH	C	No	16FP4	14	32	No	Key	4	25.75	No	3	10	No
	CD1930	TT-63-SH	C	No	19AP4		32	No	Key	4	25.75	No	3	10	No
	CFD1920	T-20	C	No	19AP4	11.5	21	No	Ord	3	25.75	No	3	12	No
	D250	TT-63-SH	T	No	19AP4	14	32	No	Key	4	25.75	No	3	8	RC
	KP1260	T-20	C	No	16KP4	11.5	21	No	Ord	3	25.75	NT	3	12	No
	KP1920	T-20	C	No	19AP4	11.5	21	No	Ord	3	25.75	NT	3	12	No
	P-13, P-14			No	5TP4[31]	35	35	No	No	4	25.75	No	4	5-12[9]	RC
Transvision Inc. 460 North Ave. New Rochelle, N. Y.	A		K	FM	Note 45	11	25	No	No	3	26.4	No	3	6x9	RC
	A-3 Standard		WC[46]	No	Note 47	13	25	No	Ord	4	26.25	TU	3	6x9	PRC
	A-3 Deluxe		WC[46]	FM	Note 47	13	25	No	Ord	4	26.25	TU	3	6x9	PRC
Trans-Vue Corp. 1139 S. Wabash Ave. Chicago 5, Ill.	Aristocrat (1600CD), Winfield (1600C)		C	No	17BP4A	12.5	22	Yes	Key	4		TU	3.5	8	No
	Phoenix (1600T)		T	No	17BP4A	12.5	22	Yes	Key	4		TU	3.5	5	No

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Trav-ler Radio Corp.	16G50	16G50	C	No	16GP4	12	24	Yes	Key	5	26.25	NT	2	6x9	No
571 W. Jackson Blvd.	16R50	16R50	C	No	16RP4	12	24	Yes	Key	5	26.25	NT	2	6x9	No
Chicago, Ill.	16R60	16R60	C	No	16RP4	12	24	Yes	Key	5	26.25	NT	2	6x9	No
	16R70	16R70	C	AM	16RP4	12	24	Yes	Key	5	26.25	NT	2	6x9	P3
	19A50	19A50	C	No	19AP4	12	24	Yes	Key	5	26.25	NT	2	6x9	No
	62R50	62R50	T	No	16RP4	12	20	Yes	Key	5	26.25	NT	2	6x9	No
	63R50	63R50	T	No	16RP4	12	20	Yes	Key	5	26.25	NT	2	4x6	No
	64R50	64R50	C	No	16RP4	12	21	Yes	Key	5	26.25	NT	2	6x9	No
	65G50	65G50	C	No	16GP4	12	21	Yes	Key	5	26.25	NT	2	6x9	No
United States Television Mfg. Corp.	C-16024		C	No	16DP4	11.5	24	No	No	4	25.75	No	4	12	PJ
3 W. 61 St.	C-16030P, C-19031P		C	No	16DP4	11.5	31	No	Key	4	25.75	No	4	12	PJ
New York, N. Y.	C-19032P		C	FM	19DP4	11.5	32	No	Key	4	25.75	No	4	12	PJ
	CFM-16031P		C	FM	16DP4	11.5	31	No	Key	4	25.75	No	4	12	No
	T-16030P		T	No	16DP4	11.5	30	No	Key	4	25.75	No	4	6	No
	T-19031P		T	No	19DP4	11.5	31	No	Key	4	25.75	No	4	6	PJ
Vidcraft Television Corp.	017	017	T	No	16RP4	12	17	Yes	Ord	3		No	2	4x6	No
780 E. 137 St.	017	017	C	No	16DP4A	12	17	Yes	Ord	3		No	2	10	No
Bronx, N. Y.	027	027	C	AM-FM	16DP4A	12	26	Yes	Ord	3		No	3	12	P
Video Corp. of America	601		T	No	16RP4	14	18	Yes	Ord	3		NT	2.5	8	No
229 W. 28 St.	611		C	No	16RP4	14	18	Yes	Ord	3		NT	2.5	10	No
New York 1, N. Y.	750		C	No	17AP4	14	18	Yes	Ord	3		NT	2.5	10	No
	912		C	No	19AP4	14	18	Yes	Ord	3		NT	2.5	10	No
	922		C	No	19AP4	14	18	Yes	Ord	3		NT	2.5	10	No
	2020		C	No	20DP4	14	18	Yes	Ord	3		NT	2.5	10	No
Video Products Corp. 2061 Broadway	Modern (M-5130), Traditional (R-5130, RL-5130, S-5130, SL-5130)	630-K3	C	No	19AP4	14	30	No	Key	4	26.25	No	3.5	12	PJ
New York, N. Y.	HD-5119, 3019-C	260-V	C	No	19AP4	14	30	No	Key	4	26.25	No	3.5	12	PJ
Westinghouse Electric Corp.	H624T16, H626T16	V-2172	T	No	16RP4	13	23	Yes	Key	3	45.75	TU	1.5	5	No
Sunbury, Penna.	H627K16, H628K16, H629K16	V-2171	C	No	16JP4A	13	23	Yes	Key	3	45.75	TU	1.5	10	No
	H630T14	V-2176	T	No	14BP4	13	23	Yes	Key	3	45.75	TU	1.5	5	No
	H633C17, H634C17		C	AM-FM	17AP4	13	27	Yes	Key	3	45.75	TU	2.8	12	No
Zenith Radio Corp.	H2226R, H2227E, H2227R	22H20	T	No	12UP4B	10	22	Yes	Key	4		NT	1.8	5¼	RC[40]
6001 W. Dickens Ave.	H2250R, H2255E	22H20	C	No	12UP4B	10	22	Yes	Key	4		NT	1.8	10	RC[40]
Chicago 39, Ill.	H2328E, H2328R, H2329R	23H22	T	No	17BP4	10	23	Yes	Key	4		NT	1.8	5¼	RC[40]
	H2352R, H2353E	23H22	C	No	17BP4	10	23	Yes	Key	4		NT	1.8	10	RC[40]
	H2437E, H2437R	24H20	C	No	16GP4B	12	24	Yes	Key	4		NT	1.8	10	RC[40]
	H2438R, H2439R, H2449E	24H20	C	No	16GP4B	12	24	Yes	Key	4		NT	1.8	12	RC[40]
	H2445R, H2447R	24H21	C	No	19AP4B	12	24	Yes	Key	4		NT	1.8	10	RC[40]
	H3267R, H3469E, H3475R	24H20, 8H20	C	AM-FM	16GP4B	12	34[50]	Yes	Key	4		NT	1.8	12	RC[40]
	H3477R, H3478E	24H21, 10H20	C	AM-FM	19AP4B	12	34	Yes	Key	4		NT	1.8	12	RC[40]
	H3168R	23H22, 8H20	C	AM-FM	17BP4	10	31	Yes	Key	4		NT	1.8	12	RC[40]

1 Also uses 16RP4
2 Uses 16CP4
3 Glass rectangular tube
4 Coaxial speaker
5 Also uses 17RP4, 16KP4, 16RP4, 16TP4
6 Also uses 14CP4
7 Special Farnsworth tube
8 12 watts from AM-FM radio
9 Dual speakers
10 3 x 4 foot projection picture
11 Also uses 12LP4 and 16HP4
12 Also uses 16AP4
13 Metal or glass
14 Watts output at 10% distortion
15 AM chassis type 120130B
16 AM-FM chassis type 120132B
17 Current sets of this make have chassis number beginning with 307-0-
18 5 watts AM radio
19 Also uses 16EP4, 16KP4, 17BP4
20 Also uses 16KP4
21 Also uses 16KP4, 17BP4, 20-inch rectangular
22 Also uses 16GP4, 17BP4, 20-inch rectangular
23 Type of AGC not specified
24 Also uses 16TP4
25 Also uses 16GP4
26 And 5-inch tweeter
27 And high-frequency horn
28 Round tubes
29 Called Silver Rocket
30 Chassis available separately
31 Projection tube
32 752CB and 7255CB have console-type base with 12-inch speaker
33 Also uses 12KP4
34 Also uses 16TP4 and 16RP4
35 Also uses 19AP4A
36 Also uses 16GP4 and 17BP4A
37 10 watts from AM-FM radio
38 Model 1601 does not have built-in antenna, model 1606 has 8-inch speaker.
39 Also uses 17BP4 and 19AP4
40 Optional
41 Chassis number same as model number
42 16- and 19-inch round and all rectangular tubes
43 19-inch round and all rectangular tubes
44 10- and 12-inch round and 14-inch rectangular tubes
45 10-, 12-, 16-, 17-, and 19-inch tubes
46 Also table and console models
47 16- and 19-inch round and 16- and 17-inch rectangular
48 Tubes on TV chassis
49 630D19 is assembled but unwired, 630S19 is unassembled
50 H3267R has 32 tubes
51 Also uses 20-inch rectangular tubes
52 Set has transformerless low-voltage supply operating on a.c. only
53 Set has transformerless low-voltage supply operating on a.c. or d.c.
54 Requires power amplifier and speaker which are not supplied.

C — Console or Consolette
CB — Console-type base
CC — Commercial Console
CO — Coin-operated, operates 30 minutes when 25¢ coin is inserted. Cabinet and coin box have separate locks.
NT — Built-in antenna not tunable
MR — Metal-cabinet remote unit
P — Phonograph, type not specified
PA — Separate power amplifier
PJ — Phono jack
PLD — Phono jack and local-distance switch
PLDT — Phono jack, local-distance switch, tone control
PRC — Phono jack and remote control
PS — Connections for phonograph and slave unit
PTRM — Phonograph, tape recorder, and microphone
P3 — 3-speed phono changer
P3LD — 3-speed changer and local-distance switch
P3RC — 3-speed changer and remote control
RC — Remote control
RPRC — Record player and remote control
T — Table model
TL — Transformerless low-voltage supply
TU — Tunable built-in antenna

Television DX Reports

WE admire the courage of some of our readers who live in areas not yet blessed by the presence of a television station and who must depend entirely on dx for their reception. Some of these write us about their installations and how they manage to get fairly consistent pickup over rather long distances.

One such letter comes from Maurice Dubreuil of Lavaltrie, Quebec, who not only has a fine antenna installation, but has also constructed some elaborate boosters.

"My receiver was built from a Philmore kit," writes Mr. Dubreuil. "It is an RCA 630TS model, realigned to pass only 2.5 mc. I have changed the 6AG5's for 6BC5's and am working all r.f. and i.f. tubes at about 20% more voltage than the original design calls for.

"Building the receiver was easy, but the boosters were a headache. I have tried all commercial boosters that I could get my hands on, but could only get a little sound once in a while, so I started fooling around with building some.

"My first booster was a tuned-plate 6AK5 working into a 6J4 followed by nine 6AK5's. It worked pretty well, but gave a lot of noise. The one I am using now has a 6J6 neutralized push-pull input feeding a pair of 6AK5's in push-pull. This works into a 6AK5 buffer which has no gain and then to two more 6J6 stages. Results with this booster are very good.

"For antennas I use two double-stacked Yagis cut for channel 4 and channel 5 (my boosters are good only on these channels), and a Vee-DX RD13A for all other channels. The antennas are on a tower 80 feet high, and I intend to put up a 150-foot tower soon. With this equipment I get daily reception from WRGB, channel 4, in Schenectady and WSYR-TV, channel 5, in Syracuse, both more than 260 miles distant."

Mr. Dubreuil also reports that he picked up WMBR-TV in Jacksonville and WTVJ in Miami, Florida, quite regularly during warm nights in July and August. The distance to these stations is about 1,200 and 1,500 miles. He has also received KOB-TV, channel 4, in Albuquerque, New Mexico which, according to our atlas, is over 1,850 miles.

Other channel 4 stations that Mr. Dubreuil has picked up during the summer are WLW-T in Cincinnati, Ohio; WTAR-TV, Richmond, Virginia; and WMCT, Memphis, Tennessee. Channel 5 stations are WOC-TV, Davenport, Iowa; KSTP-TV, St. Paul, Minnesota; KSD-TV, St. Louis; WSAZ-TV, Huntington, West Virginia; and WAGA-TV, Atlanta, Georgia.

While this installation is perhaps a little more elaborate than most dx'ers would care to use, it does show that dx can be had fairly consistently with good equipment. We thank Mr. Dubreuil for sending us the details of his TV receiving setup, and also thank all the the others who have sent us the dx reports which are listed in the two tables below.

Occasionally we get reports of dx from Europe where television is now becoming more common. One report is of an Italian in Turin who received the British station at Sutton Coldfield, a distance of 1,300 kilometers. Now that a common set of European standards is being accepted by many countries, we should be getting more reports of dx from abroad.

TABLE I—REPORT OF RECEPTION

STATION	REPORTED BY	TIME RECEIVED	MILEAGE
KMTV Channel 3 Omaha, Neb.	W. L. Thompson	10/27, 1:55 pm	1,200
KNBH Channel 4 Los Angeles, Cal.	C. G. Hailey	6/24	1,260
KPHO-TV Channel 5 Phoenix, Ariz.	E. Gustafson	6/21, 5 pm	1,250
WBTV Channel 3 Charlotte, N. C.	L. A. Canning	7/20	1,150
WBZ-TV Channel 4 Boston, Mass.	R. J. Walker E. Gustafson F. C. Meyers	6/11 6/30, 6 pm 7/16	1,100 1,050 1,300
WCBS-TV Channel 2 New York, N. Y.	F. C. Meyers H. L. Robins	7/16, 2 pm 10/15	1,160 1,010
WJAR-TV Channel 11 Providence, R. I.	L. A. Canning	10/30	450
WLAV-TV Channel 7 Grand Rapids, Mich.	E. Gustafson	10/21, 7-8:30 pm	475

STATION	REPORTED BY	TIME RECEIVED	MILEAGE
WLW-T Channel 4 Cincinnati, Ohio	L. A. Canning	8/12/49	1,025
WMAR-TV Channel 2 Baltimore, Md.	F. C. Meyers	7/16	1,050
WMCT Channel 4 Memphis, Tenn.	C. T. Tripp	7/20, evening	1,000
WNBT Channel 4 New York, N. Y.	F. C. Meyers	7/21	1,160
WNBW Channel 4 Washington, D. C.	F. C. Meyers	7/21	1,050
WOAI-TV Channel 4 San Antonio, Tex.	R. J. Walker	6/11	1,100
WPTZ Channel 3 Philadelphia, Pa.	F. C. Meyers	7/22	1,110

STATION	REPORTED BY	TIME RECEIVED	MILEAGE
WRGB Channel 4 Schenectady, N. Y.	F. C. Meyers	7/16	1,160
WSPD-TV Channel 13 Toledo, Ohio	E. Gustafson	10/21, 7-8:30 pm	475
WTAR-TV Channel 4 Norfolk, Va.	F. C. Meyers	7/6, 6 pm	1,100
WTCN-TV Channel 4 Minneapolis, Minn.	R. J. Walker	6/11	1,500
WTMJ-TV Channel 3 Milwaukee, Wis.	L. A. Canning	8/5	1,200
WTTG Channel 5 Washington, D. C.	F. C. Meyers	7/31, noon	1,010
WTVJ Channel 4 Miami, Fla.	C. T. Tripp	7/21, 6:45 pm	1,440
WXEL Channel 9 Cleveland, Ohio	E. Gustafson	10/22	600

TABLE II—RECEIVER DATA

NAME	LOCATION	RECEIVER	BOOSTER	ANTENNA
L. A. Canning	Halifax, N. S.	Marconi Northern Electric	National	2-bay conical
		Cossor	Masco	conical
E. Gustafson	Keokuk, Ia.	Motorola 12VF4	Regency	stacked Yagi ch. 5 Yagi
C. G. Hailey	Robstown, Tex.	Motorola 9VT1	Jerrold Anchor	conical

NAME	LOCATION	RECEIVER	BOOSTER	ANTENNA
W. L. Thompson	Saugus, Cal.	Radio Craftsman	Electro-Voice	rhombic with 2,500 ft open line
F. C. Meyers	Belleville, Kan.	Admiral 32X15	Anchor	4-bay array
H. L. Robins	Tampa, Fla.	Skyrider 513	Astatic	stacked array
C. T. Tripp	Dannemora, N. Y.	DeWald	Anchor	ch. 4 Yagi
R. J. Walker	Daytona, Fla.	Du Mont	Astatic	5-element beam

How an Electric Brain Works

Part IV—Long division with relays—our little electric brain learns how to divide and to convert decimal numbers to binary and back again. Simon is getting an education

By EDMUND C. BERKELEY* and ROBERT A. JENSEN

PREVIOUS articles of this series have shown how an electric brain made of relays can add, subtract, and multiply.

Now we shall carry out division. As before, we shall consider the process in *binary notation*, the scale of two.

As a second topic, we shall consider how to make a relay calculator convert a number from decimal notation to binary notation, and back again. There is every reason in the world why the machine itself should convert any decimal number, say 23, into the corresponding binary number (in this case 10111, one-oh-one-one-one, or one 16 plus no 8's plus one 4 plus one 2 plus one 1).

Addition, subtraction, and multiplication turned out to be very simple in binary notation as compared with decimal. The same is true with division: binary division is simple as can be.

Suppose we divide 1101 (one-one-oh-one, or 8 plus 4 plus 1, or 13 in decimal) into 10000101 (one-oh-oh-oh-oh-one-oh-one, or 128 plus 4 plus 1, or 133.

We do this in the same general way as we do in decimal division, except that we act as if we knew only the two digits 1 and 0:

```
                 01010    (Quotient)
(Divisor)  1101)10000101  (Dividend)
                0000
                10000 (1st Partial
                 1101     Remainder)
                 0111 (2nd Partial
                 0000     Remainder)
                  1110 (3rd Partial
                  1101    Remainder)
                   0011 (4th Partial
                   0000   Remainder)
                    011 (Remainder)
```

Only two multiples of the divisor are used, one times the divisor, and zero times the divisor—and the latter is of course zero in every digit. No other multiples of the divisor are needed. If we simply compare the divisor with the partial remainder at any point in the division, we can tell whether the digit of the quotient is 1 or 0.

Circuits for division

As before, to keep the circuits simple, let us ignore a number of fine points, such as: fractions; the *binal* point (the analogue in the scale of two of the decimal point in the scale of ten); positive and negative numbers; size of numbers; etc. Suppose that we have an eight binary digit dividend, and a four binary digit divisor.

The circuit is on the opposite page. In part 1, terminal T1 is energized at the start, and holds up the relays storing the dividend through their hold contacts. (All current-carrying circuits and relay contacts in the energized state are in red.) The actual number which these relays store, of course, depends on something that happened before the time at which we begin. In the same way, the divisor is stored in relays of part 2 of the circuit, and terminal T2 holds them up.

Now different things have to happen at different stages during the division. So we want to have some relays that will tell us at what stage we are during the process of the division. This is the function of the K relays of part 3 of the circuit. The stages that they detect and report are 0,1,2,3,4. The time chart in Fig. 1 shows that stage 0 lasts from time 1 to time 8, stage 1 from times 9 to 16, stage 2 from times 17 to 24, etc. At stage 0, we attend to the first quotient digit; at stage 1, we attend to the second quotient digit; etc. The red parts of the circuit apply to the first stage of the division only.

We have to start off the divisions by selecting some digits, which we can call a *partial remainder* (see part 4). At stage 0, this is the first four digits of the dividend; but at later stages this is the result of a subtraction together with "bringing down" one more digit of the dividend. The circuit of part 4 shows that at each stage of the division, we have just the partial remainder that we desire stored in the E relays. We have to look ahead to part 8, of course, and take on faith that the G relay contacts in part 4 will express the result of a subtraction that we want.

The next thing that we must do is decide whether the divisor "goes" into the partial remainder, or whether it "doesn't go". To make this decision, we must compare two numbers and decide which is the larger. The divisor "goes" and yields 1 as a digit of the quotient if, and only if, the partial remainder is larger. A circuit that does exactly this is shown in part 5. The red contacts show the original partial remainder (stored in the E relays) and the divisor (A relays). We see that there is no path for the quotient relay Q to be energized, and so the first "quotient digit" is 0.

Before we go any further, we want to store that quotient digit, so that we shall know the whole quotient when we get through with the division. This duty is performed by the circuit of part 6, which shows how the digit quotient is routed, according to the time it is obtained, into the right C relay.

We now want to determine the multiple of the divisor that depends on the quotient digit and the divisor. This is the function of part 7 of the circuit, which will give us the divisor itself if the quotient digit is one and zero in all digits if the quotient digit is zero.

In part 8 of the dividing circuit, the subtraction of the divisor multiple from the partial remainder is indicated schematically, because actual circuits for subtraction were discussed previously.

The timing of the circuits, up to the end of the first two quotient digits, is shown in the timing chart of Fig. 1. The same conventions are used here as in the time chart for multiplication in the previous article. Successive time

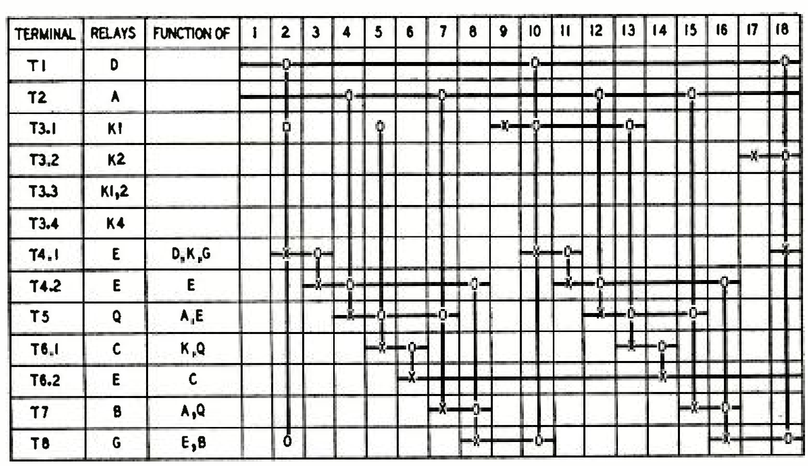
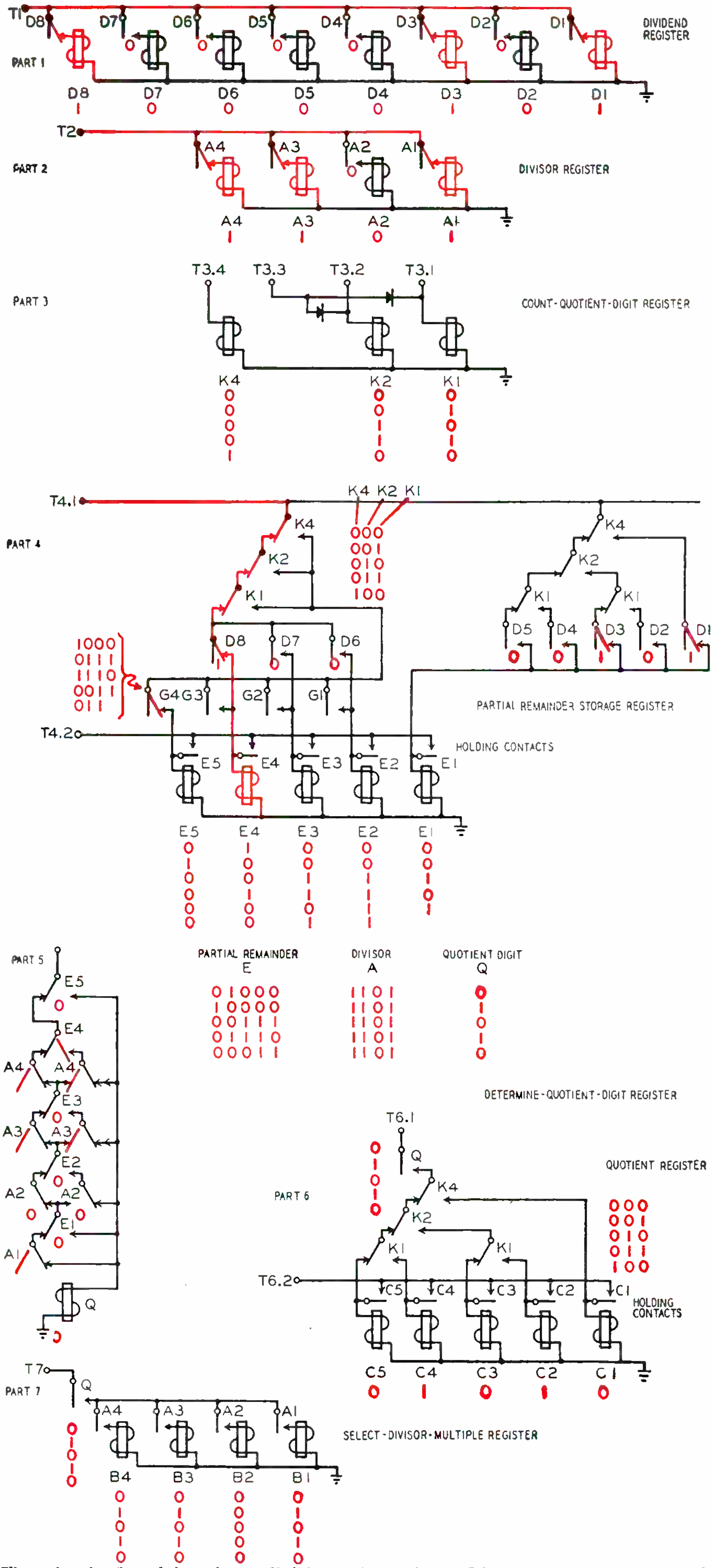


Fig. 1—Timing chart which shows the sequence of operation for the first two stages of the division with binary numbers performed by the circuit of Fig. 1.

*Author: *Giant Brains*



The circuit for doing long division with relays. Binary numbers are used for the process, and the circuits that carry current are shown in red.

intervals 1,2,3,4, are shown from left to right. In the first column, the different terminals are shown from top to bottom; in the second column, the names of the relays which the terminals energize; in the third column the names of the relay contacts through which the relays are energized. Each horizontal line begins when its terminal is energized, and stops when its terminal ceases to be energized. There are some vertical lines showing X's and O's. X marks the relays energized at a certain time, and the O's mark the contacts through which they are energized.

Now, you may say, it is all very well to be able to add, subtract, multiply and divide in binary notation, but how do we go from decimals to binaries?

In fact, even before we ask this question, we have to ask: how will the machine take in a decimal number? In other words, how will the machine accept it, record it, and store it?

Ordinarily a calculating machine (or some auxiliary part of it) will have a keyboard, containing keys numbered 0,1,2 up to 9. Often the keyboard will have a different column for each column of the number to be inserted in the machine. To put in a number like 593, we press down the 5 key in one column, the 9 key in the next column, and the 3 key in the third column.

In many calculating machines, the result of pressing down a key, say 3, is to turn some little counter wheel $^{3}/_{10}$ of one complete turn. But in our machine we want the result of pressing down the 3 key to be the energizing of certain relays, so that we can use the information later in the machine.

We would reasonably desire to convert any one of these ten decimal digits 0 to 9 into a pure binary number according to Table I.

Fig 2 is a circuit which will do this (using 15 rectifiers and 4 relays).

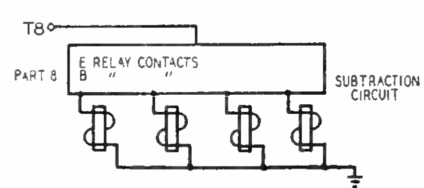
For example, if we press the 3 key, relays A2 and A1 are energized, but not relays A8 and A4, and so the information produced in the relay register is 0011, which is the binary number three.

In this way the decimal number 593 can be converted into 0101 1001 0011 stored in 12 relays. This form of representing a decimal number by a "code" for each digit is *coded decimal* notation.

Now how do we go from 0101 1001 0011 to what this number is in pure binary notation? 593 of course is 5 times 10 times 10, plus 9 times 10, plus

Table I—Decimal to Binary Conversion

Decimal	Binary	Decimal	Binary
0	0	5	101
1	1	6	110
2	10	7	111
3	11	8	1000
4	100	9	1001



3, and all we have to do is write this in binary and tell our machine do it:

0101 times 1010 times 1010 plus
1001 times 1010, plus
0011.

And this our machine can do because it has an addition circuit and a multiplication circuit.

It will be neater to program this operation with:

5 times 10, plus 9,
all times 10, plus 3.

Thus for a ten-digit decimal number, we shall only need nine multiplications.

Binary to decimal

Now suppose that we have the opposite problem. Given a binary number, we want to find the corresponding decimal number. We divide this number by 1010 (one-oh-one-oh, or 8 plus 2, or 10 in binary) and find the remainder, which will be less than 10, and store it. Then we take the quotient. and divide that by 1010, and store the new remainder. And so on.

For example, suppose we desire to convert the binary number 10000101 into a decimal number.

```
             1101
1010 ) 10000101
       1010
        1101
        1010
          1101
          1010
            11, which is 3 in decimal,
```

and becomes our first decimal digit.

```
          1
1010 ) 1101
       1010
         11, which is 3 in decimal, and
```

is our second decimal digit

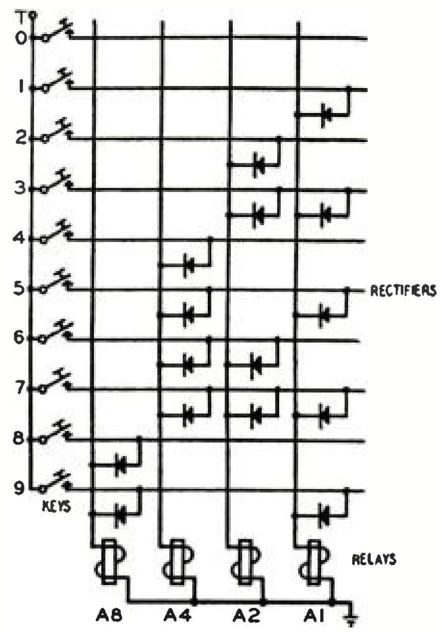


Fig. 2—Circuit for converting a decimal digit to a 4-digit binary number.

```
     0
1010 ) 1,
```

our dividend being also our remainder, and becoming the first decimal digit.

Our relay electric brain has division circuits and registers where we can store remainders; and so we can convert from binary into decimal. In this case we obtain the coded decimal form 0001 0011 0011 which is the same as 133.

How do we get this out of the machine? For example, suppose we have ten typewriter keys, bearing the characters 0,1,2,3,4,5,6,7,8,9. We wish to impulse these keys in order. The circuit in Fig. 3 will do this. When terminal T is energized, the appropriate K relay is energized, depending on the state of the A relays which hold the corresponding binary number.

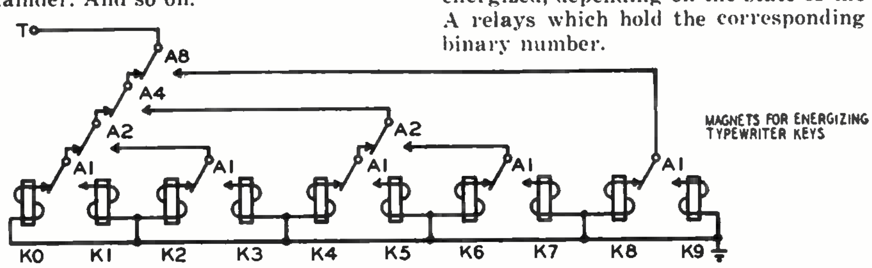


Fig. 3—Circuit for converting 4-digit binary system digits to decimal digits.

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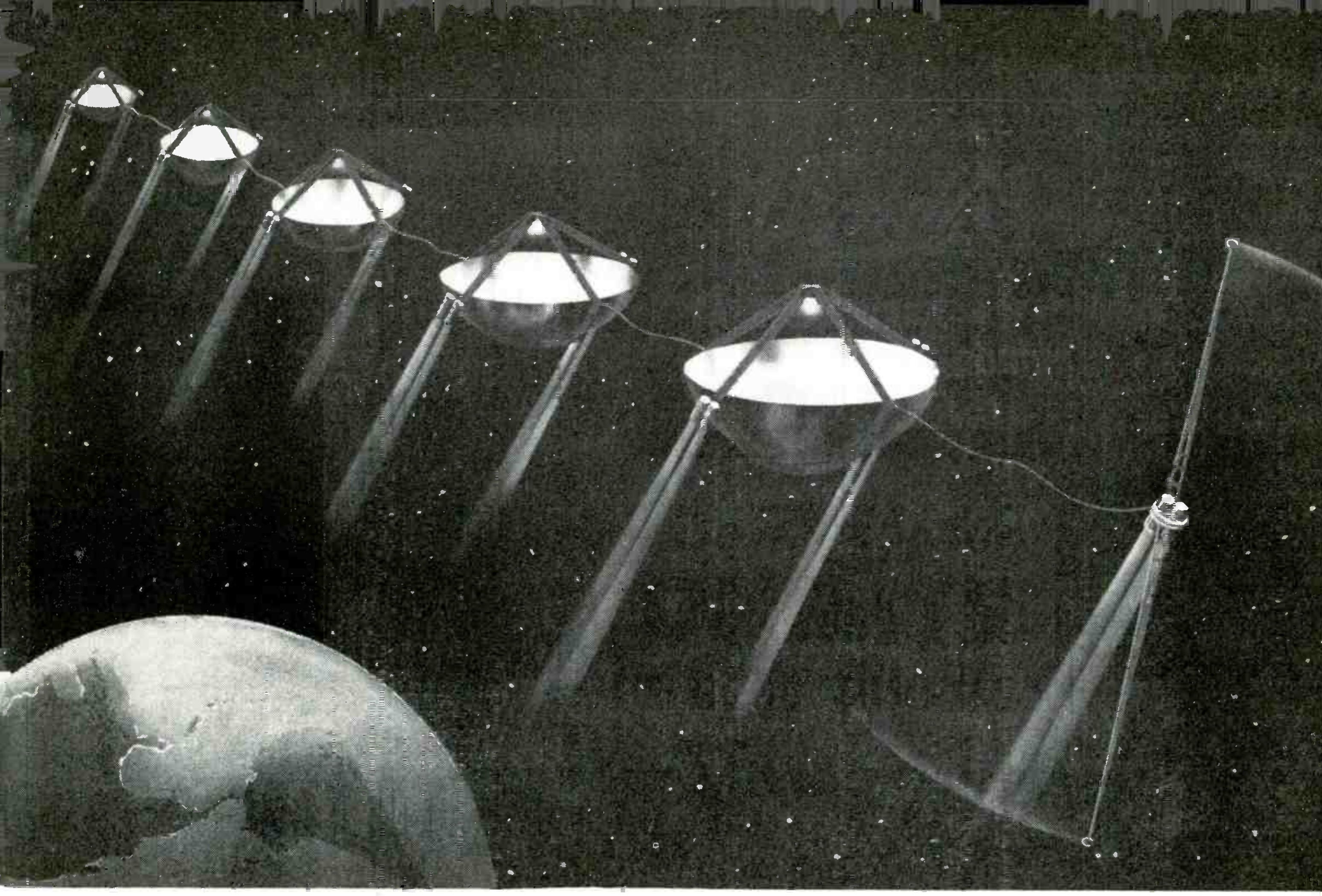


The author's concept of a string of the electric spaceships on a flight through outer space. Because there is no gravity, the saucer-like ships can be made extremely light by earthly standards, although they cannot land on a planet.

ELECTRIC SPACE SHIPS

Part II—Using the sun's energy

By PROFESSOR HERMANN OBERTH

IN this second article of this series we shall discuss the details of a spaceship and its power plant—the energy source being the sun's rays. A large mirror concentrates solar heat on a specially constructed boiler. The vapor produced by the boiler drives a turbine, and the turbine in turn drives a special electric generator which provides both the propelling force and control for the ship.

The parabolic mirror 1 (see Fig. 1) reflects the sunlight on the boiler 2 which drives the dynamo. (Whether this should be a dynamo or an influence machine of the Wommelsdorf type depends on the behavior of the electrodes in outer space, a factor which cannot yet be predicted. My present feeling is that the Wommelsdorf machine is most suitable.)

The side of the boiler toward the mirror has a dark surface, while the side away from the mirror has a reflecting surface to reduce heat loss. The elements marked 3 are supporting rods. Like the mirror, these can be very lightly built (by earthly standards) because of the extraordinarily slight acceleration.

An exhaust pipe 4 leads the vapor in a spiral to the shady side of the mirror where the vapor condenses. Another pipe leads the condensed vapor back to the boiler. (I purposely avoid using the terms water and steam because other liquids are better suited for this machine.)

The two electrode couples are marked 5. and are of the type described in the first article. These can be rotated about axis 6. Since the mirror itself can be rotated about its own axis and the direction of this axis is that of the sun's rays, the recoil can be made to work in any direction in space. With the couples in the position shown, acceleration takes place in the direction of the arrow.

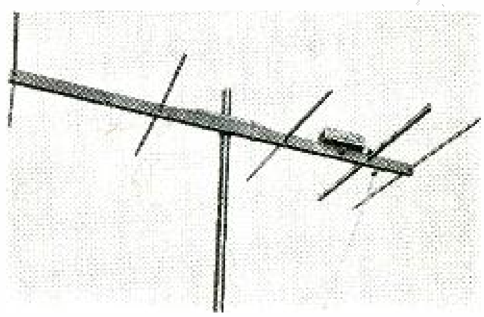
The slight acceleration which the recoil imparts to the apparatus is not enough to separate the vapor and the liquid from each other, and even this slight acceleration is available only after the boiler begins to function. Furthermore, the liquid can collect on the side facing the mirror only when the acceleration is toward the sun; otherwise the empty wall would be heated.

A rotating boiler

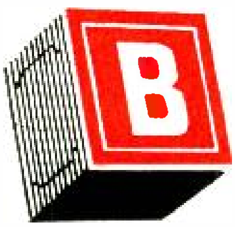
We can overcome this difficulty as well as gain other constructional advantages by allowing the entire cylindrical boiler to rotate about its own axis. Fig. 2 is a sketch of the boiler. Here 1 is the boiler and 2 is the working liquid which, because of the rapid

PERFECT *Fringe Area* RECEPTION

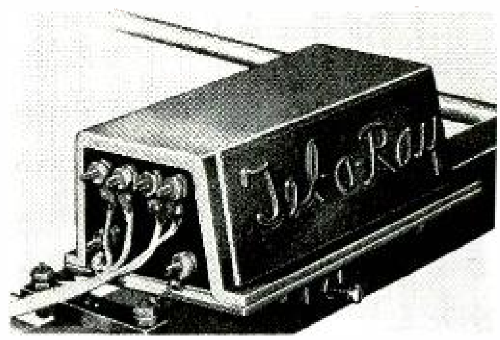
IS AS SIMPLE AS



You can have nearly perfect TV reception — strong, "snow"-free images — regardless of how faint an image you now receive — with the complete Tel-a-Ray System for fringe areas! It's simple and economical.



The first step in the Tel-a-Ray System is the Tel-a-Ray "T" antenna, which consistently receives images from stations 200 miles away.



To your Model T antenna, mount the new, powerful Tel-a-Ray Pre-Amplifier. This amazing new product of the Tel-a-Ray Research Department eliminates, or greatly reduces, "snow." Because it mounts right to the antenna, it has a high signal-to-noise ratio, bringing you stronger, clearer pictures with less noise. It furnishes consistent reception beyond the fringes and eliminates matching problems and line loss. It is completely weather-resistant, like all Tel-a-Ray products, and sells at a much lower price than other antenna-mounted amplifiers or boosters.

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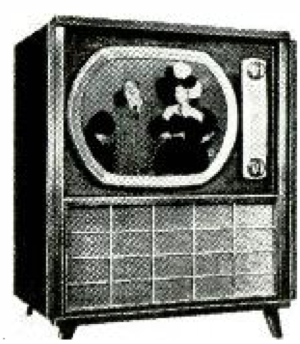

The final step that brings you almost perfect TV reception is your TV receiver. This simple parlay, A-B-C, is your guarantee of hours of television pleasure, unmarred by foggy images and irritating noise.

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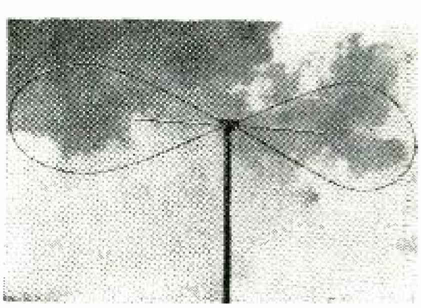


The Tel-a-Ray Butterfly receives 13 channels and FM radio. Guaranteed to be weather-resistant, it will consistently provide the best reception possible. And the price is just $2.95 (suggested list).

Televiewers throughout the country have come to associate the name Tel-a-Ray with good reception through quality products. If you have a particular reception problem, Tel-a-Ray engineers will be glad to help you.

Tel-a-Ray
ENTERPRISES, INC.
P.O. Box 332A HENDERSON, KY.

rotation, collects on the boiler walls. The vapor collects in the middle of the boiler and flows to the turbine 3, which I have taken to be a two-stage machine. The guide vanes of the turbine are rigidly connected to the boiler wall.

The vapor then enters pipe 4 which leads it to the shadow of the mirror, where it is condensed, and the liquid returns through pipe 5. From 5 the liquid enters funnel 6 which is rigidly attached to the boiler and rotates with it. Centrifugal force then drives the liquid out of 6 and into the boiler 17 which is permeable to both heat and light, and the rest of 16 is made of reflecting sheet metal. The outside of the boiler is black. The space between 1 and 16 or 17 is, of course, filled with vapor at the temperature of the boiler and at the same pressure as the exhaust vapor at 4.

Completely sealed

No rotating parts of the machine pierce the outer wall at 4, 5, 16, or 17. The machine can therefore be effectively sealed off against losses of the

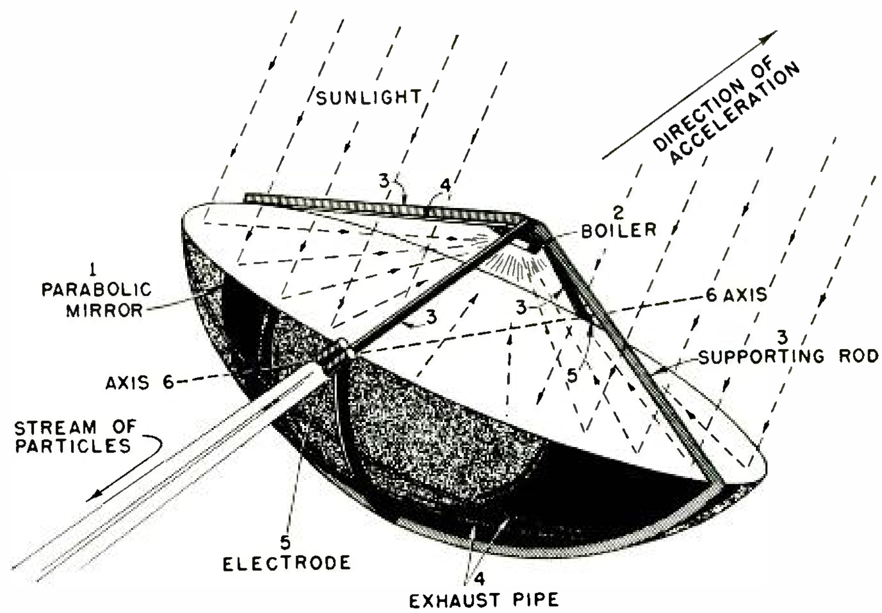


Fig. 1—Drawing showing the essential parts of the solar-powered spaceship.

through the tubes marked 7. Valves to prevent backflow of the liquid are marked 8.

The rotating vanes 10 of the turbine are mounted on shaft 9 which rotates within the boiler but in the opposite direction. The rotor runs at a hypercritical velocity and therefore acts as its own counterbalance.

The source of current, here taken to be a Wommelsdorf machine (an improved influence machine invented in 1922), is indicated by 13, and 12 is a special coupling unit. The space within this machine is at the same pressure as the boiler for better efficiency and simpler construction.

The construction of the machine would be greatly simplified if the vapor within the boiler could flow freely in and out through 11, but this is not possible if water is used as the working fluid. The stator of the current generator 13 rotates in the same direction as the boiler, while the rotor turns with shaft 9. Slip rings are marked 14 and 14′, while 15 and 15′ are current collectors. The potential difference between these will be in the order of several thousand volts, but it is possible to insulate the rings very effectively in gravitationless space.

In Fig. 2 we also have 16, a casing which contains the whole machine. On the side toward the mirror is a window working liquid—a most necessary measure.

In this machine three rotations are possible with respect to shaft 9:

a. Rotation of the shaft and of the rotors;

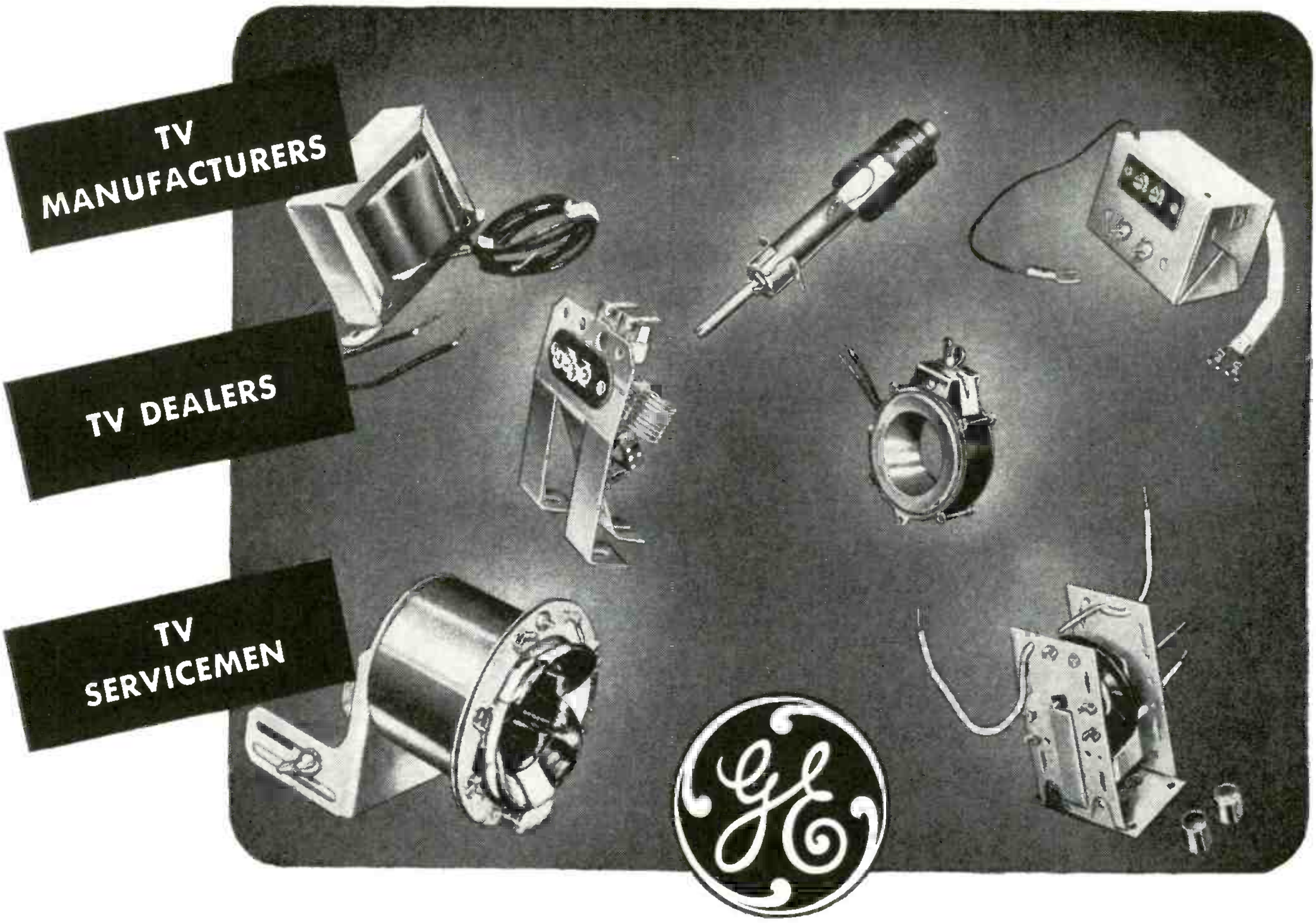
b. Rotation of the boiler together with the stators;

c. Finally, the casing 16 together with all the other equipment, rods, mirror, electrodes, etc., can be brought to rotate about the boiler shaft.

In fact, because of the friction in bearings 18 and 19, the boiler must eventually impart its rotation to the rest of the device, while the turbine rotors 3 and the rotors of the current generator 13 absorb the opposite momentum.

I have therefore provided for another influence machine 20, whose stator is rigidly connected with the outer casing 16 while its rotor is similarly fastened to the shaft of the boiler. Depending on which direction the current flows through this machine, it will exert a turning moment on 16. Thus it is backed up, so to speak, on the boiler and accordingly turns the rest of the machine in the right position.

It would be advantageous to connect several such mirror engines with cables which, because of the small current, can be quite thin. The artist's drawing shows a string of such engines. In the



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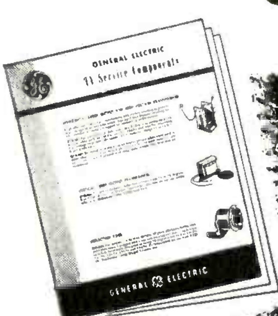

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CITY ____________________ STATE __________ foreground, to the right is the shelter or cabin for the space travelers. Ordinarily they occupy two chambers, connected by a long cable, which rotate about the common center of gravity. In this way the illusion of weight arises. Near the center of gravity is a pair of electrodes which draws its power from the mirror engines through the common cable. One can also imagine a switch point placed between the two electrodes to connect the influence machines either in parallel or in series.

Power and efficiency

We must now say something about the propulsive power and the efficiency of the electric spaceship.

The machines naturally perform better the stronger the sunlight. For example, in the vicinity of Venus they could accomplish twice as much as in the neighborhood of the earth. But of course the exact value of the solar constant outside the earth's atmosphere is unknown. Since the appropriate measurements are not available, I would guess it to be about 2.2 gram-calories per square centimeter per minute, and for our purpose this is close enough. Converted into the corresponding values for square meters and meter-kilograms per second, the radiation falling on each square meter is 156 mkg/sec. We can assume that the boiler can use about 30% of this energy, which might appear to be quite high, but we are justified in assuming a high operating efficiency here. The influence machine would, in turn, convert about 95% of this into electrical energy, which, expressed in m-g/sec per square meter of the mirror surface, comes to

$$44.5 \text{ m-g/secm}^2.$$

We can assume that without the fuel the apparatus weighs 400 grams per m^2. This appears to be very small, but because of the slight requirements which they must meet from a statics point of view, these machines do not need to be heavier. Naturally one can take as much propellant for such a machine as is desired.

The first problem which could be solved—which, incidently could be solved with liquid propellants only at great, unnecessary expense—would be the construction of a station circulating about the earth at a distance of 42,100 km (about 25,300 miles) above the center of the earth or 35,700 km (about 21,420 miles) above its surface at a velocity of 1,723 m/sec (3,850 miles an hour). Such a station would always hover above the same point on the equator if its orbit were in the equatorial plane. Otherwise it would describe a figure eight, as seen from the earth, which would bring it over the same point of the equator twice a day.

Such a station would be extremely valuable for television as well as for many other, particularly military, uses.

The next problem for the electric spaceship would be a flight around the moon.

The electric spaceship could also carry out interplanetary flights, and indeed, this could be done in several

months, whereas it has been estimated that such voyages would have to be reckoned in terms of years if liquid propellants alone were used (cf. Hohmann: *Die Erreichbarkeit der Himmelskorper.* [The Attainability of the Celestial Bodies]).

In any case this spaceship could not land on one of the larger celestial bodies—it is far too weakly constructed for that. For this purpose it would have to carry a space boat which would be powered with atomic energy or with liquid propellant, while the spaceship itself circled about the celestial body like an observer's station without further expenditure of fuel.

Besides these two possibilities—powering the space boat with fuel or with atomic energy—there is a third, at least for visiting celestial bodies which have no atmosphere, like the moon.

Corpuscular radiations contain very little matter. At high potentials they have only a very slight impact force, but they do have a high energy content. We can also assume that, given high enough velocities, the particles would travel a great distance in parallel paths.

Equally charged mass-particles repel each other, but currents traveling in the same direction attract each other. Moving charged particles are electric currents. If we can impart a high enough velocity to streams of particles, it is reasonable to assume that the particles would no longer tend to fly apart. Of course this will have to be tested first on a station in cosmic space, for I would not care to extrapolate blindly the results obtained from Geissler tubes and cyclotron streams to the corpusclar streams from an electric spaceship. I assume that this would certainly succeed with electron streams, but whether it would work with positive rays is something I do not care to affirm.

The spaceboat could receive in a Faraday cage the corpuscles streaming toward it and with this help generate an electric wind whose reaction is sufficient for landing on Mercury, the moon, or Ceres. Since it is also much lighter than the spaceship and does not have to carry the latter's machinery with it, its acceleration can be much greater and its construction heavier and more compact.

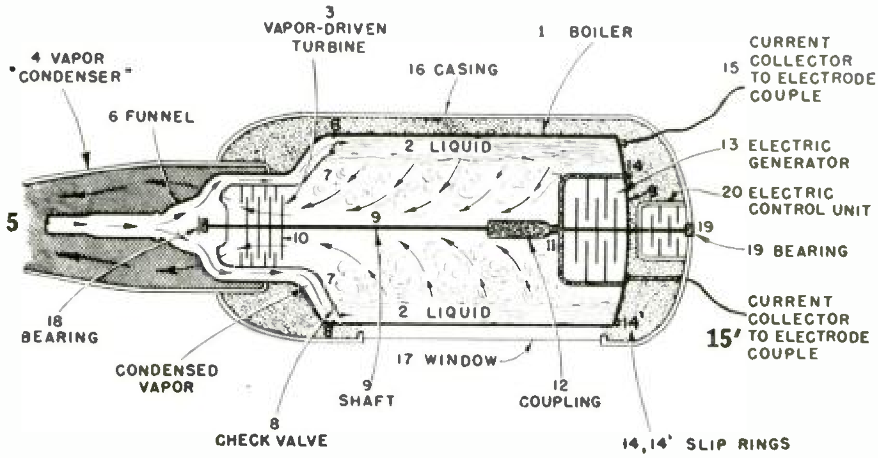


Fig. 2—A simplified cross-section of the vapor driven power plant proposed for the spaceship. The entire unit can be sealed against losses of the vapor.

Mathematical Analysis

From our estimated solar constant we might expect a kinetic energy of 8.8 to 14.6 mkg sec m^2. If we wish to give the propellant a velocity of 10 km/sec, then 1 gram of the latter contains kinetic energy equal to 5,100 m/kg. It therefore follows that at a distance of 150 million kilometers from the sun, energy can be radiated at a rate of 8.8 : 5100 = 1.7 mgr sec to 14.6 : 5,100 = 3 mgr/sec per second per square meter of the mirror surface.

If the electric spaceship carries 2 kg (1kg = 2.2 lbs.) of matter per square meter of mirror surface, this would suffice for a period of acceleration of from 670,000 sec. or 8 days to 1,170,000 sec. or 14 days.

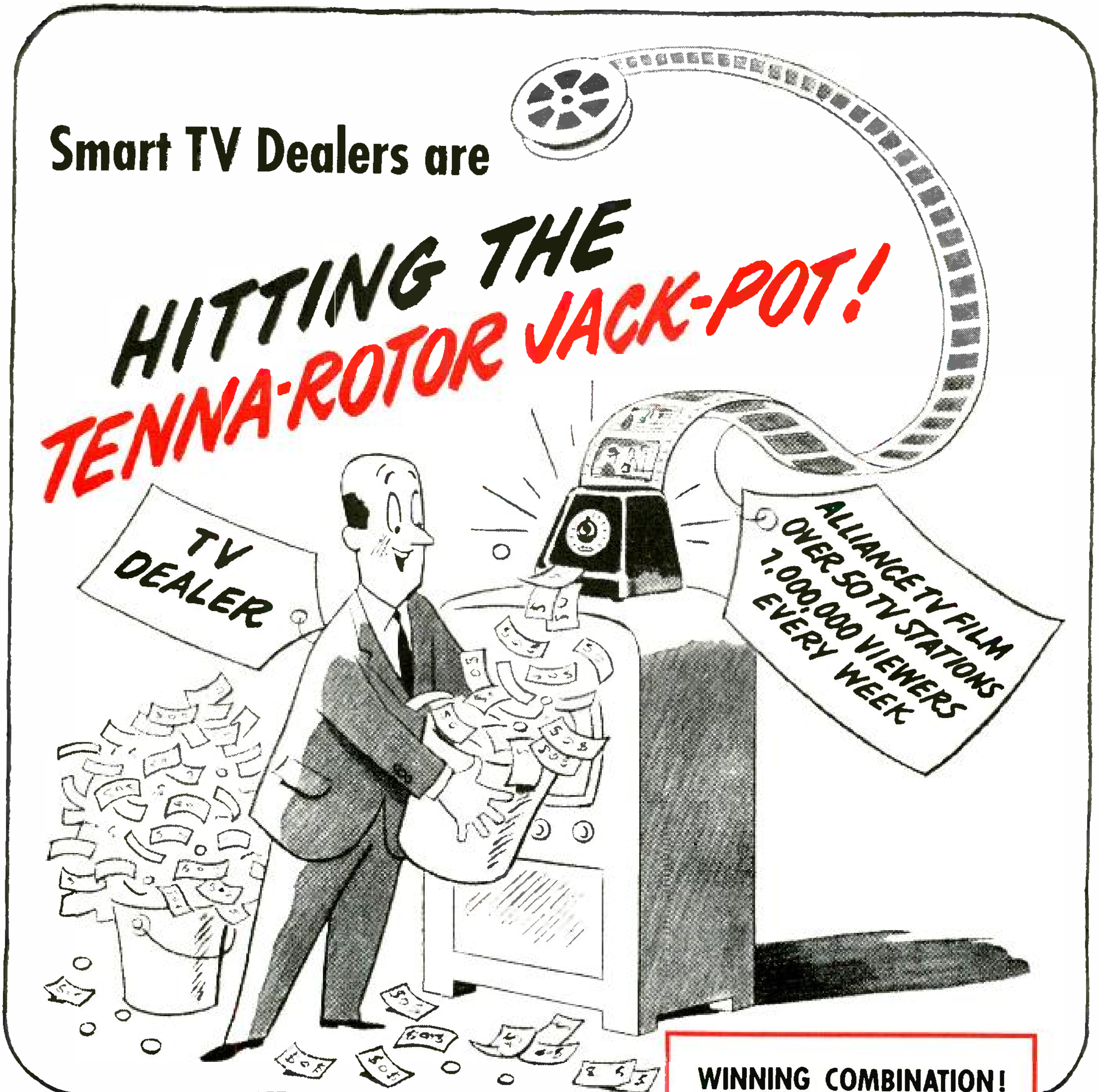
The total increase in velocity would be:

$$v_i = 10 \ln \frac{2{,}400 \text{ gr}}{400 \text{ gr}} = 17{,}918 \text{ m/sec.}$$

I have added the subscript i to v because the spaceship would attain this velocity only in gravitationless space. If it started out from a station rotating about the earth, it would have to exceed the velocity of the station. In so doing, the original circular orbit (in the sense indicated by the Keplerian laws of planetary motion) would first have to pass over to an elliptical orbit; however, the ellipse would not be completed, but in each instant it would develop into an ever wider ellipse, so long as the machine operates.

Accordingly the spaceship ascends in a spiral path, the differential equation of which cannot be integrated in a closed expression. And its velocity actually diminishes in the process at the same time that its total energy, because of the increment of potential energy, increases. Thus v_i indicates only the so-called ideal velocity. I would also like to point out that this 17 km/sec only about one-half or 9,000 m/sec can be used for propulsion, while the remainder must be used to check the velocity in the vicinity of the goal.

The following formulas refer to fuel



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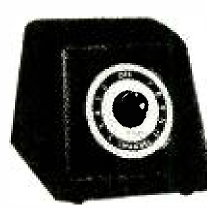

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consumption, increase of velocity, and the duration of the acceleration:

$$m = m_0 + m' \ t. \qquad (1)$$

where m is the mass of the electric spaceship, m_0 its initial mass, t the time, and m' the quantity of fuel or propellant expelled during each second. Obviously the spaceship expels the same quantity of propellant in each second, since its distance from the sun does not change so rapidly, and, to save time, the machines are allowed to run at the highest number of revolutions per minute so long as they must operate. From (1) and the equation for velocity increase (see Part I) we obtain the increase in velocity between the times t_1 and t_2:

$$v = c \ln \frac{m_0 - m' t_1}{m_0 - m' t_2} \qquad (2)$$

From this we get:

$$t_2 = \frac{m_0}{m'} \left(1 - e^{-v/c}\right) + e^{-v/c} \ t_1. \qquad (3\text{-a})$$

If we substitute m_1 for $m_0 - m' t_1$ and t for $t_2 - t_1$ we get.

$$t = \frac{1}{m'} (m_0 - m_1). \qquad (3\text{-b})$$

It is obvious that all the energy derived from the source of current will not be used for the acceleration of the propellant. A large part of it is lost in the charging processes going on. Moreover, not all the corpuscles fly off at the same speed, so that here too a certain amount of energy is lost.

It would take us too far afield, and would also be pointless in view of the uncertainty of the estimates referred to above, to describe exactly how I arrived at the values used. But I estimate that the kinetic energy of the expelled particles constitutes about one-fifth to one-third of the electrical energy supplied. While this may seem a rather low efficiency, it is no problem as we have an unlimited energy source from the sun.

With an exhaust or repulsion velocity of 20 km/sec, v_1 would therefore be twice as great, i.e., 35,836 m/sec; but from 32 to 56 days would then be required for the approach and slowing down for landing.

"—n press this for close-ups."

New Devices

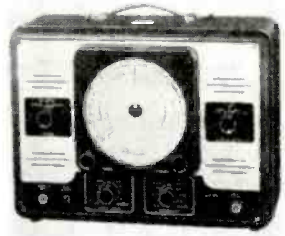
TV COMPONENTS
General Electric Co.
Syracuse, N.Y.

TV receiver components in this new line include 70-degree deflection yokes for magnetic deflection circuits, horizontal sweep output and high-voltage

transformers, and other components such as EM-PM focus coils, width and linearity controls, ion trap magnets, etc. These parts are usable with G-E and other receiver makes.

SWEEP GENERATOR
Triplett Electrical Instrument Co.
Bluffton, Ohio

Model 3435 is a sweep generator with continuous range coverage to 240 mc and covers all TV and FM carrier and intermediate frequencies in three bands. The main frequency dial is marked



with channels as well as frequencies. The continuously variable, phase-controlled sweep is effective from 500 kc to 12 mc. A standby switch is provided for temporary silencing. Provision is made for connecting an external marker generator.

The instrument is constructed of copper-plated steel throughout. Critical circuits are enclosed, and the power transformer is electrostatically shielded.

V.T.V.M. KIT
Allied Radio Corp.
Chicago, Ill.

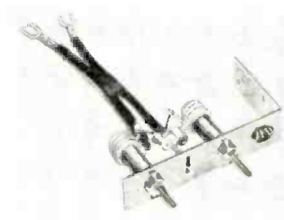
This new Knight v.t.v.m. kit has 30 ranges in all: d.c. volts (20 megohms input impedance), 7 ranges; a.c. volts (10 megohms input), 6 ranges; d.c.

milliamperes, 4; ohms, 6; db, 5; capacitance, 6 ranges. It reads up to 5,000 volts d.c., 1,000 volts a.c. (full audio range), and to 1,000 megohms. High-voltage and r.f. probes are available.

The instrument has a zero-center scale for FM discriminator alignment and a pilot light for on-off indication. A 4½-inch meter is used, and the 5 x 6 x 10-inch steel case has a gray hammertone finish.

TV WAVE TRAPS
JFD Mfg. Co.
Brooklyn, N.Y.

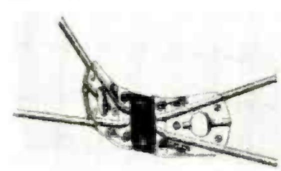
These wave traps, installed by connecting the leads to the antenna input terminals in parallel with the transmission line and tuning coils, come in four models. No. BR106-10-30 traps amateur harmonics from the 14- and 28-mc bands. No. BR106-80-110 traps FM image interference. No. BR106-30-60 traps amateur harmonics from 30 to



60 mc, and No. BR106-60-90 traps diathermy interference from 60 to 90 mc.

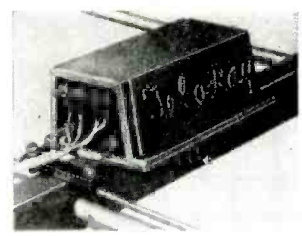
TV ANTENNAS
Telrex, Inc.
Asbury Park, N.J.

The new Monarch series of conical V beams offers standard units for all-channel reception and modified beams for greater selectivity. The series will be available in single-, double-, and four-bay models designated at K2X-TV, K4X-TV, and K8X-TV. All models are available with either doweled, with heat-treated dural tubular elements or solid dural rods.



TV BOOSTER
Tel-A-Ray Enterprises, Inc.
Henderson, Ky.

This antenna-mounted booster is easily attached to any folded dipole. When used with a Tel-A-Ray model T antenna, the unit provides a gain of up to 300 to provide better signal-to-noise ratio for fringe reception.



PANEL INSTRUMENTS
Simpson Electric Co.
Chicago, Ill.

Three new panel instruments (models 1029, 1027, and 1127) come in 4½-, 3½-, and 2½-inch sizes. The large scales are easy to read, and the etched faces of these meters extend across the entire front and are protected with unbreakable plastic. Vertical chrome plated strips are recessed into the plastic, fluted cover.

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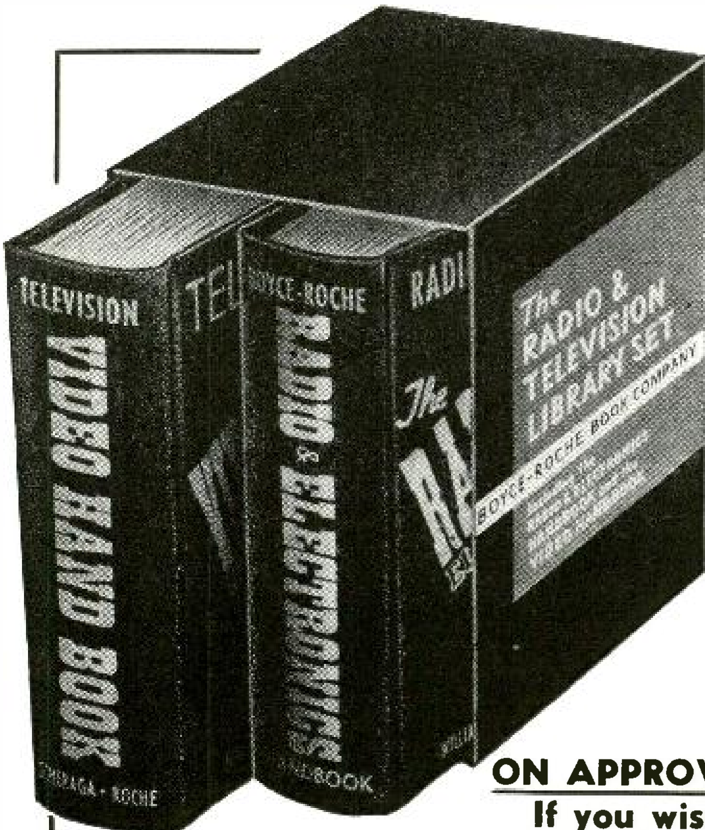

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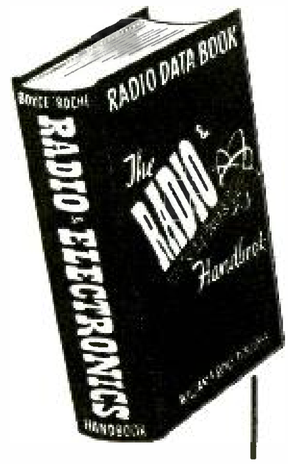

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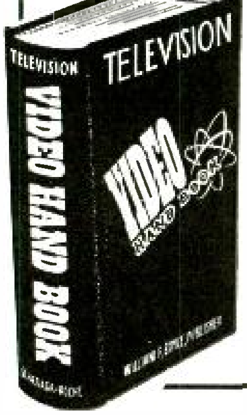

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VOLTAGE REGULATOR

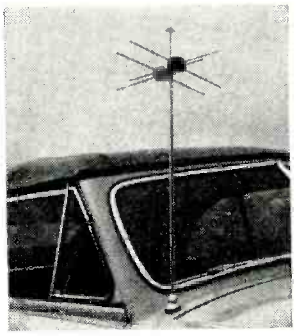
Clarostat Mfg. Co.
Dover, N.H.

Designed to reduce line voltage fluctuations, for better TV pictures, this regulator has male and female Edison connections at either end. It plugs in between the TV set's line plug and the outlet. Two models are available: TV-A rated at 300 watts; and TV-B, rated at 375 watts.

AUXILIARY AUTO AERIAL

Insuline Corp. of America
Long Island City, N.Y.

Tele-Con is a miniature double-conical auxiliary auto antenna patterned after a TV antenna. Its four 10½-inch



arms are made of chrome-plated brass tubing and are set in red plastic center pieces. The assembly clamps to any vertical auto antenna and is easily installed. This is an eye-catching device.

MULTI-SECTION ELECTROLYTICS

Aerovox Corp.
New Bedford, Mass.

Having a special internal construction which provides low r.f. impedance and minimum coupling between sections, the type AFH multi-section electrolytic capacitors are said to produce less hum and hash. Especially suited for television, these capacitors are available in a large selection of capacitance and voltage combinations for a variety of uses.

CORNER ANTENNA

Technical Appliance Corp.
Sherburne, N.Y.

Designated as the 1700 series, this new twin-driven corner antenna, has narrow directivity, a high front-to-back ratio, and controlled phase relationship of both high- and low-band lobes. The antenna has low wind resistance and is rigidly constructed.

The Technical Appliance Co. also announces *Engineering Bulletin No. 64*, free to service technicians, which contains actual measurements of db gain over half-wave dipoles for all popular antenna types. This information is valuable for selecting the best antenna for any particular installation.

MULTIPLE POWER OUTLET

Sun Radio & Electronics Co.
New York, N.Y.

To eliminate makeshift outlets in labs, shops, homes, and offices, this portable outlet box provides eight standard line cord sockets from one electrical outlet. The box contains two fuses to prevent overloads, a d.p.d.t. switch to turn off both legs of all eight receptacles, and a neon bulb to indicate power flow through the switch. A 12-foot heavy-duty line cord connects the box to the electrical outlet.

RECORD CHANGER SPINDLE

V-M Corp.
Benton Harbor, Mich.

A U.S. patent has been granted on the Tri-O-Matic record changer spindle. This spindle does not drop, but lowers the records to the spindle shelf. The records are then air-cushion-dropped to the turn table.

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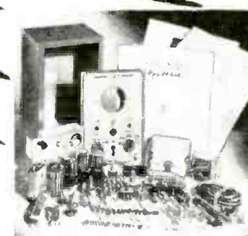

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Accuracy ASSURED BY PRECISION PARTS

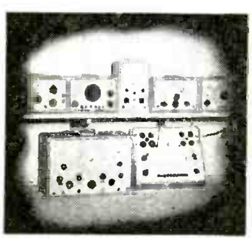
Wherever required, the finest quality 1% ceramic resistors are supplied. These require no aging and do not shift. No matching of common resistors is required. You find in Heathkit the same quality voltage divider resistors as in the most expensive equipment.

The transformers are designed especially for the Heathkit unit. The scope transformer has two electrostatic shields to prevent interaction of AC fields.

These transformers are built by several of the finest transformer companies in the United States.

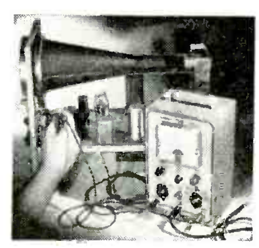
Complete INSTRUCTION MANUALS

Heathkit instruction manuals contain complete assembly data arranged in a step-by-step manner. There are pictorials of each phase of the assembly drawn by competent artists with detail allowing the actual identification of parts. Where necessary, a separate section is devoted to the use of the instrument. Actual photos are included to aid in the proper location of wiring.



Used BY LEADING MANUFACTURERS

Leading TV and radio manufacturers use hundreds of Heathkits on the assembly lines. Heathkit scopes are used in the alignment of TV tuners. Impedance bridges are serving every day in the manufacture of transformers. Heathkit VTVM's are built into the production lines and test benches. Many manufacturers assemble Heathkits in quantity for their own use thus keeping purchase cost down.



Used BY LEADING UNIVERSITIES

Heathkits are found in every leading university from Massachusetts to California. Students learn much more when they actually assemble the instrument they use. Technical schools often include Heathkits in their course and these become the property of the students. High schools, too, find that the purchase of inexpensive Heathkits allows their budget to go much further and provides much more complete laboratories.

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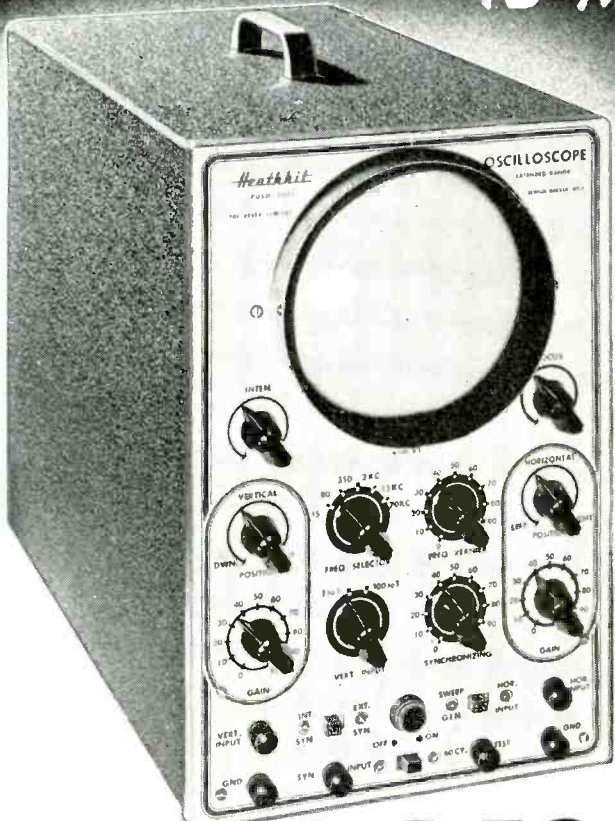
The HEATH COMPANY
. . . BENTON HARBOR 20, MICHIGAN

12 Improvements IN NEW 1951

MODEL O-6 PUSH-PULL

Heathkit OSCILLOSCOPE KIT



Only $39.50

- ★ New AC and DC push-pull amplifier.
- ★ New step attenuator frequency compensated input.
- ★ New non frequency discriminating input control.
- ★ New heavy duty power transformer has 68% less magnetic field.
- ★ New filter condenser has separate vertical and horizontal sections.
- ★ New intensity circuit gives greater brilliance.
- ★ Improved amplifiers for better response useful to 2 megacycles.
- ★ High gain amplifiers .04 Volts RMS per inch deflection.
- ★ Improved Allegheny Ludlum magnetic metal CR tube shield.
- ★ New synchronization circuit works with either positive or negative peaks of signal.
- ★ New extended range sweep circuit 15 cycles to over 100,000 cycles.
- ★ Both vertical and horizontal amplifier use push-pull pentodes for maximum gain.

The new 1951 Heathkit Push-Pull Oscilloscope Kit is again the best buy. No other kit offers half the features — check them.

Measure either AC or DC on this new scope — the first oscilloscope under $100.00 with a DC amplifier.

The vertical amplifier has frequency compensated step attenuator input into a cathode follower stage. The gain control is of the non frequency discriminating type — accurate response at any setting. A push-pull pentode stage feeds the C.R. tube. New type positioning control has wide range for observing any portion of the trace.

The horizontal amplifiers are direct coupled to the C.R. tube and may be used as either AC or DC amplifiers. Separate binding posts are provided for AC or DC.

The multivibrator type sweep generator has new frequency compensation for the high range it covers; 15 cycles to cover 100,000 cycles.

The new model 0-6 Scope uses 10 tubes in all — several more than any other. Only Heathkit Scopes have all the features.

New husky heavy duty power transformer has 50% more laminations. It runs cool and has the lowest possible magnetic field. A complete electrostatic shield covers primary and other necessary windings and has lead brought out for proper grounding.

The new filter condenser has separate filters for the vertical and horizontal screen grids and prevents interaction between them.

An improved intensity circuit provides almost double previous brilliance and better intensity modulation.

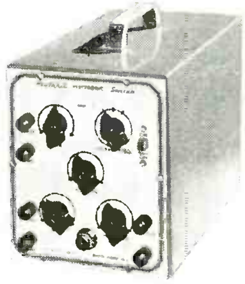
A new synchronization circuit allows the trace to be synchronized with either the positive or negative pulse, an important feature in observing the complex pulses encountered in television servicing.

The magnetic alloy shield supplied for the C.R. tube is of new design and uses a special metal developed by Allegheny Ludlum for such applications.

The Heathkit scope cabinet is of aluminum alloy for lightness of portability.

The kit is complete, all tubes, cabinet, transformer, controls, grid screen, tube shield, etc. The instruction manual has complete step-by-step assembly and pictorials of every section. Compare it with all others and you will buy a Heathkit. Model 0-6. Shipping Wt., 30 lbs.

New INEXPENSIVE MODEL S-2 ELECTRONIC SWITCH KIT



Twice as much fun with your oscilloscope — observe two traces at once — see both the input and output traces of an amplifier, and amazingly you can control the size and position of each trace separately — superimpose them for comparison or separate for observation — no connections inside scope. All operation electronic, nothing mechanical — ideal for classroom demonstrations — checking for intermittents, etc. Distortion, phase shift and other defects show up instantly. Can be used with any type or make of oscilloscope. So inexpensive you can't afford to be without one.

Has individual gain controls, positioning control and coarse and fine switching rate controls — can also be used as square wave generator over limited range. 110 Volt transformer operated comes complete with tubes, cabinet and all parts. Occupies very little space beside the scope. Better get one. You'll enjoy it immensely. Model S-2. Shipping Wt., 11 lbs.

Only $19.50

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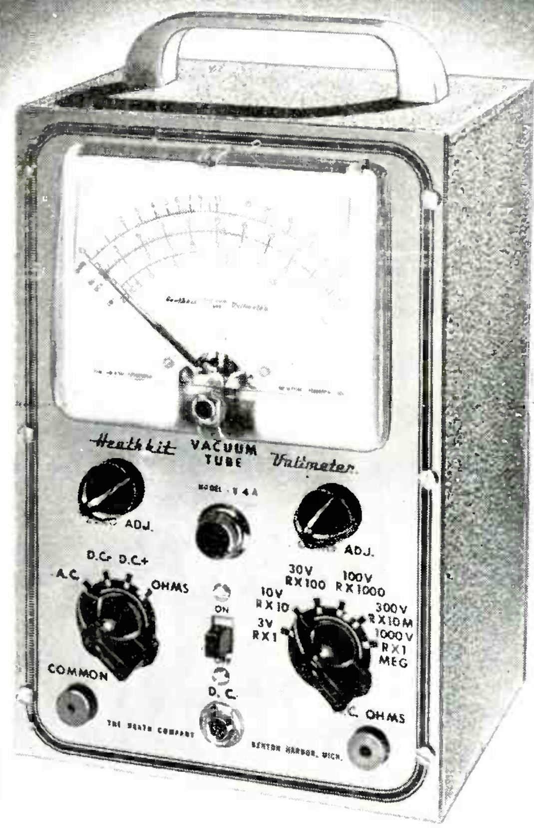
... BENTON HARBOR 20, MICHIGAN

New 1951 • • MODEL V-4A *Heathkit* VTVM KIT

HAS EVERY EXPENSIVE *Feature*



- ★ Higher AC input impedance, (greater than 1 megohm at 1000 cycles).
- ★ New AC voltmeter flat within 1 db 20 cycles to 2 megacycles (600 ohm source).
- ★ New accessory probe (extra) extends DC range to 30,000 Volts.
- ★ New high quality Simpson 200 microampere meter.
- ★ New ½% voltage divider resistors (finest available).
- ★ 24 Complete ranges.
- ★ Low voltage range 3 Volts full scale (⅓ of scale per volt).
- ★ Crystal probe (extra) extends RF range to 250 megacycles.
- ★ Modern push-pull electronic voltmeter on both AC and DC.
- ★ Completely transformer operated isolated from line for safety.
- ★ Largest scale available on streamline 4½ inch meter.
- ★ Burn-out proof meter circuit.
- ★ Isolated probe for dynamic testing no circuit loading.
- ★ New simplified switches for easy assembly.

New LOW PRICE $23.50

The new Heathkit Model V-4A VTVM Kit measures to 30,000 Volts DC and 250 megacycles with accessory probes — think of it, all in one electronic instrument more useful than ever before. The AC voltmeter is so flat and extended in its response it eliminates the need for separate expensive AC VTVM's. + or − db from 20 cycles to 2 megacycles. Meter has decibel ranges for direct reading. New zero center on meter scale for quick FM alignment.

There are six complete ranges for each function. Four functions give total of 24 ranges. The 3 Volt range allows 33⅓% of the scale for reading one volt as against only 20% of the scale on 5 Volt types.

The ranges decade for quick reading.

New ½% ceramic precision are the most accurate commercial resistors available — you find the same make and quality in the finest laboratory equipment selling for thousands of dollars. The entire voltage divider decade uses these ½% resistors.

New 200 microampere 4½" streamline meter with Simpson quality movement. Five times as sensitive as commonly used 1 MA meters.

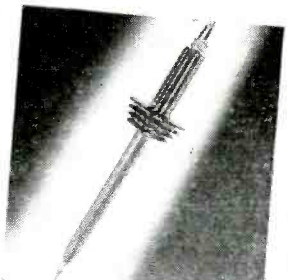
Shatterproof plastic meter face for maximum protection.

Both AC and DC voltmeter use push-pull electronic voltmeter circuit with *burn-out* proof meter circuit.

Electronic ohmmeter circuit measures resistance over the amazing range of 1/10 ohm to one billion ohms all with internal 3 Volt battery. Ohmmeter batteries mount on the chassis in snap-in mounting for easy replacement.

Voltage ranges are full scale 3 Volts, 10 Volts, 30 Volts, 100 Volts, 300 Volts, 1000 Volts. Complete decading coverage without gaps.

The DC probe is isolated for dynamic measurements. Negligible circuit loading. Gets the accurate reading without disturbing the operation of the instrument under test. Kit comes complete, cabinet, transformer, Simpson meter, test leads, complete assembly and instruction manual. Compare it with all others and you will buy a Heathkit. Model V-4A. Shipping Wt., 8 lbs. Note new low price, $23.50



New 30,000 VOLT DC PROBE KIT

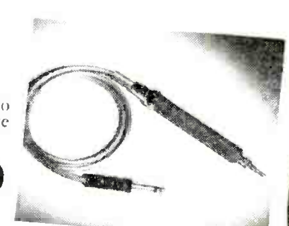
Beautiful new red and black plastic high voltage probe. Increases input resistance to 1100 megohms, reads 30,000 Volts on 300 Volt range. High input impedance for minimum loading of weak television voltages. Has large plastic insulator rings between handle and point for maximum safety. Comes complete with PL55 type plug.

No. 336 High Voltage Probe Kit. Shipping Wt., 2 pounds. **$5.50**

Heathkit RF PROBE KIT

Crystal diode probe kit extends range to 250 megacycles ± 10% comes complete with all parts, crystal, cable and PL55 type plug.

No. 309 RF Probe Kit Shipping Wt., 1 lb. **$5.50**



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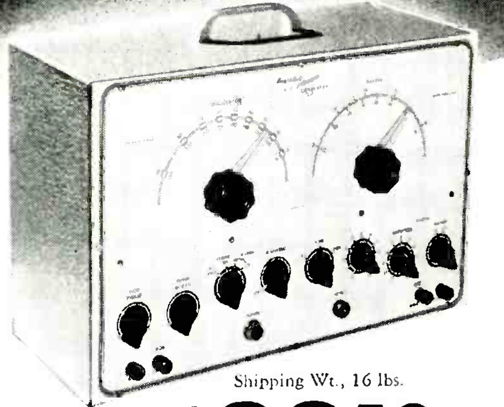
The HEATH COMPANY

... BENTON HARBOR 20, MICHIGAN

NEW *Heathkit* T.V. ALIGNMENT GENERATOR KIT



Shipping Wt., 16 lbs.

$39.50

- ★ New simplified circuit for easy calibration and assembly.
- ★ New 2 band built-in marker covers 19 to 75 Mc.
- ★ New dual spider sweep motor for long life.
- ★ New blanking circuit gives base line for better alignment.
- ★ New variable oscillator gives high output fundamentals on high TV band.
- ★ New standby switch keeps instrument ready for instant use.
- ★ New 6 to 1 slow speed drive on both master oscillator and marker tuners.

The new Heathkit TV Alignment Generator incorporates the new developments required for modern TV servicing. An absorption marker circuit covering all possible IF bands and even several of the RF bands. The new blanking circuit provides a base reference line which is invaluable in establishing proper traces. The new sweep motor incorporates dual spiders in the speaker frame assuring better alignment and long life. The mounting of the speaker sweep motor has been simplified for easy alignment.

The variable master oscillator covers 140 to 230 Mc. thus giving high output fundamentals where they are most needed. Low band coverage 2 Mc. to 90 Mc.

A new step attenuator provides excellent control of output.

Planetary 6 to 1 drives on both oscillator and marker provides smooth easy control settings.

A standby position is provided making the instrument always instantly available.

Horizontal sweep voltage with phasing control is provided. No other sweep generator under $100.00 provides all these features — comes complete with instruction manual. Model TS-2.

Heathkit CONDENSER CHECKER KIT

Only **$19.50**

Features

- Power factor scale.
- Measures resistance.
- Measures leakage.
- Checks paper-mica-electrolytics.
- Bridge type circuit.
- Magic eye indicator.
- 110 V. transformer operated.
- All scales on panel.

Checks all types of condensers over a range of .00001 MFD to 1,000 MFD. All on readable scales that are read direct from the panel. NO CHARTS OR MULTIPLIERS NECESSARY. A condenser checker anyone can read. A leakage test and polarizing voltage for 20 to 500 Volts provided. Measures power factor of electrolytics between 0% and 50%. 110 V. 60 cycle transformer operated complete with rectifier and magic eye tube, cabinet, calibrated panel, test leads and all other parts. Clear detailed instructions for assembly and use. Model C-2. Shipping Wt., 7 lbs.

NEW *Heathkit* SIGNAL TRACER AND UNIVERSAL TEST SPEAKER KIT

$19.50

Features

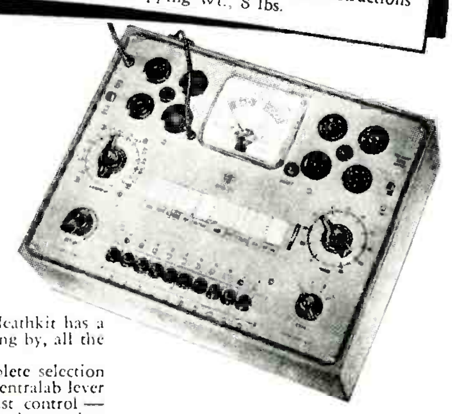
- High sensitivity
- Complete set of speaker impedances
- Tests microphones and PA systems
- Tests both single and push-pull speaker circuits

The popular Heathkit Signal Tracer has now been combined with a universal test speaker at no increase in price. The same high quality tracer follows signal from antenna to speaker — locates intermittents — defective parts quicker — saves valuable service time — gives greater income per service hour. Works equally well on broadcast — FM or TV receivers. The test speaker has assortment of switching ranges to match push-pull or single output impedance. Also test microphones, pickups, PA systems — comes complete — cabinet, 110 V. 60 cycle power transformer — tubes, test probe, all parts and detailed instructions for assembly and use. Model T-2. Shipping Wt., 8 lbs.

Heathkit TUBE CHECKER KIT

Features

- Sockets for every modern tube — blank for new types.
- Fastest method of testing tubes — saves time — makes more profit.
- Rugged counter type birch cabinet.
- Gear driven roller chart gives instant setup for all types.
- Tests each element separately for open or short and quality.
- Beautiful 3 color meter — reads good-bad and line set point.



Test your tubes the modern way — dynamically — the simplest, yet fastest and surest method — your Heathkit has a switch for each tube element and measures that element — no chance for open or shorted elements slipping by, all the advantages of the mutual conductance type without the slow cumbersome time consuming setups.

Your Heathkit Tube Checker has all the features — beautiful 3 color BAD-GOOD meter — complete selection of voltages — roller chart listing hundreds of tubes including the new 9 pin miniatures — finest quality Centralab lever switches for each element — high grade birch counter type cabinet — continuously variable line adjust control — every feature you need to sell tubes properly. The most modern type tube checker with complete protection against obsolescence. The best of parts — rugged oversize 110 V. 60 cycle power transformer — finest of Mallory and Centralab switches and controls, complete set of sockets for all type tubes with blank spare for future types. Fast action brass gear driven roller chart quickly locates the settings for any type tube. Simplified switching cuts necessary testing time to minimum and saves valuable service time. Short and open element check. Simple method allows instant setup of new tube types without waiting for factory data. No matter what the arrangements of tube elements, the Heathkit flexible switching arrangement easily handles it. Order your Heathkit Tube Checker Kit today. See for yourself that Heath again saves you two-thirds and yet retains all the quality — this tube checker will pay for itself in a few weeks — better assemble it now. Complete with instructions — pictorial diagrams — all parts — cabinet — ready to wire up and operate. Model TC-1 Shipping Wt., 12 lbs.

$29.50

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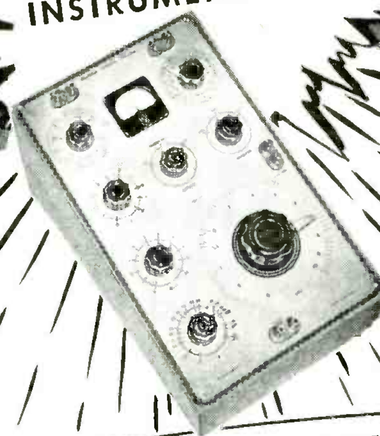
New LABORATORY INSTRUMENT KITS

HUNDREDS OF LABORATORIES USE

Heathkit IMPEDANCE BRIDGE *as Standard*



Features

• Measures inductance 10 microhenries to 100 henries • Measures resistance .01 ohms to 10 megohms • Measures capacitance .00001 MFD to 100 MFD • Measures "Q" and power factor.

Measures inductance from 10 microhenries to 100 henries, capacitance from .00001 MFD to 100 MFD. Resistance from .01 ohms to 10 megohms. Dissipation factor from .001 to 1. "Q" from 1 to 1,000. Ideal for schools, laboratories, service shops, serious experimenters. An impedance bridge for everyone — the most useful instrument of all, which heretofore has been out of the price range of serious experimenters and service shops. Now at the lowest price possible. All highest quality parts. General Radio main calibrated control. General Radio 1,000 cycle hummer. Mallory ceramic switches with 60 degree indexing — 200 microamp type binding posts with standard ¾" centers. Beautiful birch cabinet. Directly calibrated "Q" and dissipation factor scales. Ready calibrated capacity and inductance standards of Silver Mica, accurate to ½ of 1% and with dissipation factors of less than 30 parts in one million. Provisions on panel for external generator and detector. Measure all your unknowns the way laboratories do — with a bridge for accuracy and speed.

$69.50

Internal 6 Volt battery for resistance and hummer operations. Circuit utilizes Wheatstone, Hay and Maxwell circuits for different measurements. Supplied complete with every quality part — all calibrations completed and instruction manual for assembly and use. Deliveries are limited. Model IB-1. Shipping Wt., 15 lbs.

NEW *Heathkit* LABORATORY RESISTANCE DECADE KIT

Features

- ½% Accuracy
- Birch Cabinet
- Ceramic Switches
- Covers 1 ohm to 99,999 ohms

The new Heathkit Resistance Decade is a handy tool for laboratory, school and service shop. Ideal for test setups, calibrating instruments, bridge measurements, selecting multipliers, etc.

$19.50

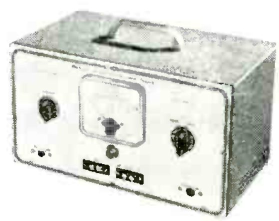
Uses the finest Centralab ceramic switches, ½% ceramic decade resistors and heavy birch cabinet matching other laboratory equipment. The range is 1 ohm to 99,999 ohms in one ohm steps.

Finest quality throughout to withstand school usage — heavy aluminum panel — laboratory type binding posts — the fine decades are extremely simple to assemble — complete kit. Model RD-1. Shipping Wt., 4 lbs.

NEW *Heathkit* LABORATORY POWER SUPPLY KIT

Features

- Supplies 6.3 V. AC at 4.5 Amps.
- Heavy duty construction.
- Handy for schools, labs., and service shops.
- Supplies variable DC 50-300 Volts.
- Shows voltage or current on 3½" meter.

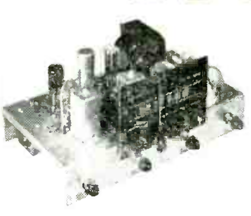


$29.50

This new Heathkit Variable Power Supply Kit fills hundreds of needs — use it for experimental circuits — no need to build a separate power supply — use it for a test voltage to determine proper coefficients in unknown circuits — calibrate instruments with its variable voltage, etc. This new Heathkit supplies 50 to 300 Volts continuously variable DC together with an AC filament voltage of 6.3 Volts at 4.5 Amperes. A built-in 1 MA 3½" meter has proper shunts to read 0-500 Volts and 0-200 Milliamperes. The circuit uses a 5Y3 rectifier, two 1619 tubes as electronic control tubes to vary the output voltage with a single potentiometer. Case measures 7⅛" x 13" x 7⅛". Has instruction manual for assembly and use. Model PS-1. Shipping Wt., 18 lbs.

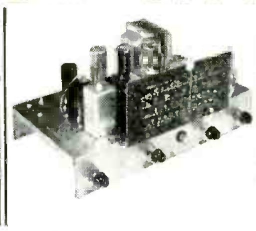
Heathkit RECEIVER & TUNER KITS for AM and FM

TWO HIGH QUALITY *Heathkit* SUPERHETERODYNE RECEIVER KITS



Model BR-1 Broadcast Model Kit covers 550 to 1600 Kc. Shipping Wt., 10 pounds.

$19.50



Model AR-1 3 Band Receiver Kit covers 550 Kc. to over 20 Mc. continuous. Extremely high sensitivity. Shipping Wt., 10 lbs.

$23.50

Two new Heathkits. Ideal for schools, replacement of worn out receivers, amateurs and custom installations.

Both are transformer operated quality units. The best of materials are used throughout — six inch calibrated slide rule dial — quality power and output transformers — dual iron core shielded I.F. coils — metal filter condensers and all other parts. The chassis has phono input jack — 110 Volt outlet for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.

TRUE FM FROM *Heathkit* FM TUNER KIT

$22.50

The Heathkit FM Tuner Model FM-2 was designed for best possible tonal reproduction. The circuit incorporates the most desirable FM features — true FM — ready wound and adjusted coils — 3 stages of 10.7 Mc. I.F. (including limiter).

Tube lineup: 7E5 oscillator, 6SH7 mixer, two 6SH7 I.F. stages, 6SH7 limiter, two 7C4 diodes as discriminator, 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. The R.F. coils are ready wound — mounted on the tuning condenser and the condenser is adjusted — no R.F. coils to wind or adjust.

A calibrated six inch slide rule dial has vernier drive for easy tuning. The finest parts are provided with all tubes, punched and formed chassis, transformers, condensers and complete instruction manual. Model FM-2. Shipping Wt., 10 lbs.

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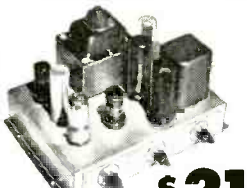
... BENTON HARBOR 20, MICHIGAN

ENJOY MUSIC AT ITS *Finest* WITH *Heathkit* AMPLIFIERS

NEW *Heathkit* AMPLIFIER KIT

HIGH FIDELITY 20 WATT



Features

- Push-pull 6L6's.
- Full 20 Watts output.
- Fully enclosed chassis.
- Provisions for reluctance pickup compensation stage.
- Cased high fidelity output transformer.
- Treble and bass boost tone controls.
- Full range of output impedances 3.2 ohms to 500 ohms.

$21.50

The finest amplifier kit we have ever offered — check the features. This inexpensive amplifier compares favorably with instruments costing five times as much. Nothing has been spared to provide the best reproduction — an ideal amplier for the new Heathkit FM Tuner listed below.

Dual tone controls for control of both treble and bass. Bass control is of the boost type for maximum listening pleasure. Optional preamplifier stage for use with G. E. reluctance pickup or microphone. Uses inverse feedback to give excellent response over entire range. Tube lineup: 6SJ7 preamplifier stage, 6J5 phase splitter stage, two 6L6's in push-pull and 5Y3 rectifier. (6SC7 as optional compensation stage).

Uses highest quality Chicago Transformer Corporation cased output transformer with taps of 3.2, 8, 15, 60 and 500 ohms to match any speaker combination. Power transformer is conservatively rated for continuous operation in sound systems. Tone control gives maximum bass boost of 6 db at 70 cycles. Amplifier has maximum gain of 75 db. Response within 3 db 20 to 20,000 cycles. Shipping Wt., 17 lbs. Complete with all parts, tubes and instruction manual.

Model A-5A Amplifier with preamplifier for G. E. cartridges or microphone $23.50
12" 20 Watt Speaker, No. 326 .... 7.50

Heathkit ECONOMY 6 WATT PUSH-PULL AMPLIFIER KIT

$12.50

No. 304, 12-inch Speaker... **$6.95**

This new Heathkit Amplifier was designed to give quality reproduction at a very low price. Has two preamp stages, phase inverter stage and push-pull beam power output. Comes complete with six tubes, quality output transformer (to 3-4 ohm voice coil), husky cased power transformer and all other parts. Has tone and volume controls. Instruction manual has pictorial for easy assembly. Six watt output with response flat ± 1½ db from 50 to 15,000 cycles. A quality amplifier kit at new low price. Better build one. Model A-4. Shipping Wt., 7 lbs.

Heathkit RECEIVERS and TUNER CABINETS

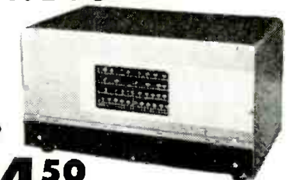
$4.95

Order No. 350 for FM tuner

Blonde birch veneer cabinet for either the receivers or tuner. Modern styling is an asset to any room. 5" speaker fits in end of cabinet when used with receivers. Size 7 x 13½ x 8¼ inches. Shipping Wt., 5 lbs. Order No. 345 for either receiver

Metal professional type communications receiver cabinet. Finished in deep grey to fit the panel supplied with Heathkit BR-1 and AR-1 Receivers (panel shown not included with cabinet). 5" speaker mounts in end of cabinet. Gives professional appearance to Heathkit receivers. Size 7 x 14 x 7¾ inches. Shipping Wt., 6 lbs.

5" Permoflux Speaker for either cabinet for use with either Heathkit Receiver No. 320 5" Speaker $2.75



$4.50

No. 335 Cabinet for receivers only.

ORDER BLANK

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BENTON HARBOR 20, MICHIGAN

From ____________________
____
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(PLEASE PRINT)

SHIP VIA
☐ Parcel Post
☐ Express
☐ Freight
☐ Best Way

Quantity	Item	Price	Quantity	Item	Price
	Heathkit Oscilloscope Kit — Model O-6			Heathkit VTVM Kit — Model V-4A	
	Heathkit T.V. Alignment Gen. Kit — TS-2			Heathkit R.F. Probe Kit — No. 309	
	Heathkit FM Tuner Kit — FM-2			Heathkit H.V. Probe Kit — No. 336	
	Heathkit Broadcast Receiver Kit — Model BR-1			Heathkit R.F. Signal Gen. Kit — Model SG-6	
	Heathkit Three Band Receiver Kit — Model AR-1			Heathkit Condenser Checker Kit — Model C-2	
	Heathkit Amplifier Kit — Model A-4			Heathkit Handitester Kit — Model M-1	
	Heathkit Amplifier Kit — Model A-5 (or A-5A)			Heathkit Variable Power Supply Kit — Model PS-1	
	Heathkit Tube Checker Kit — Model TC-1			Heathkit Resistance Decade Kit — Model RD-1	
	Heathkit Audio Generator Kit — Model G-2			Heathkit Impedance Bridge Kit — Model IB-1	
	Heathkit Battery Eliminator Kit — Model BE-2			Heathkit Signal Tracer Kit — Model T-2	
	Heathkit Electronic Switch Kit — Model S-2				

On Parcel Post Orders, include postage for weight shown and insurance. (We insure all shipments.)

On Express Orders, do not include transportation charges — they will be collected by the Express Agency at time of delivery.

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Fundamentals of Radio Servicing

Part XXIII—Signals in Space

By JOHN T. FRYE

IN THE last chapter we wrote as though the transmitted radio wave traveled a simple, straightforward path from transmitting antenna to the various receiving antennas. That is not the case! Nothing about this wacky radio business could ever be that simple, direct, and easy to understand!

Fig. 1 shows what really happens. Some of the waves from the transmitter at A travel along the surface of the earth like the one designated G. These

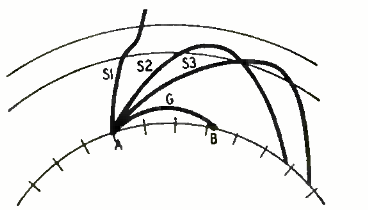
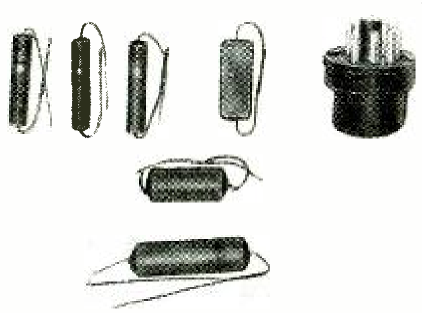


Fig. 1—How radio waves act in space.

"ground waves" induce currents in the earth immediately beneath them, and the resistance of the earth to the passage of these currents cause them to die out rapidly, particularly at the higher frequencies. On the broadcast band these ground-hugging waves account for practically all the daytime reception. They are good for about 50 miles at the high-frequency end of the band and up to 200 miles at the low-frequency end.

Then there are the "sky waves" that travel upward from the transmitter at various angles as shown at S1, S2, and S3. Some of these waves, like the one at S1, imitate the famed traveling salesman and keep right on traveling, never to be heard from again. Others, like S2 and S3, meet a "something" up there in the wild blue yonder that persuades them to turn around and come back to earth.



The components for an a.v.c. circuit.

The "something" that turns them back is a series of ionized layers above the earth's surface at various distances of from 30 to 250 miles. You will recall that an ion is really a positively charged molecule that got that way from having lost some of its negative charge in a collision with a fast-moving electron or through some other molecular mayhem. The gases in the upper reaches of the earth's atmosphere are being constantly bombarded by ultra-violet and cosmic ray radiation, and this bombardment ionizes many of their molecules. Since these gases hover at various heights according to their weight, and since the bombardment is more effective as the atmosphere becomes rarer, it is not surprising that the ionization is in layers, each layer being more intensely ionized than the one below it.

Did you ever see a stick lying half in and half out of a pool of clear water and notice that the stick seemed to be sharply bent right at the point where it enters the water? We learned in

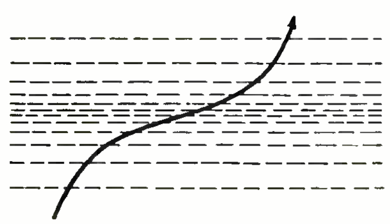


Fig. 2—Wave path in an ionized layer.

high school physics, of course, that it was not the stick but the light rays reflected from it that were bent.

Just as a light ray changes course when it passes from one medium to another, so are radio waves bent when they pass through an intensely ionized layer. The wave behaves as though it hated ions and wants to avoid any concentration of them. This is shown in Fig. 2. Notice that as the radio wave enters the ionized layer from below, it tries to shy away from the more deeply ionized center portion of the layer; but once it is forced to pass through this center portion, it reverses its direction of curvature so as to escape from the layer as soon as possible.

The actual amount of bending depends upon three things: the angle with which the radio wave strikes the layer, the frequency of the wave, and the intensity of ionization of the layer. If the wave strikes the layer nearly at right angles, as shown at A in Fig. 3, there is very little bending. As this angle decreases, the bending becomes more pronounced, as illustrated at C and D. A low-frequency wave bends or "refracts" much more than one of higher frequency. If a wave of a given frequency strikes the layer at an angle that just permits it to be bent back to earth, one of a little higher frequency will pass on through the layer. Often a wave will penetrate a lower layer only to be turned back by the increased ionization of the layer above it, as pictured at B.

The whole subject of what happens to a radio wave in the ionosphere is a most interesting and complicated one, but we do not need an exhaustive explanation of the various phases of that esoteric matter. For our purposes we need know only that sky waves can be bent back to the earth in the ionosphere; that most broadcast-frequency sky waves are absorbed in this region during the day time but are returned to earth at night; and that the exact spot to which a wave returns depends upon several highly variable factors.

And now we are ready to take up *fading*. As the curtain rises on this drama, we see two portions of the same radio wave perched on the transmitting antenna just prior to taking off. The ground wave is saying to the sky wave, "You take the high road and I'll take the low road, and I'll be there before you." It is this choice of paths by which the signal can go from the transmitter to the receiving location that causes the trouble.

If the receiver is near the trans-

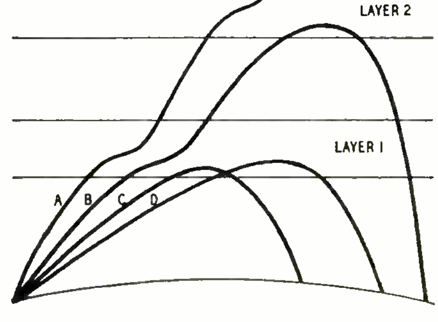


Fig. 3—The amount of bending depends on the angle at which the wave strikes.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mitter, reception is dominated by the powerful ground wave and is not affected by any sky waves that may or may not be returned from the ionosphere. As the distances from the transmitter increases, the ground wave grows weaker and weaker until finally it cannot be heard at all. At this point and beyond, the station cannot be received in the daytime. At night the waves "reflected" from the ionized layers permit signals to be received.

At a point where the sky wave and the ground wave are received about equally well, we have an area or belt of very bad "fading," or fluctuation in the intensity of the received signal. Since the two portions of the same signal arrive over different paths and cover different distances, they may arrive with a difference in timing or "phasing" that will cause their two separate intensities either to be added together or to buck one another. In the first case, the resulting signal will be

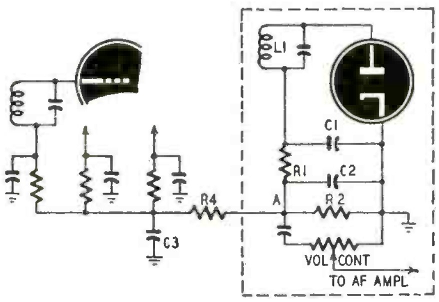

Fig. 4—A detector circuit with a.v.c.

stronger than the one from the ground wave alone; in the latter the two portions may so effectively cancel one another that nothing can be heard. Furthermore, since the path the sky wave travels is constantly changing with shifts in the height and ionization of the refracting layer, the signal intensity may vary constantly between these two extremes.

You might think that once the receiving station was beyond the reach of the ground wave, fading would be at an end, but such is not always the case. You have to remember that the wave-bending ionosphere is as unstable as a bucket of smoke and the path pursued by a radio wave through this ionosphere is constantly changing. At one time the receiver may be getting the full intensity of the refracted wave, while a few minutes later this center of intensity may have shifted to a spot several hundred miles away, and the receiver will be sitting in the weak fringe of the earth-returning wave.

What is even worse, the sideband frequencies of the wave may travel different paths in the ionosphere because of their slightly different frequency, and when they arrive at the receiver the phase of these intelligence-carrying sidebands may be altogether different from what they were at the transmitter. As a result, the music or voice may be very badly garbled by the interaction of these out-of-phase sidebands. This very annoying brand of

(*Continued on page* 100)

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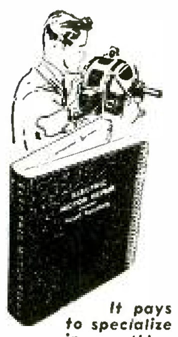

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fading accompanied by distortion is called "selective fading."

Night radio reception in the old days used to be a pretty exasperating affair. The operator had to ride the controls constantly to prevent the received signal from blasting the speaker one minute or fading clear out the next.

The cure, once found, was simple. *Automatic volume control* was the very poor name selected for it. I say "poor" because it is evident that any attempt to hold the volume at a constant level—making the whisper of the flute as loud as the bellow of the tuba—would result in distortion. What really was done was to make the r.f. sensitivity of the receiver inversely proportional to the intensity of the signal. As the signal intensity goes up, the receiver sensitivity goes down, and *vice versa.* The end result is that the signal delivered to the detector is practically independent of variations in the strength of the received signal.

This control is secured by varying the bias voltage applied to the r.f., mixer, and i.f. stages. As the negative bias on the grids of these tubes is increased, their ability to amplify is decreased, and the sensitivity of the receiver is reduced. Since we want this bias voltage to rise and fall with the strength of the received signal, the best place to get such a control voltage is from the signal itself.

Fig. 4 shows how this is done. The portion of the diagram inside the dotted lines is that of the diode detector shown and discussed in the chapter on

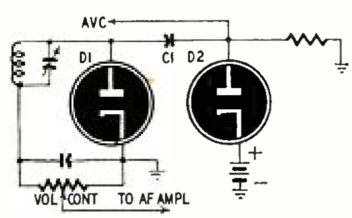

Fig. 5—A basic delayed a.v.c. circuit.

detector action (August, 1950, RADIO-ELECTRONICS). You will recall that the rectifying action of the diode causes three different types of current to flow downward through L1: first, the pulses of rectified r.f. carrier that were filtered out by the combination of R1, C1, and C2; second, the audio fluctuations that appear across R2; and third, the d.c. voltage produced by the one-way movement of electrons through R2 to ground. This last voltage is the one we are interested in.

The d.c. voltage drop across R2 is produced by rectifying the carrier envelope; so it stands to reason that it will be directly proportional to the amplitude of the carrier. If this amplitude increases, point A will become more negative with respect to ground; if it decreases—which is another way of saying the intensity of the signal goes down—point A becomes less negative.

Before this controlling voltage can be applied to the grids of our r.f. and i.f. tubes, however, we must comb out of it the a.f. variations still present at point A. This is done by means of a resistor-capacitor filter R4-C3.

The values of this resistor and capacitor are carefully chosen and should not be changed. When a capacitor charges and discharges through a resistor, as happens here, the time required for the voltage to build up and fall depends upon the values of the two components. The larger they are, the more time is required. What we want here is a combination that will be too slow to follow the voltage variations caused by the lowest audio frequency but fast enough to let the system have time to "recover" in the time required to tune from one station to another. Otherwise, when tuning from a strong station past a weak one, the sensitivity of the receiver might not have time to adjust itself upward after leaving the strong station, and the weak station would not be heard. The usual time constant is 0.1 second.

This negative voltage is fed to the various grids of the controlled tubes through isolating resistors that prevent coupling between the grid circuits. Tubes controlled by a.v.c. are the "remote-cutoff" type, the ones whose amplifying properties respond smoothly to wide variations in bias voltage. These tubes also are provided with a certain amount of minimum fixed bias—such as cathode bias—so that the plate current does not become excessive when no a.v.c. voltage is being produced.

In an ordinary a.v.c. system, the controlling action starts on even the weakest signal and begins to reduce the gain of the receiver when increased sensitivity would really be a help. "Delayed a.v.c.," as diagrammed in Fig. 5, shows the basic circuit for overcoming this problem. One diode D1 of a duo-diode is used for detection in the usual manner. The i.f. signal is also applied, through C1, to D2. The cathode of D2 is positive with respect to ground, which makes the plate negative with respect to the cathode. As long as the peak amplitude of the i.f. signal applied to D2 is less than this bias voltage, there will be no rectification, and consequently no a.v.c. voltage will be developed. As soon as the peak i.f. voltage rises above this bias voltage, rectification begins and the a.v.c. voltage is developed just as before. A battery is used for bias in the diagram, but the cathode may be tapped in at some point on a current-carrying resistor to get the correct bias.

Automatic volume control troubles are almost entirely due to failures of the capacitors, resistors, or diodes that make up a.v.c. circuits. Since the voltages are fed to the grids of the tubes through high-ohmage resistors, even a slightly leaky capacitor will short-circuit the a.v.c. voltage.

A possibly worse trouble is an intermittently leaky capacitor, which will produce its own type of fading. Where the complaint is "fading" or "intermittent," it is often a good idea to replace all capacitors in the a.v.c. circuit and to replace or make sure the resistors are not changing their ohmage.

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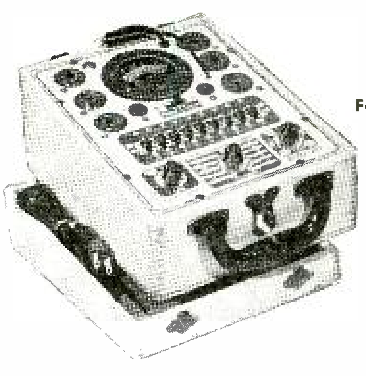

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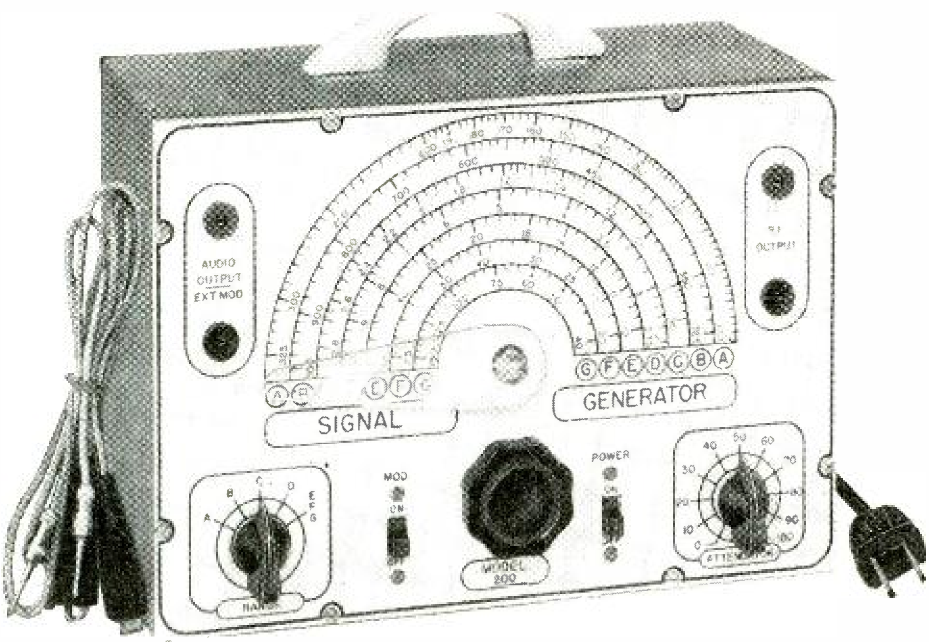

★ **TUBES USED:** 12AU7—One section is used as oscillator and the second is modulated cathode follower. T-2 is used as modulator. 6C4 is used as rectifier.

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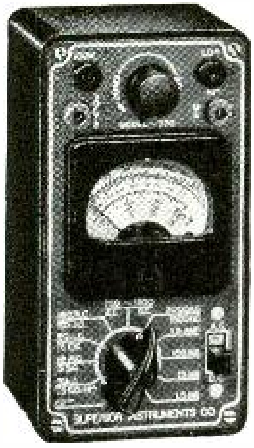

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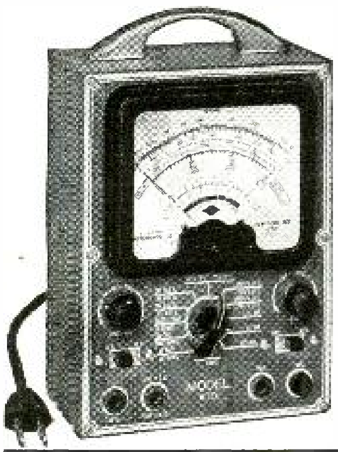
FEATURES: Compact—measures 3⅛" x 5⅞" x 2¼". Uses latest design 2% accurate I Mil. D'Arsonval type meter. Same zero adjustment holds for both resistance ranges. It is not necessary to readjust when switching from one resistance range to another. This is an important time-saving feature never before included in a V.O.M. in this price range. Housed in round-cornered, molded case. Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use. **SPECIFICATIONS: 6 A.C. VOLTAGE RANGES:** 0—15/30/150/300/1500/3000 VOLTS. **6 D.C. VOLTAGE RANGES:** 0—7.5/15/75/150/750/1500 VOLTS. **4 D.C. CURRENT RANGES:** 0—1.5/15/150 MA. 0—1.5 AMPS. **2 RESISTANCE RANGES:** 0—500 OHMS 0—1 MEGOHM.

The Model 770 comes complete with self-contained batteries, test leads and all operating instructions.

$14.90 NET



Superior's new model 670

SUPER-METER

A COMBINATION VOLT-OHM MILLIAMMETER PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5 Amperes
RESISTANCE: 0 to 500/100,000 Ohms 0 to 10 Megohms
CAPACITY: .001 to .2 Mfd. .1 to 4 Mfd. (Quality test for electrolytics)
REACTANCE: 700 to 27,000 Ohms 13,000 Ohms to 3 Megohms
INDUCTANCE: 1.75 to 70 Henries 35 to 8,000 Henries
DECIBELS: —10 to +18 +10 to +38 +30 to +58

ADDED FEATURE:

The Model 670 includes a special GOOD-BAD scale for checking the quality of electrolytic condensers at a test potential of 150 Volts.

The Model 670 comes housed in a rugged, crackle-finished steel cabinet complete with test leads and operating instructions. Size 5½" x 7½" x 3".

$28.40 NET

Superior's new model TV-20

20,000 OHMS PER VOLT MULTI-METER and TELEVISION KILOVOLTMETER

The Model TV-20 was designed to provide all the multi-meter measurement requirements of A. M., F. M. and Television. Unlike other recent models, which are actually standard V.O.M.'s converted to test the new Television Voltages, the Model TV-20 is a completely new unit. It provides the sensitivity, ranges and accessories which are needed to service F. M. and Television in addition to A. M. Radio. The High Voltage Probe for example, with a range of 50,000 volts and designed to withstand 100,000 volts, is an integral part of the instrument with a special compartment for housing it when not in use.

SPECIFICATIONS

- 9 D. C. VOLTAGE RANGES. (at 20,000 ohms per Volt) 0-2.5/10/50/100/250/500/1,000/5,000/50,000 Volts
- 8 A. C. VOLTAGE RANGES: (At 1,000 ohms per Volt) 0-2.5/10/50/100/250/500/1,000/5,000 Volts
- 5 D. C. CURRENT RANGES
  0-50 Microamperes
  0-5/50/500 Milliamperes
  0-5 Amperes
- 4 RESISTANCE RANGES:
  0-2,000/20,000 ohms 0-2/20 Megohms
- 7 D. B. RANGES: (All D. B. ranges based on ODb = 1 Mv. into a 600 ohm line)
  — 4 to + 10 db; + 36 to + 50 db
  + 8 to + 22 db; + 42 to + 56 db
  + 22 to + 36 db; + 48 to + 62 db
  + 28 to + 42 db
- 7 OUTPUT VOLTAGE RANGES:
  0 to 2.5/10/50/100/250/500/1,000 Volts

ADDED FEATURE:

The Model TV-20 includes an Ultra High Frequency Voltmeter Probe. A Silicon V. H. F. Diode together with a resistance capacity network provides a frequency range up to 1,000 MEGACYCLES. When plugged into the Model TV-20, the V. H. Probe converts the unit into a Negative Peak-Reading H. F. Voltmeter which will measure gain and loss in all circuits including F. M. and T. V.; check capacity and impedance; test efficiency of all oscillator circuits; measure bandwidth of F. M. and T. V.; etc.

$39.95 NET

The Model TV-20 operates on self-contained batteries. Comes housed in beautiful hand-rubbed oak cabinet complete with portable cover, Built-In High Voltage Probe, H. F. Probe Test Leads and all operating instructions. Measures 4½" x 10¼" x 11½". Shipping Weight 10 lbs.

TO ORDER TURN TO PAGE 104 FOR RUSH ORDER FORM

3

GENERAL ELECTRONIC DISTRIBUTING CO.

98 PARK PLACE DEPT. RC-1 NEW YORK 7, N. Y.

Superior's model CA-12

SIGNAL TRACER

THE WELL KNOWN MODEL CA-12 IS THE ONLY SIGNAL TRACER IN THE LOW PRICE RANGE INCLUDING BOTH METER AND SPEAKER!!!

SPECIFICATIONS

- ★ Comparative Intensity of the signal is read directly on the meter—quality of the signal is heard in the speaker.
- ★ Simple to Operate—only one connecting cable—no tuning controls.
- ★ Highly Sensitive—uses an improved vacuum-tube voltmeter circuit.
- ★ Tube and Resistor Capacity Network are built into the detector probe.
- ★ Built-In High Gain Amplifier—Alnico V Speaker.
- ★ Completely Portable—weighs 8 pounds—measures 5½" x 6½" x 9".

Model CA-12 comes complete with all leads and operating instructions...... **$29.95 NET**

Superior's new model TV-30

TELEVISION SIGNAL GENERATOR

ENABLES ALIGNMENT OF TELEVISION I F. AND FRONT ENDS WITHOUT THE USE OF AN OSCILLOSCOPE!

The Model TV-30 represents a radical departure in the design of Television Signal Generators. Unlike the "sweep" type of Generator which requires the use of an Oscilloscope and extensive technical knowledge including pattern interpretation etc., the TV-30 is a self-contained unit which permits alignment of Television Receivers by the use of exactly the same methods employed in the past to align Broadcast and Short-Wave Receivers.

FEATURES

Built-in modulator may be used to modulate the R. F. Frequency also to localize the cause of trouble in the audio circuits of T. V. Receivers.

Double shielding of oscillatory circuit assures stability and reduces radiation to absolute minimum.

Provision made for external modulation by A. F. or R. F. source to provide frequency modulation.

All I. F. frequencies and 2 to 13 channel frequencies are calibrated direct in Megacycles on the Vernier dial. Markers for the Video and Audio carriers within their respective channels are also calibrated on the dial.

Linear calibrations throughout are achieved by the use of a Straight Line Frequency Variable Condenser together with a permeability trimmed coil.

Stability assured by cathode follower buffer tube and double shielding of component parts.

SPECIFICATIONS

Frequency Range: 4 Bands—No switching; 18-32 Mc., 35-65 Mc., 54-98 Mc., 150-250 Mc.

Audio Modulating Frequency: 400 cycles (Sine Wave). Attenuator: 4 position, ladder type with constant impedance control for fine adjustment. Tubes Used: 6C4 as Cathode follower and modulated buffer. 6C4 as R.F. Oscillator. 6SN7 as Audio Oscillator and power rectifier.

Model TV-30 comes complete with shielded co-axial lead and all operating instructions. Measures 6" x 7" x 9". Shipping Weight 10 lbs.

$29.95 NET

RUSH ORDER FORM

CUT OUT AND MAIL TODAY!

4

GENERAL ELECTRONIC DISTRIBUTING CO.
DEPT. RC-1, 98 PARK PLACE, NEW YORK 7, N. Y.
GENTLEMEN:
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QUANTITY	MODEL	PRICE

TOTAL

$............ (Payment in Full Enclosed) $.......... (Deposit Enclosed—Ship Balance C.O.D.)

SHIP TO:

Name ....

Address ....

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

Television Service Notes

By MICHAEL L. TORTARIELLO

Speedy television receiver servicing depends on the ability to locate the trouble quickly from the symptoms in the set. This article presents a number of troubles and their cures for some of the more popular TV receivers.

RCA

9T270

All tubes light, sound O.K., picture goes from bright to dim. Upon becoming dim, the picture increases to about 1⅓ normal size and high voltage goes from a normal 12,500 to about 9,500.

Inspection revealed that one of the 1B3-8016 high-voltage rectifier tubes in the voltage doubler also varied in brightness. The trouble was a defective 3.9-ohm resistor in one leg of the filament circuit of the high-voltage rectifier.

9TC272

Sound O.K., no horizontal sync, no raster on screen. Adjusting the horizontal hold did not remedy this condition.

C-159, a .01-μf capacitor in the horizontal oscillator, was leaking badly. Replacing it with a new .01-μf, 600-volt capacitor fixed the trouble.

9T275

Picture and sound O.K., but when a large white or black object or large lettering appeared on the screen, there was a disturbing smear.

Checked second video amplifier tube circuit, a 6K6-GT, and found an open L109, a 180-μh peaking coil. The smear disappeared when this was replaced.

Westinghouse

H-600T16

A common fault in this set is the simultaneous burning out of these resistors: R-401, a 400-ohm wire-wound focus control; R-407, 560 ohms; and R-410, 110 ohms. This trouble is caused by an internal short in the 6Y6-G high-voltage oscillator tube. Replace the tube and the resistors.

H-613K16

Sound O.K., no raster, no high-voltage on picture tube.

Checking the high-voltage rectifier and the 6Y6-G high-voltage oscillator showed that the 1B3-8016 rectifier did not light. The same tube in another set worked O.K. Further check showed that two turns of wire on the high-voltage oscillator transformer which supplies filament current for the 1B3-8016 had slipped a ½ inch away from the primary. This made the coupling between the two windings too loose for normal operation. Fastening the windings in their proper place with household cement cured the trouble.

H-600T16

Sound O.K., thin vertical line on picture tube.

The 12AU7 horizontal multivibrator showed a normal sawtooth. Checked output of three 7A5 horizontal output tubes and found no signal and no B-plus. Tested R-406, a 5,000-ohm wire-wound variable width control, and found it burned out. Also one of the 7A5's was shorted.

H-605T12

Sound shaky, raster normal, video signal very erratic.

When the outdoor antenna was disconnected from the set, channels 2 and 4 worked normally with a short piece of wire attached to one of the antenna posts. Tubes in the front end were tested and the 6AG5 mixer tube was found gassy. Set worked normally on all channels when this was replaced.

H-600T16

No sound but noticeable hum from speaker, picture showed a crease about 2 inches from the left side.

Audio amplifier checked O.K. with an audio oscillator, but no sound was reaching the audio system from the 6AL5 ratio detector. C-211, the .01-μf a.f. coupling capacitor, was found shorted. Replacing this corrected the audio trouble and also eliminated the crease in the picture.

After about three or four months of use, the cathode-ray tube in these sets develops a brownish-yellow spot near the center of the screen. This is caused by a charge remaining on the two 500-μμf capacitors in the high-voltage circuit after the set is shut off. This trouble can be eliminated by disconnecting the lead from the 500-μμf capacitor that goes to pin 7 of the 1B3-8016 high-voltage rectifier tube. The manufacturer has already made this change in the late models.

Muntz

Model 169

Sound O.K., picture has normal brightness but opens to full width of screen and then shrinks to about 3 inches wide. This repeats about every 15 seconds.

A leaky 0.2-μf capacitor in the screen circuit of the 6BG6-G horizontal oscillator and output tube causes this trouble. Replace this capacitor.

Ansley

Model 703

Sound O.K., no raster, and no high voltage at the cathode ray tube.

The two 1B3-8016 high-voltage rectifiers and the 6BG6-G horizontal output tubes checked O.K. High voltage was present at terminal 3 of the horizontal output transformer. The trouble was finally pinned down to the high-voltage doubler rectifier circuit where the 500-μμf capacitor connecting the two plates of the tubes was found shorted.

..this letter speaks for itself!

Admiral Corporation
SERVICE DIVISION
201 E. NORTH WATER STREET · CHICAGO 11 · TELEPHONE MOHAWK 4-4622

Mr. Mel Buehring
Simpson Electric Company
5200 West Kinzie Street
Chicago 44, Illinois

Dear Mel:

This is to tell you how delighted we are here at Admiral with the new Model 303 Simpson Vacuum Tube Volt-Ohmmeter. It certainly is a versatile instrument for television servicing.

The large meter is very legible, and yet the instrument itself is a compact size. I particularly like the AC voltage range, which is the widest I've ever seen on this type of instrument.

Our service engineers think you've done a good job on the Operator's Manual, too, because it is both complete and concise.

Of course, we've used the Simpson Model 260 Volt-Ohm-Milliammeter for years. The "303" is a fine companion instrument to the "260".

Congratulations!

Sincerely yours,

M. J. Schinke

ADMIRAL CORPORATION
M. J. Schinke
National Service Manag

MJS:ar

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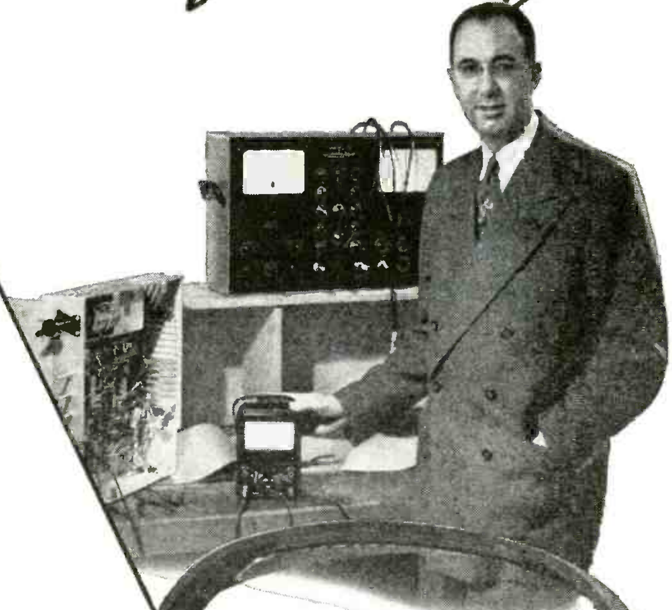
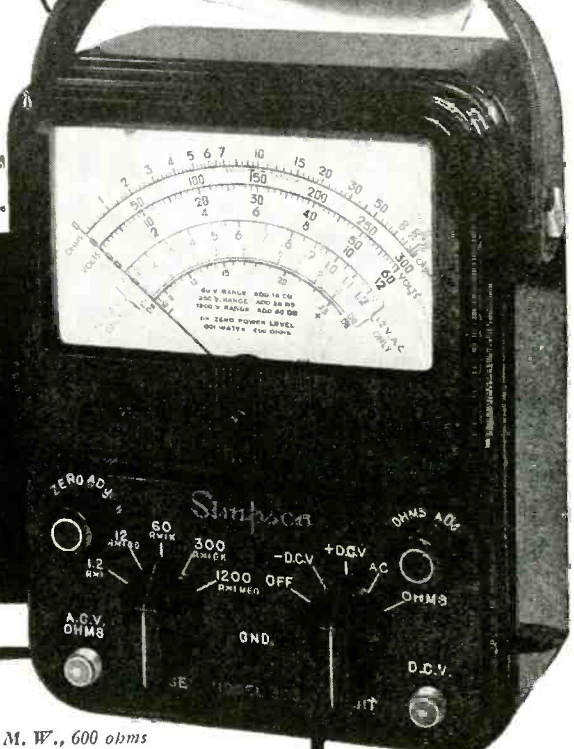
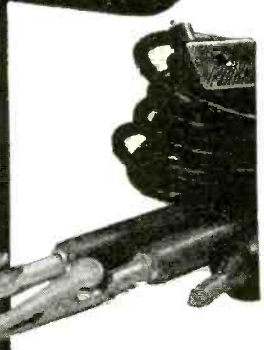




Model 303
VACUUM TUBE VOLT-OHMMETER



SPECIFICATIONS

DC Voltage
Ranges 1.2, 12, 60, 300, 1200 (30,000 with Accessory High Voltage Probe)
Input Resistance 10 megohms for all ranges
DC Probe with one megohm isolating resistor Polarity reversing switch

Ohms *Ranges 1000 (10 ohms center)*
100,000 (1000 ohms center)
1 megohm (10,000 ohms center)
10 megohms (100,000 ohms center)
1000 megohms (10 megohms center)

AC Voltage
Ranges 1.2, 12, 60, 300, 1200
Impedance (with cable) approx. 200 mmf shunted by 275,000 ohms

AF Voltage
Ranges 1.2, 12, 60
Frequency Response Flat to 100,000 cycles

Decibels
Ranges —20 to +3, —10 to +23, +4 to +37, +18 to +51, +30 to +63

Zero Power Level 1 M. W., 600 ohms

Galvanometer
Zero center for FM discriminator alignment and other galvanometer applications

R. F. Voltage
(Signal tracing with Accessory High Frequency Crystal Probe)
Range 20 volts maximum
Frequency Flat 20 KC to 100 M.C.
105-125 V. 60 cycles

Size
5¼"x7"x3⅛" (bakelite case). Weight: 4 lbs. Shipping Wt.: 6½ lbs.

Dealer's Net Price
Model 303, including DCV Probe, ACV—Ohms probe and Ground Lead—$58.75;
Accessory High Frequency Probe, $7.50;
Accessory High Voltage Probe, $14.85
Also available with roll top case, Model 303RT—$66.70

Simpson ELECTRIC COMPANY
5200 WEST KINZIE STREET, CHICAGO 44, ILLINOIS • IN CANADA: BACH-SIMPSON, LTD., LONDON, ONTARIO
Phone: COlumbus 1-1221

METER FOR POWER SUPPLY CHECKS VOLTS AND AMPS

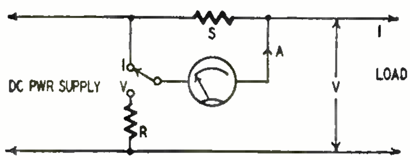
By I. QUEEN

Any utility power supply becomes far more useful if it can measure voltage, current, and power into its load. The only parts to be added are a milliammeter, s.p.d.t. switch, and a couple of resistors. Current and voltage are measured separately (see figure). The product of these numbers gives the power.

The shunt S parallels the meter for measuring current. Its resistance is found from the following:

$$S = \frac{MA}{I-A},$$

where M is the meter resistance, I the *maximum* load current, and A the meter current for full-scale deflection. For an example, assume M is 100 ohms, I is 100 ma, and A is 1 ma. The shunt should be 1.01 ohms.



The circuit for using a milliammeter to measure the power supply's output.

The multiplier R is connected for voltage measurement. Its resistance should be

$$R = \frac{V}{A} - M,$$

where E is the *maximum* voltage to be indicated.

Only slight errors are introduced by the presence of the meter. Generally they are neglible.

USING SMALL MAGNETS

The chart for my tube tester is on a large cardboard sheet. There are no index lines so it is easy to make a mistake in setting up the tester. To avoid mistakes, I place the chart over a sheet of galvanized iron and use a thin bar magnet as a movable index point or pointer. You can even cement the chart to the metal sheet and hang it on the wall. A strong magnet will remain in position until you move it.—*Joseph Amorose*

"Remember that old pop-up toaster you were going to throw out?"

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See these big-space ads! They're appearing in the *Saturday Evening Post, Life, Look,* and *Collier's Magazine.* Each is loaded with stop-appeal and sales-appeal. Each one features an endorsement *of your service* by a famous star such as Paulette Goddard, Marie Wilson, Diana Lynn, or Patrice Munsel.

SYLVANIA

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS; ELECTRONIC TEST EQUIPMENT;

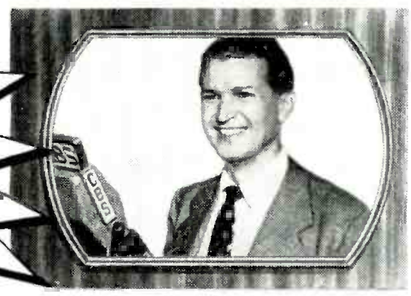
TV SERVICE

Campaign ever launched!

HERE'S the hardest hitting . . . and the most complete advertising campaign ever planned, to bring service business to every dealer who displays the Sylvania emblem.

All during 1951, your prospects are certain to SEE, HEAR, and READ about your expert service in magazines, on television, and through window displays.

POPULAR WEEKLY TV SHOW



The great Nation-wide TV show, "Beat the Clock," featuring Bud Collyer over CBS-TV, will go to bat for your service and the Sylvania products which you sell. Clever animated cartoon commercials on the CBS-TV station in your area will inform prospects of your expert workmanship and prompt service.

DEALER TIE-IN PROGRAM

Tying everything together is the greatest and most colorful dealer tie-in program you have ever seen!

You get FREE giant, full-color displays of the featured stars. You get counter cards . . . bright window streamers . . . spot radio announcements . . . mailing pieces . . . all designed to identify you as the Sylvania Service Dealer advertised on television and in the national magazines.

Ask your jobber for full information about the bigger-than-ever 1951 Service Dealer Advertising Program. If he can't give you all the facts, mail the coupon now!

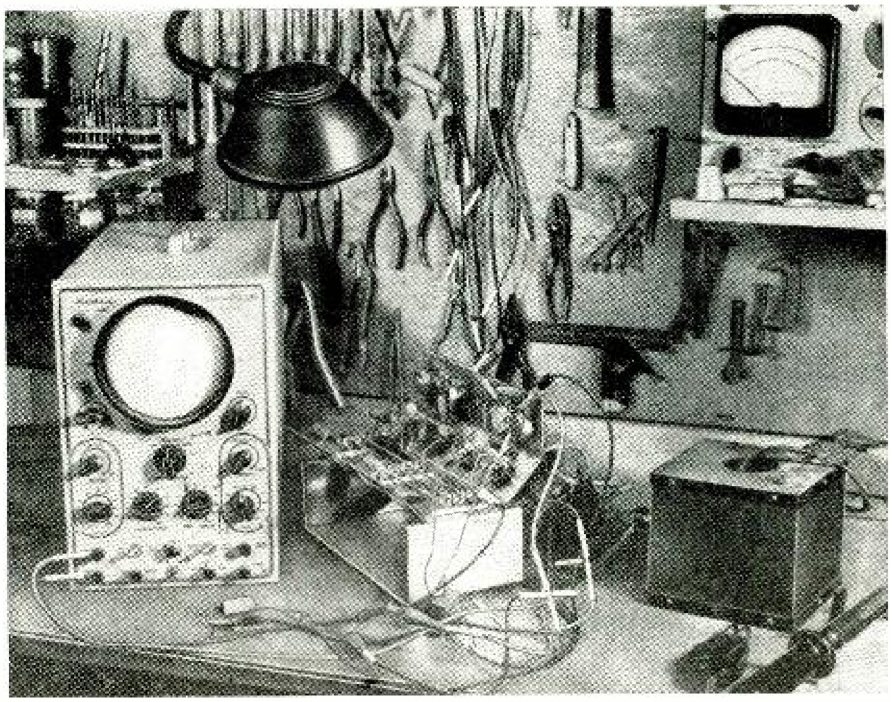
RADIO TELEVISION SERVICE — SYLVANIA RADIO TUBES Authorized Dealer

Be sure to display this emblem. Put up these Sylvania decals right now! This seal is the target of the whole Sylvania Service Dealer campaign. Put them on your windows and on your trucks. Made in 8-inch and 12-inch sizes. Order a supply from your jobber TODAY! They're free!

Sylvania Electric Products Inc.
Dept. R–2401, Emporium, Pa.
Please send me full details about the greatest Radio-Television service advertising campaign in the history of the industry.
Name ____________
Street ____________
City ____________ *Zone* ____ *State* ____________

ELECTRIC

FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS



Experimental setup of oscillator in Fig. 1-c used for making oscillograms. Special Unichassis in center is made for experimental work and simplifies breadboard wiring. Experimental power supply appears at the right in the photograph.

Electronics and Music

Part VII—Designing tone generators for electric organs

By RICHARD H. DORF*

CONSTRUCTING a polyphonic electronic musical instrument is a big job compared to building many other electronic devices. Sixty separate tone frequencies must be available for even a single-manual, five-octave instrument. So the number of components will not be small. And after the bare tone frequencies have been provided, the tones must be shaped—varied in quality—and volume-controlled. Keying delay should also be provided; vibrato or tremolo is needed; couplers may be desired between manuals; octave couplers may be wanted; manuals (and pedals) and a console must be secured or made; and so on.

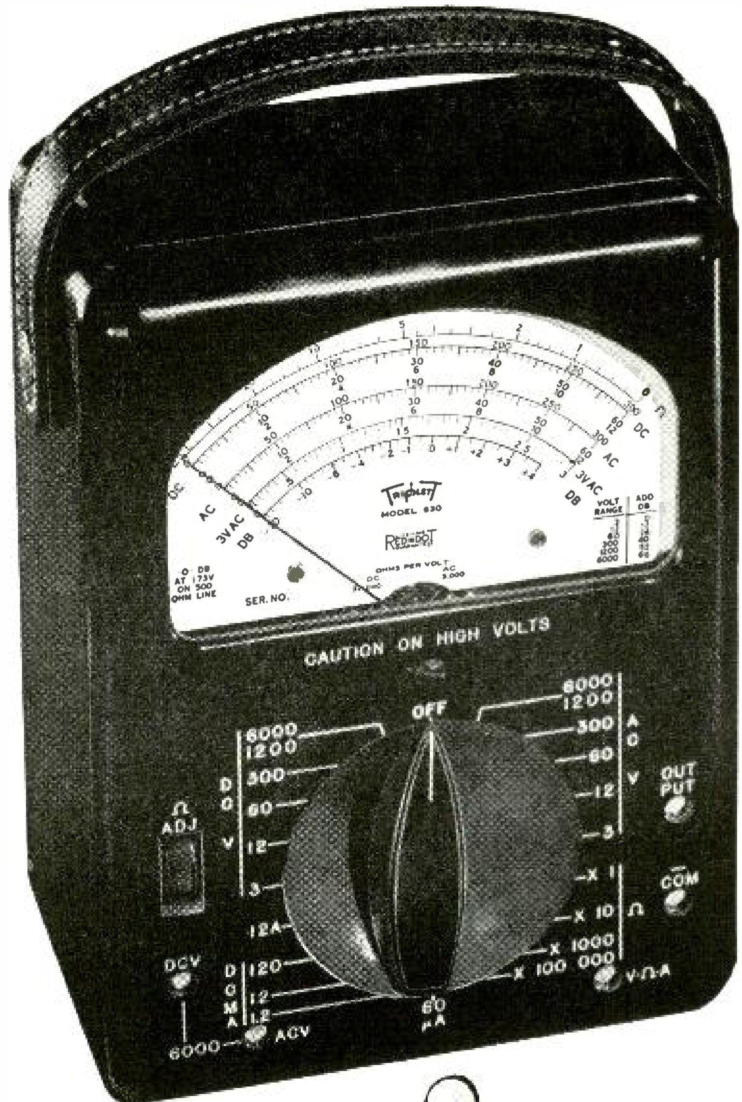
Building an electronic organ is not a job for the novice, nor is the design for such an instrument a decision to be taken in five minutes. But strangely enough, initial generation of the necessary tones, which is what this article deals with, is the easiest part of the job.

There are only two basic requirements. The first is to provide as many tone sources as necessary and the second is that each should be of the correct pitch. These requirements indicate that (initially at least) the designer may consider all of the many oscillator circuits brought forth up to date.

Depending on what the designer has in mind, several other conditions may have to be met, and they may be no less important than the basic ones. The tones must be keyed somehow, and it may be desirable to key the oscillators themselves without running into "chirp" or clicks. A keying delay should be included somehow. The oscillators themselves may have to provide it. The desired waveform may be anything from a sine to the most complex and the oscillators rather than following tone-shaping circuits may have to provide it. Frequency stability may be important unless there is some provision for synchronization. And other points may crop up, not the least of which may be the necessity of keeping costs and space requirements down.

For frequency stability it is desirable to have all oscillators tuned to the octaves of each of the 12 notes synchro-

* Audio Consultant



ALL RANGES WITH THIS ONE CONTROL

Model 630

Just *one* knob—extra large—easy to turn—flush with the panel, controls all ranges. This one knob saves your time—minimizes the chances of "burn-outs" because you don't have to remember to set another control. You can work fast with Model 630 with your eyes as well as your hands. Look at that scale—wide open—easy to read, accurately. Yes, this is a *smooth TV* tester. Fast, safe, no projecting knobs, or jacks, or meter case. Get your hand on that single control and you'll see why thousands of "Model 630's" are already in use in almost every kind of electrical testing

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nized so that they will "lock in" with each other. But synchronization has two disadvantages. First and most important to the tonal effect, it eliminates the chorus effect described in the first article of this series since all the oscillators operate in phase. Second, if sine waves are desired, very few oscillators will be found which can be synchronized and which will produce sine waves. Oscillators naturally lock in, of course, when both are at the same frequency, but synchronization is a touchy matter when sine-wave oscillators are required to lock with a harmonic or subharmonic.

Fig. 1 illustrates six representative feedback oscillators, all of which are suitable for electronic organs (though not all have been used in commercial instruments). Fig. 1-a is the tuned-grid (plate tickler) oscillator, in which the

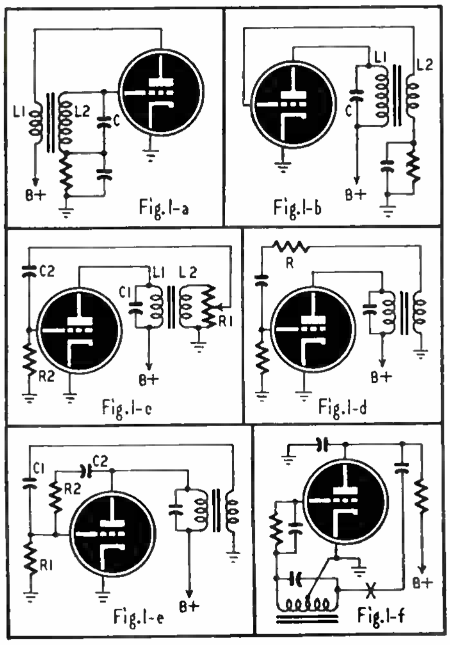


Fig. 1—Six oscillators suitable for producing tones for electronic music.

grid circuit is tuned and a secondary winding on the inductor feeds back energy from the plate. As in all feedback-transformer arrangements, the connection polarity of primary and secondary must be correct for positive feedback; if the circuit does not oscillate, reverse the connections to primary or secondary (not both).

Fig. 1-b diagrams the tuned-plate (grid-tickler) oscillator, which is exactly the same as that of Fig. 1-a except that the plate circuit is tuned. In this case the values of the tank inductor and capacitor play the greatest part in determining frequency, though the tube characteristics, plate current, tank current, and other factors do influence it. The paralleled resistor and capacitor in each circuit is the grid leak. Values are very noncritical and experiments to find correct values may be begun around 50,000 ohms and .01 µf. If the time constant (product of R in megohms and C in microfarads) is too long, the oscillator may not start or may go on and off at intervals.

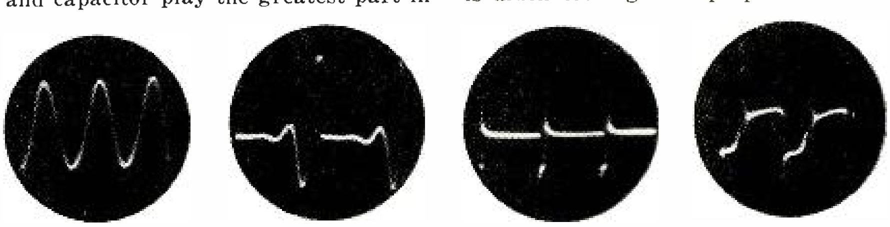
The amplitude of the positive feedback is a very important factor in determining output waveform and frequency stability. It is controlled within limits by the grid-leak arrangement because the increase in grid current which accompanies an increase in feedback amplitude automatically increases the negative bias and lowers the amplification of the tube. The grid leak controls amplitude only within a fairly narrow range, however.

In the two oscillators of Figs. 1-a and 1-b the principal factor controlling feedback is the turns ratio of the transformer. Ideally it should be wound so that the voltage reaching the grid due to the tube output is exactly the same as the voltage at the grid which produced that output. A feedback oscillator is almost a perpetual-motion machine in that it supplies its own input. (The fact that external plate and filament power supplies are necessary, however, prevented the first oscillator inventor from rushing to Washington with a final solution to the perpetual-motion riddle.)

If the feedback is too great, the output waveform distorts and frequency stability suffers. Increased above a certain point, the feedback causes relaxation oscillations with a roughly sawtooth waveform having sharp, needlelike peaks at each apex. The frequency is then extremely sensitive to the slightest changes in supply voltage or heat movement of the tube elements and is not useful for electronic music unless synchronized because of the excessive frequency drift.

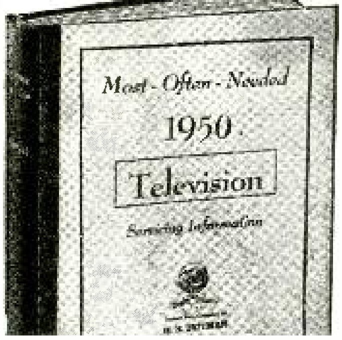
The usual noncommercial constructor shies away from winding his own coils for these oscillators and prefers to use available ones. That is made possible by the circuits of Figs. 1-c, 1-d, 1-e, and 1-f.

Fig. 1-c is a tuned-plate oscillator like that of Fig. 1-b. The transformer, however, is a standard interstage unit: L1 is usually the higher-impedance winding, tuned by C1. Normally the voltage across L2, which usually has a stepdown ratio of only a very few times, is much too high for proper feedback.



These oscillograms show what happens when feedback in a conventional oscillator is too great and when the time constant of the grid-leak is too long. The perfect sine wave results when feedback is reduced to the optimum value by any of the methods illustrated in Figs. 1-c through 1-f, or by using a suitable transformer.

New SUPREME TELEVISION *Manuals*



New 1950 Television Manual

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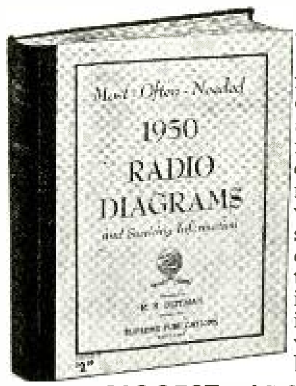

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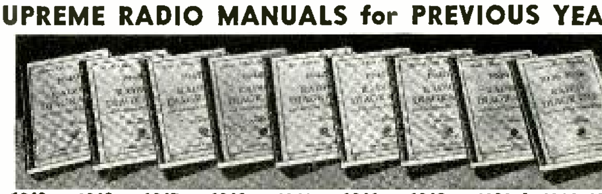

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However, a potentiometer R1, which may be anywhere between 10,000 and 100,000 ohms or even more, is shunted across L2 and the arm is adjusted until just enough voltage is fed to the grid to sustain oscillations. At this point the waveform will be almost pure sine (if the grid-leak components R2 and C2 are chosen correctly) and the frequency will be most stable and nearest to the resonant frequency of L1 and C1. Once the correct values for the upper and lower halves of R1 have been found, the potentiometer may, of course, be replaced with a pair of ½-watt resistors.

The same trick may be done in a slightly different way by using the circuit of Fig. 1-d. Here resistor R is a series limiter. This, incidentally, is a well-known form of resistance stabilization ordinarily used to stabilize frequency. It is also useful here, of course, to compensate for the fact that the transformer turns ratio is not ideal.

Fig. 1-e illustrates a method of combined stabilization and feedback correction original with the writer (although it was probably original with other workers at prior times). As usual with the standard interstage transformer used, the positive feedback is too great for stable sine-wave oscillation. The positive feedback is produced in the usual way.

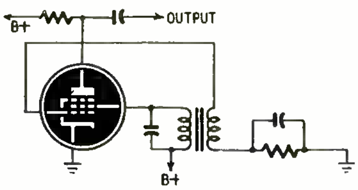


Fig. 2—This stable audio tone generator uses the electron-coupled circuit.

The excess of positive feedback is remedied by adding negative feedback. An oscillator of the feedback type may be considered simply as a perfectly standard amplifier which produces its own input. The amplitude of oscillation depends on two things: the amount of coupling between plate and grid, and the amplification of the tube. The previous circuits have been stabilized by varying the coupling. In Fig. 1-e the feedback voltage is lessened by reducing the amplification of the tube. R2 is a simple negative feedback resistor from the plate to the grid. C2 is a blocking capacitor which should have a low reactance compared to the resistance of R2.

After the circuit is connected, R2 is varied (use a 10-megohm potentiometer) until the circuit just oscillates. The positive feedback voltage is then correct. In addition, since the amplifier is operating with a fair degree of negative voltage feedback (the degree of permissible negative feedback depending on how much too large the transformer secondary voltage is), it is itself stabilized to a large degree against changes in amplification caused by fluctuations of supply voltages. Since, in an audio oscillator of this kind, changes in plate current and amplification, rather than changes in tube-element capacitances cause most of the undesirable frequency irregularities, stabilizing the amplifier helps matters considerably. An additional effect of the negative feedback is to lower the tube's effective output impedance, reducing the importance of any tube output capacitance that may affect the frequency, especially in the higher octaves.

Fig. 1-f is a standard Hartley oscillator, which is usable for electronic music. Since, however, most tapped inductors ordinarily available are center-tapped (often primaries or secondaries of push-pull transformers), there will be too much feedback. This can be reduced by inserting a resistor at point X.

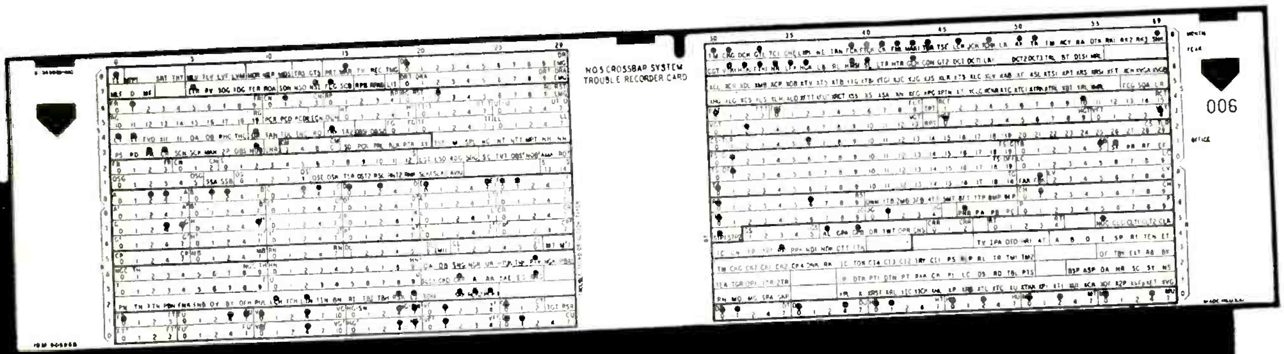
Output may be taken from the plates of any of the oscillators shown in Fig. 1 without a great effect on frequency, provided the impedance of the load is high and its shunt reactance low. For maximum freedom from loading effects, however, especially where the load is keyed or otherwise altered during operation, electron coupling is desirable. Almost any feedback oscillator may be used in an electron-coupled circuit. The method illustrated in Fig. 2 is to use a pentode tube and employ the screen as the oscillator anode. The circuit of Fig. 2 is exactly the same as Fig. 1-a with those exceptions. The screen does not, of course, draw much current, but the electron stream passing through it to the plate is modulated by the oscillations. The plate output, taken across a standard load resistor, is of the oscillation frequency and may be passed on to following stages. The output capacitor is uncritical, values between .01 and .05 μf being suitable.

Changes in the load which would affect the plate current have little effect on the oscillator circuit, and reactive loading of the plate has almost none at all. The screen supply voltage should be somewhat less than that supplied to the plate and should, of course, be under the maximum specified by the tube manual. It may be obtained from a tap on the power-supply bleeder resistor. The tap should be bypassed to ground.

The discussion of vacuum-tube oscillators for polyphonic electronic musical instruments will be continued in the next issue.

STABLE TONE GENERATOR

Stable a.f. or ultrasonic signals for test and control purposes can be generated by heterodyning signals from two crystal-controlled oscillators. Any conventional oscillator can be used. Feed the outputs into the grid circuit of an a.f. amplifier and the difference frequency will appear at the plate. Suitable crystals can be obtained on the surplus market for less than one dollar each.—*Francis Roberts*



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Studying punched card record of dial system operation. Each card (top) can report 1080 items

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Audio Feedback Design

Part IV

By GEORGE FLETCHER COOPER

An amplifier design. Output is ten watts and response flat from 30 to 15,000 cycles

In the previous article we examined Mr. Williamson's amplifier to determine how to apply the design methods described in earlier articles. Now we shall consider a new design from the beginning.

We shall start off with the assumption that the gain of the amplifier is to be 50 db (316 times), that the output power is to be 10 watts, and that the distortion is to be below 1%. It really is not worth while pressing the distortion below ½ to 1%, because the transmitter distortion is more than this if we take a broadcast signal, while disc distortion is a good deal more than 1%. The response should be uniform from 30 to 15,000 cycles.

To get 10 watts we may use, as Mr. Williamson does, 6L6 or KT66 tubes, but we shall use them as tetrodes with a lower plate voltage. This will save quite a lot in smoothing capacitor costs. I will use figures for the KT66, but the 6L6 values will not be significantly different. Since the distortion requirement suggests that we aim at 20 decibels of feedback, the over-all gain without feedback must be at least 70 decibels, or approximately 3,000 times.

First, then, how many stages? A KT66 has a mutual conductance of 6,150 μmhos (5,200 μmhos for 6L6) and an optimum load of 2,200 ohms (2,500 ohms for 6L6). This gives a gain of just over 26 times for the two tubes. An input transformer, for I have assumed that we use one, will give about 20 db gain, or 10 times (This is not, of course, a power again). We need, therefore, an additional gain of 3,000/260 times, which is about 12 in voltage gain. A miniature pentode, such as the 6AU6, will do this very nicely. So, for that matter, will a 12AT7 triode.

The so-called seesaw circuit gives a gain of about 40, which means an input of rather less than ½ volt without feedback, or 5 volts with feedback, will be needed. This is at the grid; and if we use a transformer stepping up from 600 ohms to 100,000 ohms, we shall require roughly 0.3 volt at 600 ohms for the input.

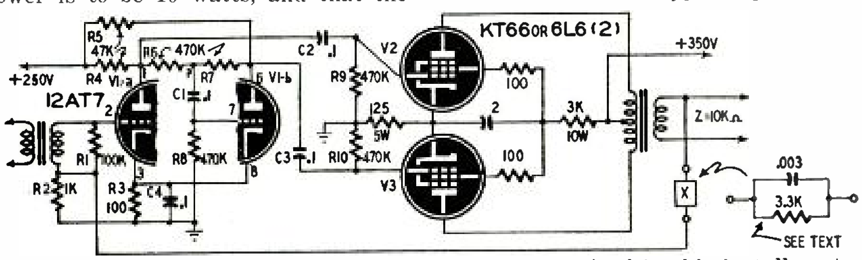


Fig. 1—Circuit of the amplifier whose design is described in this installment.

The output stage

My main difference in approach from Mr. Williamson is in the design of the output transformer. He keeps the direct current balanced and uses a large inductance. I use the smallest possible inductance and then allow an air gap to avoid dependence on the d.c. balance. It seems easier that way. We begin with the design of the output transformer.

To make life easy, I have assumed that the load impedance is 10 ohms. The lowest frequency is to be 30 cycles, and we want the output transformer to be as small as possible. If the inductance is made too low, however, we shall get distortion in the transformer and the load as seen by the tubes becomes reactive. A fairly sound working rule is to allow the response to drop by 3 db: this rule has the additional merit that it is simple. The reactance must therefore have on its low-impedance side a reactance of 10 ohms at 30 cycles, or $2\pi \times 30\,L = 10$, or L = 50 mh.

The optimum load for each tube is 2,200 ohms (2,500 ohms for 6L6), so that the transformer must have a ratio of 440 to 1, center-tapped, in impedance, or 21 to 1 in turns. The high side inductance is equal to 440 × 50 mh = 22 h (25 h for 6L6). The air gap must be chosen so that the inductance is not altered appreciably by a current of 20 ma. This is the unbalance current which may be obtained if the two tubes are at opposite ends of the tolerance range. The only effect of a drop in transformer inductance will be an increase in distortion at the lowest frequencies.

The circuit

Before going any further we need to draw the circuit diagram, as far as we know it. This is shown in Fig. 1. Since we have only two stages, there is theoretically no possibility of low-frequency instability: if we want to add another stage to obtain a high-impedance input, we must watch this in the design. The first step is to decide on the value of C2 and C3.

For class-A operation, R9 and R10 can be made 470,000 ohms. This value will be chosen, because the larger R9 and R10, the smaller C2 and C3 for the same R-C product. The output transformer is designed to have a characteristic frequency R/L of 30 cycles which brings its response 20 db down at 3 cycles. The reader can check this for himself, but it is exactly the same as saying that the response falls 6 db per octave.

To provide 20-db feedback. the response must be down 26 db, at least.

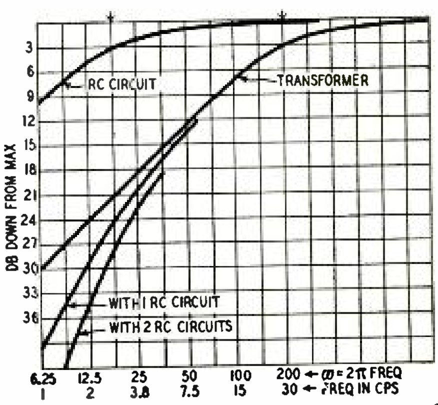


Fig. 2—The low-frequency response of the feedback amplifier.

If we take the frequency at which ωCR = 1, we have 45 degrees of phase shift, so that for two similar R-C terms (one from the preamplifier stage which we may add), there is a 90° phase shift at ω = 1/RC. The transformer gives 90°, too, so that we must make 1/CR less than 2 π x 3 cycles, to allow 26-db feedback at the 180 degrees point. This means a capacitance of at least 0.1 μf must be used. Let us go ahead with this value, and if necessary use a slightly more sophisticated preamplifier stage.

The phase splitter

This reservation has been made because we have not yet considered what happens in the phase splitter V1. This circuit is a rather attractive one, and seems to work very well. The first half of the double triode acts as an ordinary amplifier, with a plate load R4. The second triode is driven by the difference in plate voltages between V1-a and V1-b.

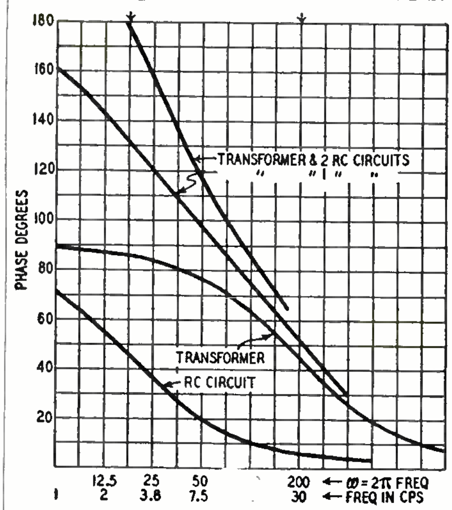


Fig. 3—High-frequency phase curves.

The two tubes seesaw about the fulcrum P. That, at least, is the usual way of describing the operation of the circuit. There is, however, another way of looking at it. The output from V1-a is applied, through the voltage divider R6-C1-R8, to the grid of V1-b. R7 provides feedback to make the gain in V1-b sufficient for pushpull operation.

Looked at like this it is easy to see that the phase shift produced by C1-R8 is greatly reduced by the feedback, which is of the order of 20 db. I should like to go into this more fully, because the usual analysis of this circuit tends to conceal this rather important fact.

The suspicious reader may have noted that I have not mentioned C4 yet. If the two triodes are really operating in pushpull, the current in R3 should not contain any alternating component, and C4 has no decoupling function. It is indeed, a safety term, put in to deal with any tendency of the stage to act as a cathode-coupled multivibrator at very high frequencies. I have not found it necessary, but if there is excessive capacitance across R6, C4 might save the situation.

High and low response

The over-all response curves are shown as Figs. 2 and 3. It will be seen that with two R-C circuits there is 21 db of feedback for the 30-degree phase margin, and that under these conditions the gain margin is just over 6 db. Because these margins can be easily increased by increasing the capacitances, we need not worry about the low-frequency response.

The high-frequency stability is, as always, a problem. The values chosen for R4 and R5, with the total interstage stray capacitance and the tube impedance, about 1,200 ohms, give $R \times C = 40 \times 10^{-12} \times 10{,}000$, a characteristic frequency $\omega_o = 2\pi f_o = 2{,}500{,}000$. The interstage circuit should therefore be flat up to about 400,000 cycles.

The exact design of the output transformer now comes under consideration. With a factory under my office, I can get any transformer I want. The reader will probably prefer to buy one ready made, or at least use the parts he already possesses. The only thing to avoid is the influence of the output transformer at high frequencies. To do this we shall add a few small components and then determine the limits to be imposed on the transformer.

Feedback resistor

Let us assume that we do not want any frequencies above 14,000 cycles, or at least that the response can roll off there. We shall begin by calculating the feedback resistance, which is in the little box marked X in Fig. 1. Our gain requirements are that 0.25 volt at 600 ohms at the input must give 10 volts across the 10-ohm output.

Assuming a 1 to 10 stepup in the input transformer, we have 2.5 volts across R1. Since we need only 0.25 volt from grid to cathode, across R2 we must have 2.25 volts. Immediately, therefore, R2 Rx = 2.25/ (10-2.25) = 1/3.4. Let us take R2 = 1,000 ohms, and Rx = 3,400 ohms. We use a standard value here, 3,300 ohms. To produce the required roll-off at 14,000 cycles connect a capacitor in parallel with this resistor. The capacitor must have a reactance of 3,300 ohms at 14,000 cycles, so that the capacitance will be .003 μf.

This capacitor is very important, because it produces a phase shift rising to

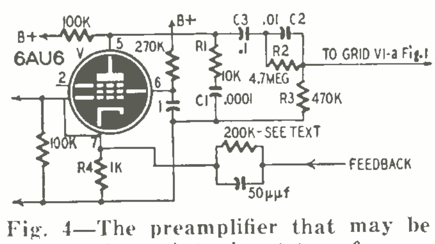


Fig. 4—The preamplifier that may be used in place of the input transformer.

90 degrees and in the opposite sense to the phase shift produced by the transformer. The result is that, without the preamplifier stage, the system must be stable so long as the transformer has no awkward resonances. The practical implications are that we design the transformer for the right low-frequency inductance and use the simplest possible balanced structure. This is necessary if we are to avoid these odd resonances due to partial leakage inductance. Hav-

ing done this, we can very profitably load down the two halves of the primary with capacitance to make the frequency response drop off above 14,000 cycles. Something of the order of .003 to .005 μf is indicated here, but I have not shown these components.

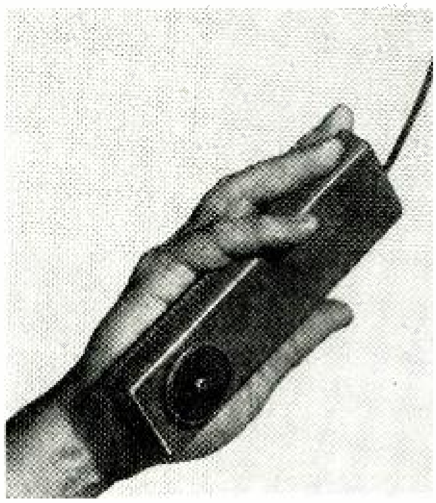
Does this seem rather vague? It is not really, because now the reader should have acquired some sort of "feel" for these circuits. Gardeners talk about people who have the green finger! The most important thing in this work seems to me to be to acquire the "feedback filter": I dare not give it a color because they all seem to be political nowadays. The important thing is to be able to sketch the phase characteristic on the back of an old envelope, and then to correct it.

My own amplifier, built to this general design, gives about 0.3% distortion at 1,000 cycles at 10 watts output, and 0.5% at 30 cycles and 6 watts output.

A preamplifier stage

The circuit diagram of a possible preamplifier stage is shown in Fig. 4. The interstage network is made up of two parts: R1 and C1, for high frequencies; C2, C3, R2, R3 for low frequencies.

I want to discuss this type of interstage circuit in detail some time—a little further along in this series. The basic idea is to provide a step in the amplitude response, and this enables more feedback to be used. We saw this, in a simple way, in connection with the cathode and plate decoupling circuits.



Receiver is made to be held to the ear.

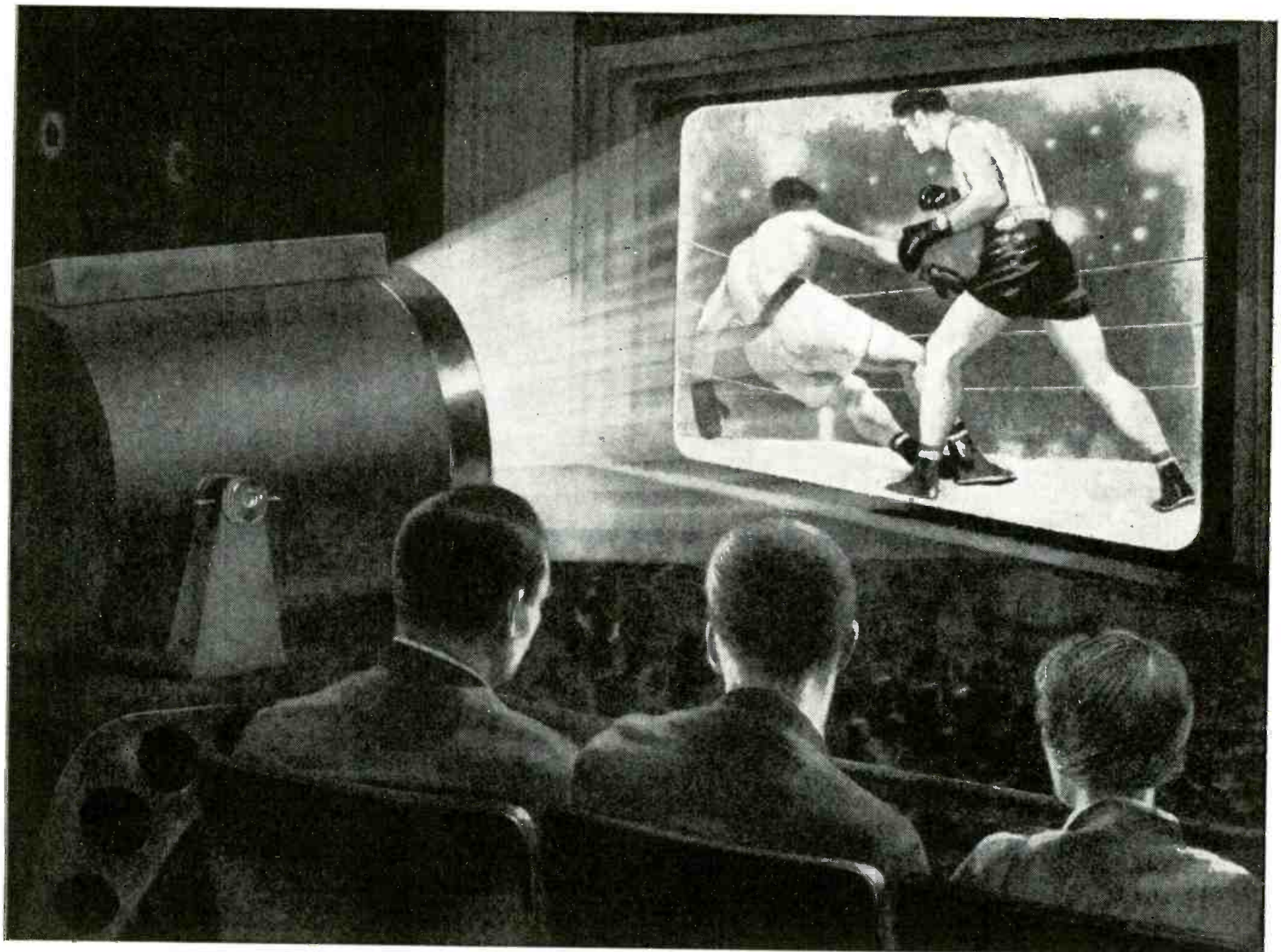
DOCTOR ALWAYS ON CALL WITH RADIOPAGING UNIT

Radiopaging is the latest comer to the ranks of radio services for the safety of human life. The new service calls a doctor to the nearest phone, wherever he may happen to be. In the past, reports Sherman Amsden, head of the Telanserphone service who originated the new service, many patients have suffered and some have died while telephone answering services have been frantically endeavoring to locate their doctors.

Aircall Radiopaging, as Telanserphone calls it, is the answer to the problem of locating a doctor (or any other person) who is temporarily out of reach by phone. The doctor carries a small radio receiver like the one in the photo. This receiver repeats once every minute a series of numbers, one of which may be his special code call. If, during the minute, the subscriber hears his number, he calls his office from the nearest phone. If not, he knows he is not needed at the moment, and can continue his golf game or auto drive with a free heart and conscience.

The little receivers are fixed-tuned to 43.58 mc. Their range is therefore about that of a low-band televiser, though Telanserphone stresses that the area of 100% reliable service extends only 20-25 miles from the transmitter.

The first station of Aircall Radiopaging, KEA627, is in New York City. Its operation is automatic. The subscribers' numbers are recorded by voice on a 16-mm sound strip on Lucite slides about 6 inches long. These are placed in an ingenious machine known as Mechanicall, a development of Reeves Sound Laboratories. Hung on an endless track, each sound strip is carried past a photocell once every minute. The cell is above the track along the top of the Mechanicall. The box shown in the photo houses the light which shines up through the strip. The long series of up-and-down loops permits stopping part of the track for a few



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Because of its size and shape, the new projector is referred to by engineers as the "barrel." It's already going into theatres, where you'll be seeing giant television—shot from a barrel.

* * *

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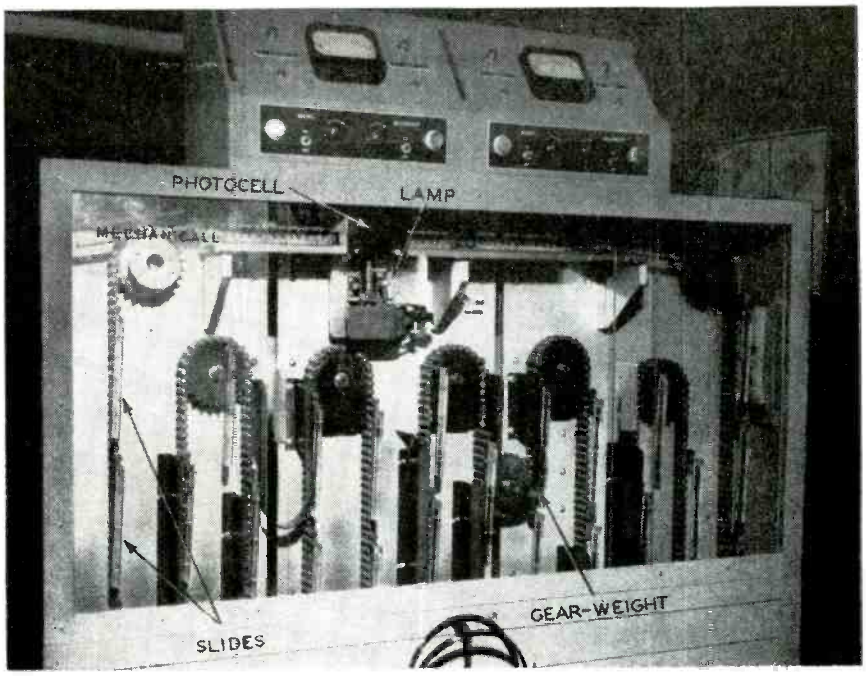


The Mechanicall equipment reads each wanted code number once every minute.

seconds to take off or put on a slide without stopping the endless procession of slides under the photocell. When the track is stopped, the long loops (normally held to full length by gear weights like the one shown in the photo) shorten as the machine takes up the slack. Thus a portion of the track can be held motionless for 10 seconds without interfering with the continuous transmission of messages.

At present, Aircall Radiopaging has something over 200 subscribers, each of whom pays $10 per month for the service. This includes rental of the small radio receiver, as well as maintenance, should it go out of order during the month.

TUBES OF THE MONTH

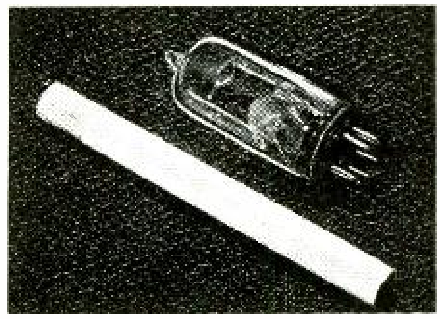
New tubes this month include a cathode-ray tube, a miniature magnetron, and a double triode.

The C-R tube, announced by RCA, is the 7QP4, a 7-inch direct-view kinescope using magnetic focus and deflection and designed for portable monitor equipment. It has a high-efficiency white fluorescent screen on a relatively flat face and an ion-trap gun requiring a single-field external magnet. The tube takes a small shell 5-pin duodecal base. Typical operating values are: 8,000 volts on the anode; 300 volts on grid No. 2; –33 to –77 volts on grid No. 1 for visual extinction of the undeflected spot; and 80 ma in the focus coil.

The new 7QP4, for monitor equipment.

The miniature magnetron Z-2061 is a new G-E development. Using an external permanent magnet, the little tube is for use as a local oscillator for u.h.f. television receivers and other applications requiring a low-power oscillator in the frequency range from 65 to 1,000 mc. An external tuned circuit, of either the lumped-constant or distributed-constant type, controls the frequency.

Maximum ratings for the magnetron



G-E's new magnetron is the first of its type to be used in receiving sets.

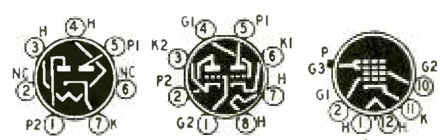
are: plate potential, 200 volts; total plate dissipation, 3 watts; total cathode current, 30 ma; and heater-cathode potential, 90 volts. The tube has about 250-mw output within its frequency range. At present this tube is available in limited quantities for experimental work, but G-E sources state that mass production will be timed for the FCC's release of the u.h.f. band for television.

Sylvania has released the double triode 6BL7-GT, intended for wide-

The vertical deflection tube 6BL7-GT.

angle vertical deflection in large TV picture tubes. The tube has two identical triode sections with separate cathodes and has high mutual conductance. It uses an 8-pin octal base.

Typical operating conditions for the 6BL7-GT in a vertical deflection circuit are: d.c. plate potential, 450 volts; cathode bias resistor, 1,200 ohms; peak-to-peak sawtooth input, 36 volts; d.c. plate current, 11 ma; peak-to-peak sawtooth output, 270 volts; and peak positive pulse component output, 600 volts.



Basing diagrams for the latest tubes.

NATIONAL FEDERATION NOW BEING ORGANIZED

Formation of a national radio-electronic technicians' association was voted at a meeting of delegates from four states and the District of Columbia, held in New York City October 19.

After some discussion, the question was put in the form of the resolution: "Resolved that a National Association of electronic technicians' associations be formed," and passed.

A temporary organizing committee was formed, with Dave Krantz, of the Federation of Radio Servicemen's Associations of Pennsylvania (FRSAP), as chairman, Max Liebowitz, of the Empire State Federation of Electronic Technicians Associations (ESFETA), as vice-president, and Norman Chalfin, secretary of the Associated Radio-Television Servicemen of New York (City) (ARTSNY), as secretary.

The next meeting was set for January 28, in Washington, D. C. Messrs. Salinger, of the TV Associates, Washington, D. C., and Fisher, of ARTSNY, were appointed a committee to make arrangements for the meeting. Invitations will be sent to all known radio and television technicians' associations to send delegates to that meeting, at which the permanent foundations of the new organization will be laid.

The New York meeting, at which 31 delegates were present, was the outgrowth of a move to form a national federation initiated at Binghamton, N. Y., a little more than a year ago by ESFETA, and of parallel action on the part of other associations. Delegates in attendance represented a majority of the New York and Pennsylvania Federations, plus two delegates from the Radio Technicians Guild of Massachusetts, one from Trenton, New Jersey, and one from TV Associates of Washington, D. C.

N. Y. HAS LECTURE SERIES

Winter lecture series of the Empire State Federation of Electronic Technicians was inaugurated in late October with a lecture in New York City by John F. Rider. The second N. Y. C. lecture, on November 2, was by Walter H. Buchsbaum, Editor of the Television Clinic in RADIO-ELECTRONICS.

New York State has been divided into four lecture areas: New York City and Long Island, Poughkeepsie-Kingston, Endicott-Binghamton, and Rochester.

N. J. TELECONTRACTORS FORM NEW ASSOCIATION

To protect the public from poor television servicing, 14 service organizations of northern New Jersey have formed the Television Contractors Association of New Jersey. Managing director of the group is Walter Ferry, former sales manager of D. W. May, G-E, and Westinghouse.

TCA members will be certified and their work will comply with local codes and industry standards. The group will start a campaign to educate the public to the advantages of doing business with members. Set owners are invited to register all complaints with the TCA. If the complaints are justified, the TCA will use legal means to force the offending service contractor to comply with the contract. The suit will be in the name of the person making the complaint, but the association will bear the cost.

Membership in the TCA of New Jersey is open to all TV contractors who have a place of business operating on a full-time basis. The initiation fee is $50 and additional assessments will be made at a later time.

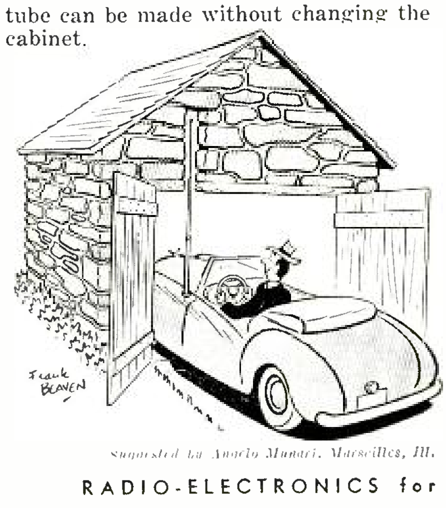
NORTH CENTRAL OHIO HEARS HUGH A. WHITE

The North Central Ohio's Radio and Television Technician's Association heard Hugh A. White, sales service engineer for the Radio Tube Division, Sylvania Electric Products, Inc., at a meeting sponsored jointly by the Association and the Burroughs Radio Co.

Mr. White discussed six problems of television receiver servicing: comparison of similarities and differences in radio and television receivers; test patterns and their use in frequency analysis; electrostatic and electromagnetic deflection sweep circuits; direct and indirect synchronizing circuits; and the use of test patterns for testing TV sets. He concluded his talk with a question period.

CORRECTION

The meaning of the third sentence in the first column of the "Television Service Clinic," in the December issue, was altered through transposition of words. This sentence, beginning on the eighth line, should read—In many cases a switch from a 10- to 12-inch picture tube can be made without changing the cabinet.

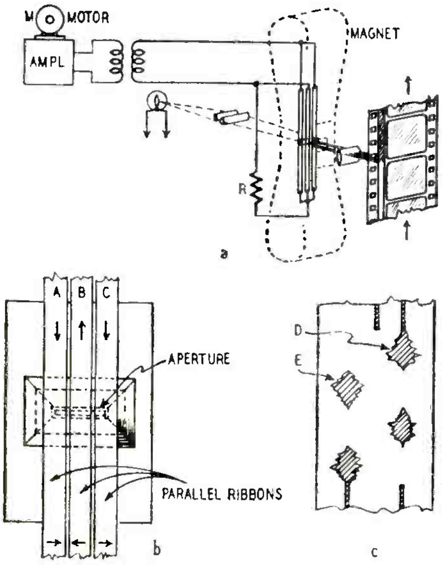


Suggested by Angelo Munari, Marseilles, Ill.

PUSH-PULL FILM RECORDING

Patent No. 2,511,199
John G. Frayne, Pasadena, Calif.
(assigned to Western Electric Co., Inc.)

This is an improved recording system for class B, bilateral push-pull tracks. In a class B variable area track, the film positive is almost completely opaque during silent periods. This reduces noise level. The bilateral push-pull feature requires two parallel tracks. Each track records and reproduces alternate half-cycles of the fundamental frequency.

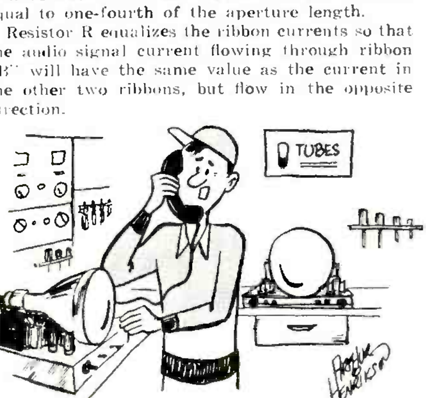


A single aperture is used in this new system. A steady light source is focused through the aperture to expose the moving film. See part "a" of the figure. The beam is modulated by metal ribbons arranged to vibrate in front of the aperture. The center ribbon is in a plane just in back of the other two so it can move without clashing with them. The ribbons are in a strong magnetic field and the current from an a.f. amplifier flows through them.

Normally the ribbons are adjacent to each other so that almost all light is masked off. At some particular instant while sound is impressed on microphone M, currents may flow through the ribbons as shown by vertical arrows in part "b" of the figure. There is a reaction between the magnetic field and these currents which sets the ribbons in motion. At this particular instant the ribbons may tend to move in the direction of the horizontal arrows (part "b"). Ribbons "A" and "B" overlap and mask off all light from the track on the left. "B" and "C" separate and expose the track on the right. As these ribbons vibrate they produce an area such as "D" in part "c" of the diagram.

During the next half-cycle, ribbons "B" and "C" overlap and mask off the light beam. At the same time "A" and "B" move apart and produce an area such as "E" at "c". Complete modulation results when each ribbon moves a distance equal to one-fourth of the aperture length.

Resistor R equalizes the ribbon currents so that the audio signal current flowing through ribbon "B" will have the same value as the current in the other two ribbons, but flow in the opposite direction.



Suggested by Arthur A. Henrikson, Chicago, Ill.

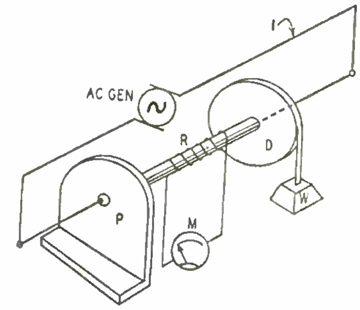
"No sound? No picture? Well—is your set plugged in?"

TORQUE MEASUREMENT

Patent No. 2,511,178
Herbert C. Roters, Roslyn, N. Y.
(assigned to Fairchild Camera & Instrument Corp.)

This invention is based on a magnetostrictive effect. The rod R made of a magnetic material such as nickel alloy is fixed to a plate P. At the other end of the rod a disc D is arranged to carry a weight W.

The rod is magnetized by a.c. flowing through it. This current is indicated as I. If the weight is taken off, there is no torque on the rod. Under this condition I produces magnetic lines of force which are circular around the rod. Since there is no component of magnetism parallel to the rod, no flux cuts the coil of wire and the meter M shows no deflection.



When a torque is present, the circular magnetism is distorted and the flux lines become helical around the rod. This is known as the inverse Wiedeman effect. This magnetic component parallel to the rod induces a.c. into the coil and M deflects. The induced current is directly proportional to the torque on the rod.

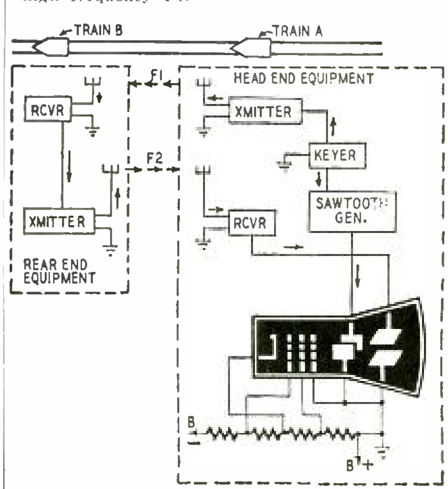
This effect is useful in many ways because it permits measurement of a force which does not produce actual motion.

RAILROAD SIGNALLING SYSTEM

Patent No. 2,509,331
Paul M. Brannen, Duquesne, Pa.
(assigned to Union Switch & Signal Co.)

Adding to the safety of railroad travel, this invention is an improvement over the usual block signal system because it indicates actual distance between trains. The illustration shows two trains A and B running in the same direction on the same track.

The first car of A is equipped with the apparatus shown on the right. A keyer modulates the transmitter. It also controls the sawtooth generator which provides the horizontal sweep for the oscilloscope. The transmitter radiates pulses at a high frequency F1.



The last car of train B is equipped with a receiver and transmitter as shown on the left. The pulses from A are picked up and passed on to the transmitter which re-radiates them on a second high frequency F2. Train A picks up the signal which appears as a pip on the oscilloscope. As in radar the exact distance between trains is indicated on the screen.

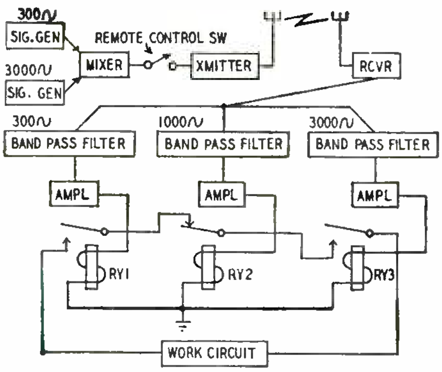
This equipment has been found effective at distances up to about 3,000 yards.

SECRET REMOTE CONTROL

Patent 2,513,342
Charles J. Marshall, Dayton, Ohio.
(assigned to the United States of America as represented by the Sec'y of the Army)

Remote circuits are here controlled by radio to insure secrecy and prevent operation due to false or interfering signals. As an example, bombs may be released from several airplanes simultaneously by a squad leader. It is obvious that the circuits must be guarded against random noise or enemy transmitter signals.

The transmitter and receiver may be conventional equipment. The transmitter is located at the control point. It is modulated by two audio frequencies when the switch is thrown.



At each receiving location separate narrowband filters are tuned to the modulating frequencies. Their output is amplified and connected to relays RY1 and RY3. A third channel, tuned to 1,000 cycles, feeds RY2. Note that this relay is normally *closed*.

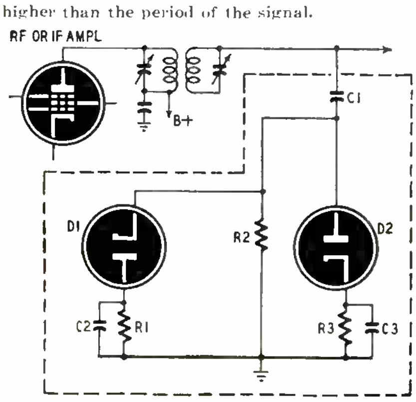
When the control switch is thrown, RY1 and RY3 contacts are closed. If no 1,000-cycle signal is present, R2 remains closed. The work circuit, for example a bomb release, is operated. If random noise or a voice signal is intercepted, it is quite likely to include 300, 1,000, and 3,000 cycles. In that case all *three* relays will operate. Since the RY2 contacts will *open*, the work circuit does not function.

NOISE SUPPRESSOR

Patent No. 2,512,637
Richard E. Frazier, Dayton, Ohio.
(assigned to the United States of America as represented by the Sec'y of War)

As the noise amplitude increases, this suppressor, shown within a dotted box becomes increasingly effective. The diodes may be within a single tube envelope or they may be twin metallic rectifiers. The suppressor is connected across an r.f. or i.f. circuit.

C1 is chosen for low reactance at signal frequency. R2 is relatively large. The time constant of the combination R1-C2 and R3-C3 is much higher than the period of the signal.

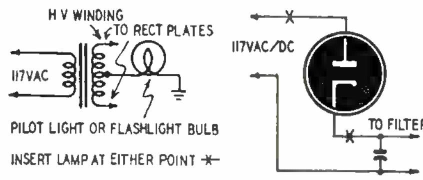


The input polarity determines which of the diodes conducts. With normal r.f. (or i.f.) signal both diodes conduct. C2 and C3 charge to an average potential and slowly discharge through their respective resistors. The capacitor charge is opposite and nearly equal to the constant signal input so there is little loss by shunting through the tubes. In the presence of a noise pulse, either D1 or D2 conducts more heavily. Temporarily the input exceeds the average capacitor potential and the input is effectively shorted to ground.

FUSE FOR RECEIVERS

A fuse to protect the rectifier tube and power transformer in case of shorts in the high-voltage supply is worth while in all receivers and is almost a necessity in experimental equipment where there is the added risk of overloads.

The easiest fuse to install and replace is a simple pilot lamp. The 150-ma

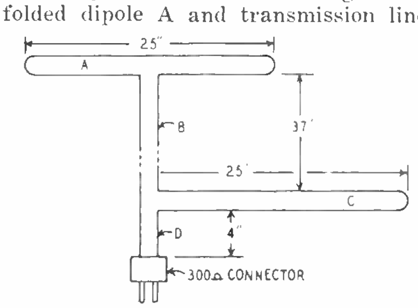


screw type is best in most equipment but an ordinary flashlight bulb will give sufficient protection. Simply wire the socket in series with the center tap of the high-voltage winding of the power transformer in series with the plate or cathode of the rectifier in a transformerless receiver. The drawings show where the bulbs may be inserted.—*Eric Leslie*

BUILT-IN TV ANTENNA

Constructed of 300-ohm ribbon line and designed for installation in TV receiver cabinets, this all-channel antenna is described in U.S. patent No. 2,514,-992, issued to Charles R. Edelsohn.

The system consists of a high-band folded dipole A and transmission line

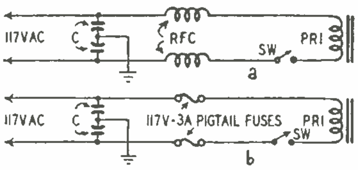


B-D with a half-wave shorted stub C inserted in one leg. The stub, being one-half wavelength at the frequency of dipole A, has no effect on the performance of the transmission line or antenna at that frequency.

On the low band, the combined length of stub C, the 37-inch line B, and antenna A form a folded dipole for the low band channels. Section D of the transmission line is not symmetrical so it should be kept short. A length of 4 inches is satisfactory.

HALLICRAFTERS 745 TV SET

Early production models of the Hallicrafters model 745 and similar sets use the a.c. input circuit shown at "a" in the drawing. The r.f. chokes in the a.c. line are wound with wire of approximately No. 24 gauge. The voltage drop is approximately 2.5 volts across each choke. This loss in line voltage affects the performance of the set when line voltage is low. Furthermore, these chokes burn out or open when circuit troubles cause excessive



primary current. A shorted damper tube, low-voltage rectifier tube, filter capacitor, or coupling capacitor to the horizontal output tube can cause this trouble.

Performance under low line-voltage conditions is improved and the power transformer protected against shorts and overloads by replacing these chokes with 3-ampere Slo-Blo pigtail fuses as shown at "b."—*Hubert L. Frazier*

VIBRATING TV ANTENNA

The reflector of my TV antenna would vibrate when the wind was high. This vibration could be felt all over the house and caused an annoying noise.

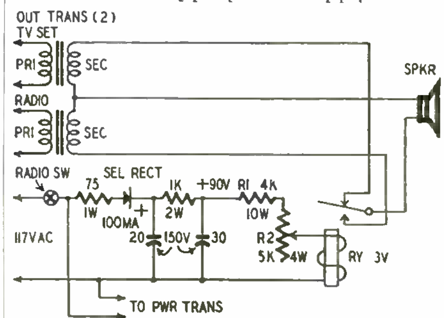
I cured the trouble by tying a piece of wire from the ends of the reflector to a point on the boom behind the radiator. This did not affect the picture and the antenna seemed to pick us less noise.—*Arthur Schweitzer*

(Using wire as a tie-down may affect the performance of some antennas. If it does, try using prestretched nylon cord or rope.—*Editor*)

TV-RADIO SPEAKER COUPLING

Tonal quality of the average table model TV set is often unsatisfactory because of the size and placement of its speaker. This circuit shows how the a.f. output of a TV set can be coupled into a console FM or AM radio to take advantage of the larger speaker and better baffling. The circuit is arranged so the speaker is coupled to the set that is in operation.

Replace the output transformer in the TV set with a husky universal type. Select the secondary taps to match the impedance of the large speaker or use those which provide the best tone. A small a.c.-d.c. type power supply is in-



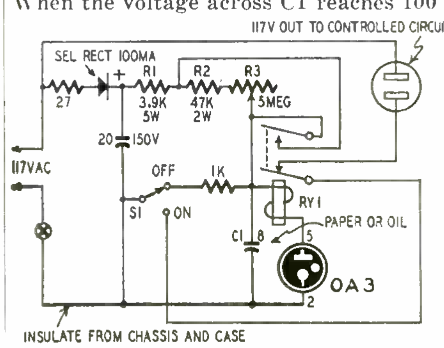
stalled in the console to supply excitation current for the change-over relay. This supply develops approximately 90 volts d.c. R1 and R2 drop the voltage to between 2.5 and 3.5 for the 3-volt relay. Any small s.p.d.t. relay requiring not more than 90 volts can be used by making appropriate adjustments in the values of R1 and R2.

If you pick up a surplus relay, be sure to check its resistance and find out how much current it draws before installing it. Some low-voltage jobs have a low-resistance coil which may draw an ampere or more. Make sure that the current drain can be met by the power supply.

The diagram shows that the speaker connects to the TV set through the normally closed contacts of the relay. The relay is energized and the speaker switches over when the console set is turned on.—*Olaf W. Bailey*

SIMPLE TIMER CIRCUIT

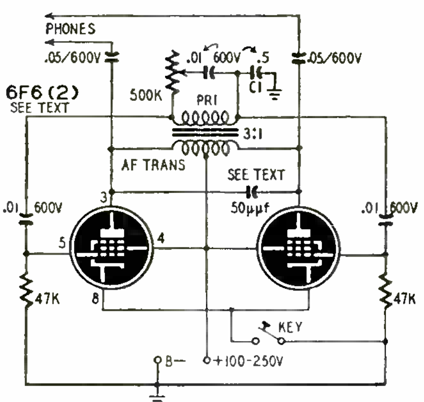
This darkroom timer is simpler than most electronic timers. With the controlled unit plugged into the receptacle, throw S1 to OFF to remove any residual charge on C1. Throwing S1 to ON removes the 1,000-ohm short circuit from C1 and at the same time energizes the output receptacle through the normally closed contacts of the relay. C1 begins to charge up through R1, R2, and R3. When the voltage across C1 reaches 100



or so, the 0A3 fires, allowing C1 to discharge through the relay and pull in its armature. The normally open contacts lock the relay closed by shorting R2 and R3, leaving only R1 in series to limit the current to approximately 30 ma. The normally closed contacts are then open, and the output receptacle is de-energized. The cycle is repeated by throwing S1 to OFF and then to ON each time the controlled unit is to be operated. S1 may be a push button if desired. RY1 must be a low-resistance (several hundred ohms), low-current relay with a light armature for fast operation. If a relay with the indicated contact arrangement is not available, a s.p.s.t. sensitive relay may be used to control a more rugged relay with the necessary contacts. The 1,000-ohm resistor prevents a spark at the contacts when the switch is thrown to OFF. R2 limits the maximum current through R3. The values of R3 and C1 shown cover a range of approximately 3 to 30 seconds, but other values could be used for different times. C1 must be fairly large so that the relay will close positively when the 0A3 fires.—*Richard H. Houston, W3MAX*

NOVEL CODE OSCILLATOR

This code oscillator uses a modified multivibrator circuit which gives it a richness of tone easy to listen to throughout long practice sessions. C1 governs the range of frequencies covered by varying the setting of the 500,000-ohm potentiometer. The frequency and signal voltage go up as C1 is made larger. When it is 0.5 μf, the range is approximately 700 to 1,000



cycles. The 50-μμf capacitor is shunted across the secondary to improve the tonal quality at low frequencies.

The audio-frequency transformer can be any interstage unit that has a step up ratio of three to one and a center tap in the secondary. The frequency will vary somewhat with the size transformer used, but C1 can be selected to give the desired pitch.

The selection of tubes is not critical. The diagram shows pentodes which may be 6L6's, 6V6's, 117L7's, 50L6's, and the like. You can use triodes such as 6C5's, 6SN7's, etc., by omitting the connection for the screen grid. In fact, you can use one triode and one pentode. The circuit will work just as well.—*Arthur Manning*

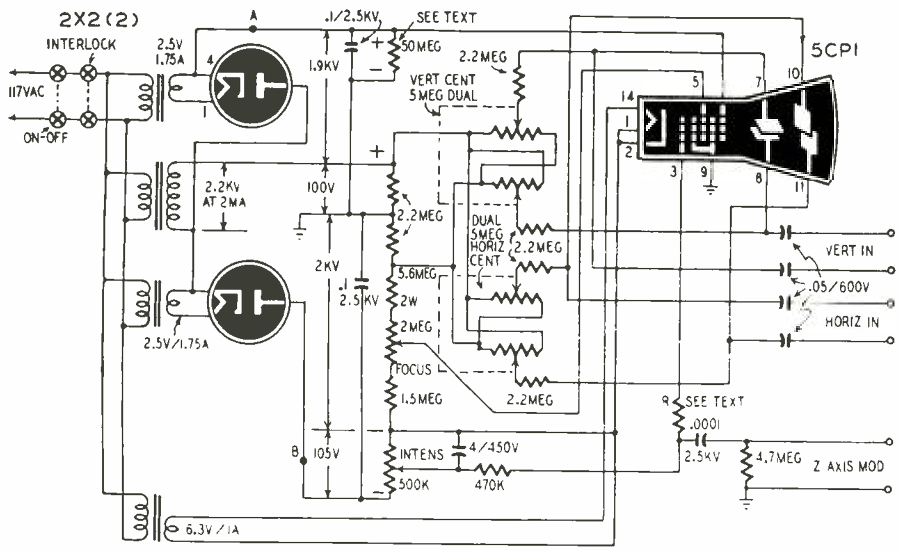
BASIC OSCILLOSCOPE

?. *Please print a circuit of a 5-inch oscilloscope, minus amplifiers, and with provisions for intensity modulation. I have a 5CP1 C-R tube, 2X2 rectifiers with heater transformers, and a 2,200-volt, 2-ma high-voltage transformer. I want to use as many of these parts as possible.—J. A., Ames, Iowa.*

A. This basic oscilloscope circuit is taken from tentative data on the 5CP1 supplied by RCA. If the voltages supplied by the 2X2's are higher than those shown on the diagram, insert suitable dropping resistors at points A and B. The 50-megohm resistor in the positive supply may consist of five 10-megohm, 1-watt resistors connected in series. The filament transformers for the 5CP1 and the 2X2's should be insulated for 2.5 kv or higher.

Take care not to exceed the maximum positive and negative voltage ratings for grid No. 1 when intensity modulation is used. Resistor R limits the positive excursions. Its value should be at least 2,000 ohms for each volt of positive signal voltage.

Dangerous voltages exist in the C-R tube circuits. Pull the line cord, throw the line switch to OFF, then short the terminals of both high-voltage filter capacitors before working on the set.



ANTENNA MATCHING SYSTEM

? *I have an all-channel antenna which does not work well on channel 13 so I want to connect a channel-13 antenna in parallel with it. How can I connect these 300-ohm antennas so there is no interaction between them? Shouldn't a 150-ohm line be used?—S. R. M., New York, N. Y.*

A. Mount the antennas 18 to 24 inches apart. Connect them together with a 48-inch piece of 300-ohm line. Tap this line 12 inches from the high-frequency antenna and connect a 300-ohm lead-in at this point. Connect a 12-inch open stub (made from 300-ohm line) across the terminals of the larger antenna.

Being approximately a quarter wavelength long at channel 13, this stub will short circuit any high-frequency signal on the low-frequency antenna.

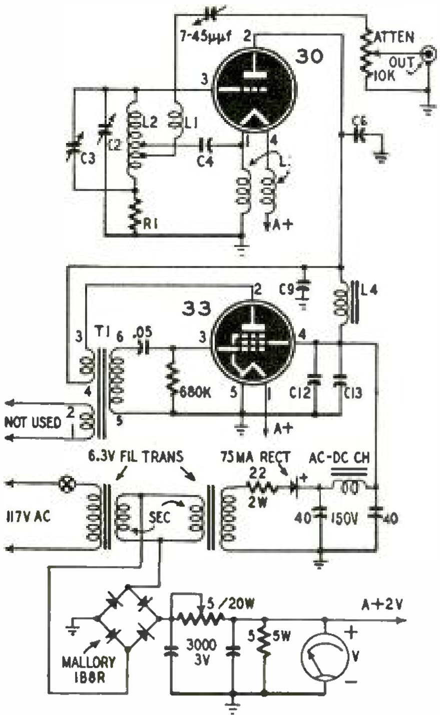
The 36-inch line between the longer antenna and the antenna terminal block acts as a three-quarter wavelength stub shorted by the longer antenna so it presents an infinite impedance to high-frequency signals arriving at the lead-in from the smaller antenna.

The impedance of each antenna is 300 ohms only at its resonant frequency. In wide-band antennas like this one, 300-ohm lines are used to provide a good match between the lead-in and the set.

BC-222 CONVERSION

? *I have a BC-222 radio set which I wish to convert to a signal generator. Please prepare a diagram showing how this can be done. I would also like to have an a.c. power supply.—C. M. E., Graham, N. C.*

A. The diagram shows how the unit can be converted to an a.c.-operated signal generator. Components shown with codes are those found in the BC-222. Parts having values given must be added. The tone of the modulator can be varied by using other resistances in place of the 680,000-ohm resistor in the grid circuit of the 33.



The power supply consists of two 6.3-volt, 3-ampere filament transformers connected back-to-back. The secondary voltage of the input transformer is rectified by a Mallory type 1B8R rectifier or its equivalent. Adjust the 5-ohm resistor so the filament voltage is 2 volts under load. The filaments in this circuit must be d.c.-operated so the generator output will not be hum-modulated.

"No, bring the antenna further back on the roof. A little further. More. Hello? Hello?

VIDEO I.F. ALIGNMENT

The test pattern from a local TV station can be used as a convenient signal for aligning the video i.f. circuits of a receiver having separate video and sound i.f. amplifiers.

The vertical and horizontal linearity of the receiver should be good. Turn on the receiver and allow it to warm up before beginning the adjustments. Make sure the set is adjusted for sharpest focus, then adjust it for normal contrast. Beginning at the converter output, peak each i.f. stage for best separation and resolution of the lines in the vertical wedges of the test pattern. A complete alignment of the system will result in maximum picture definition and horizontal detail with minimum distortion and smear.—*Olaf W. Bailey*

(If the set has a.g.c., disable it, replacing it with a negative bias of about 3 volts. Bias should be adjustable. A 10,000-ohm potentiometer across a 4.5-volt, C-battery will do the job nicely. —*Editor*)

WESTINGHOUSE H-600T16

Weak sound accompanied by picture shrinkage is often caused by weak 5U4-G low-voltage rectifiers. Replace one or both to restore the set to normal operation.

If the sound is O.K. and there is no raster on the screen, look for the trouble in the high-voltage circuit. You will probably find that the 6Y6-G is shorted or weak.

A bad or weak 12AU7 vertical multivibrator tube will cause a bright horizontal line to appear on the face of the picture tube. Try replacing this tube.—*Michael L. Tortariello*

FARNSWORTH MODEL 651P

The set came in with the complaint that the picture had insufficient height. Advancing the height control caused poor vertical linearity. The trouble was traced to the 1-ohm, 60-cycle, 3-volt capacitor which bypasses the vertical centering control. The set was restored to normal by replacing this capacitor.—*James J. McNamara*

CROSLEY 10-401, -404, -412

Neck shadow on the picture tube in these models and in the 10-414, -416, and -418 may be caused by reversed polarity of the focus coil. Wrong polarity causes the fields of the focus coil and the ion trap to interact to produce neck shadow and make centering difficult.

If this fault is suspected, reverse the current through the coil by interchanging the focus coil leads at the points where they are soldered under the chassis. If centering is easier and neck shadow diminished, and if the angle the focus coil makes with the neck of the tube is nearer 90°, this is the correct connection. When the coil is connected correctly, the current will produce a north pole on the face of the coil nearest the tube socket.—*Crosley Service Dept.*

SENTINEL 420B, 423, 425, 428

Fold-over on the left-hand side of the picture which shows up as a horizontal V pointing toward the center of the picture or a faint milky-white area between the center and left side of the picture, is caused by the horizontal hold control being out of adjustment.

To clear this trouble, turn the horizontal centering control until the left-hand edge of the picture is visible. Adjust the horizontal hold control until the fold-over just disappears. If the extreme top of the picture starts bending or jitter is noticed, adjust the hold control for minimum fold-over with acceptable stability. To find this setting, it may be necessary to readjust the horizontal lock control.

Center the picture with the centering control. Do not at any time use the hold control to center the picture.—*Sentinel Service Dept.*

LATE PHILCO TV SETS

Before tearing into the circuit in an effort to find the cause of insufficient picture height, try replacing the 5U4-G rectifier. When the emission drops off the picture height shrinks.—*Milton Margolis*

ADMIRAL 20X122 TV SETS

The built-in antenna fits rather loosely in the cabinets of some models thus causing the picture to distort when anyone walks across the floor or shakes the set. Cure this by taping the antenna firmly to the cabinet with a good adhesive.—*Bruce A. Brown*

G-E 12T7 TV RECEIVER

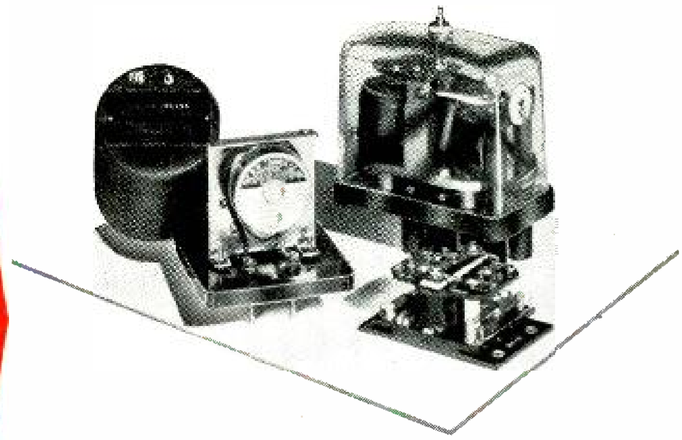
Excessive contrast which cannot be reduced to normal with the picture control is probably caused by a shorted capacitor between the first and second sections of the sync amplifier and clipper stage. This is a .01-μf capacitor connected to pin 1 of the 6SL7. If it opens, the horizontal and vertical sync circuits will fail.

Excessive contrast and a shaky picture will result if the 220-μμf capacitor at pin 5 of the 6SL7 is open. If the .02-μf capacitor at pin 4 of the 6SL7 is open, bright lines will appear at the top and bottom of the picture.—*General Electric Data*

Special Relays—

OVER A MILLION IN STOCK!

Whether you require large quantities of relays for production runs or single units for laboratory or amateur work, Wells can make immediate delivery and save you a substantial part of the cost.



This list represents only a few types of Special Relays. We also have huge stocks of Standard D.C. Telephone Relays, Midget Relays, Contactors, Keying Relays, Rotary and Slow Acting Types as well as many others. Write or wire us about your requirements.

STOCK NO.	VOLTAGE	OHMAGE	CONTACTS	MANUFACTURER & NUMBER	PRICE
R-503	12/32 VDC.	100	3A, 2C	G.E. Ant. Keying 500W 2C6530-653AR1	$ 2.25
R-749	600 VDC.	...	Max. 28 Amps.	Allen Bradley 810 Dashpot	5.95
R-804	550 VAC.	...	1B/38 Amps.	Culter Hammer C-261173A34 Contactor	3.50
R-250	115 VAC.	...	Adj. Cir. Breaker .04-.16A	Westinghouse MN Overload	12.95
R-579	220 VAC.	...	1B	Adlake 60 Sec. Thermo Delay	6.95
R-294	27.5 VDC.	200	1B	Edison 50 Sec. Thermo Delay	4.25
R-686	115 VAC.	...	2C	Leach 1157T-5/20 Sec. ADJ. Delay	4.95
R-246	115 VAC.	...	1B	Cramer 2 Min. Adj. Time Delay	8.95
R-246A	115 VAC.	...	1A	Cramer 2 Min. Aoj. Time Delay	8.95
R-611	24 VAC.	...	1A/30 Amps.	Durakool BF-63	4.25
R-283	12 VDC.	125	AC/10 Amps.	Onan Rev. Current 3H4512/R24	1.00
R-614	18/24 VDC.	60	1A/15 Amps.	Rev. Current Cutout 3H2339A/E1	3.50
R-262	....	200	1C	W. U. Tel. Co. 41C Single Current	3.75
R-245	12 VDC.	25	4 In. Micalex Lever	....	.95
R-527	6/12 VDC.	50/50	In Series	2Z7668 For Scr-274N	.95
R-544	12/24 VDC.	60/60	1C	G.E. Push Button Remote Relay #CR2791-R-106C8	1.65
R-255	....	...	1A	G.E. Pressure Switch #2927B100-C2	.95
R-669	75 VAC.	400 CYC.	1B, 1A	Clare 400	.95
R-660	6 VDC.	...	3/8" Stroke	Cannon Plunger Relay #13672	.95
R-651	24 VDC.	100	Solenoid Valve	....	2.50
R-295	12 VDC.	275	Annuncitar Drop	....	2.15
R-230	5/8 VDC.	2	2A, 1C	Guardian Ratchet Relay	2.15
R-813	12 VDC.	12	Wafer	Ratchet Relay From Scr-522	4.25
R-275	12 VDC.	750	1A, 1B, 1C	Guardian BK-10	2.75
R-716	24 VDC.	70	2A/5 Amps.	BK-13	1.45
R-620	6/12 VDC.	35	2C, 1A	Guardian BK-16	1.05
R-629	9/14 VDC.	40	1C/10 Amps.	Guardian BK-17A	1.25
R-778	8 VDC.	4500	1C/5 Amps.	Kurman BK-24	2.10
R-720	24 VDC.	50	2C, Ceramic	45A High Power	1.35
R-500	12 VDC.	10/10	2C/6 Amps.	Str. Dunn. Latch & Reset	2.85
R-816	12 VDC.	10/15	2C/6 Amps.	Guardian Latch & Reset	2.85
R-811	48 VDC.	8000	1C	Sigma 4R	1.65
R-524	24 VAC/DC.	...	....	Edwards Alarm Bell	.95
R-838	90/120 VDC.	925	2A	Allen Bradley-Bulletin #702 Motor Control	4.50
R-839	100/125 VDC.	1200	3A	Allen Bradley-Bulletin #200E Motor Control	4.50
R-840	115 VDC.	1200	2A	Allen Bradley-Bulletin #209 Size 1 Motor Control W/Type "N" Thermals	5.50
R-841	115 VDC.	1200	4A	Allen Bradley-Bulletin #709 Size 2 Motor Control W/Type "N" Thermals	25.00
R-842	115 VDC.	925	3A	Allen Bradley-Bulletin #709 Motor Control W/Type "N" Thermals	5.50
R-843	115 VDC.	1200	3A	Allen Bradley-Bulletin #200 Motor Control	4.50
R-844	115 VDC.	1200	3A, 1B	Allen Bradley-Bulletin #202 Motor Control	4.50
R-845	220 VAC.	Intermit.	3A	Allen Bradley-Bulletin #704 Motor Control	4.50
R-831	7.5/29 VDC.	6.5	1A/250A, 1000A Surge	Leach B-8	3.50
R-837	110 VAC.	...	2A/30 Amps.	Leach 6104	2.75
R-835	24 VDC.	2800	1A Dble. Brk./10 Amps.	Wheelock Signal, B1/39	1.95
R-836	220 VAC.	...	2A Ddle. Brk./10 Amps.	Wheelock Signal, A7/37	3.45
R-566	115 VAC.	(Coil only, Not a complete relay)		Leach #6104	.75
R-710	....	150-Ohms. Coil Only		Guardian #38187	.50

Wide Selection of Electronic Components at WELLS

- Tubes
- Resistors
- Condensers
- Wire & Cable
- Volume Controls
- Co-ax Connectors
- Relays
- Rectifiers
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- Micro Switches and Toggles
- Antennas and Accessories
- Electronic Assemblies
- Dial Light Assemblies

Write For New Wells Catalog

Each relay is new, individually boxed, and unconditionally guaranteed by Wells

World's Largest Display of Radio and Electronic Components

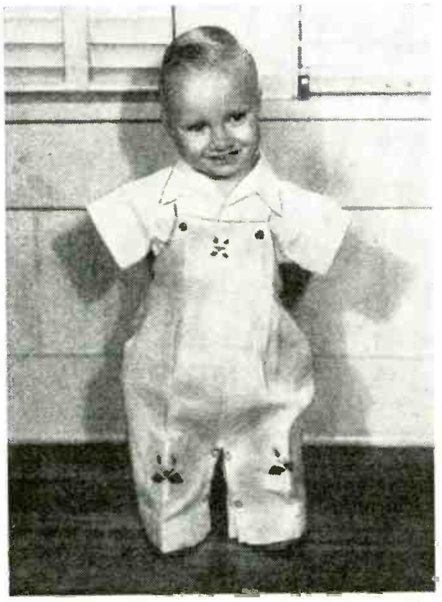
9,000 Square Feet of Display All On One Floor

WELLS SALES, INC.

320 N. LA SALLE ST., DEPT. Y   CHICAGO 10, ILL.

HELP-FREDDIE-WALK FUND

With this issue the Help-Freddie-Walk Fund reached a total of $3945.73. This fund, as our readers know, is for two-year-old Freddie Thomason, the Arkansas radio technician's son born with neither arms nor legs.



Little Freddie is trying hard to walk.

Reports from Freddie's parents are quite encouraging because the young boy now insists on wearing his special harness practically all the time and he is trying very hard to walk. Of course, he will not be able to walk as we know the term because he has no legs and the only way he can accomplish forward motion is by twisting his body first to the right and then to the left. Once he has mastered this difficult motion he will be able to get around by himself.

Long after he has become proficient

in doing so will come the task of another appliance to give him artificial arms and hands, but this is still quite a bit in the future.

In the meanwhile, Freddie's expenses are great day in and day out; and though it is true that while he is very young his parents can take care of him, later on he must have special tools, special appliances bought almost yearly, all of which adds up to quite a lot of money every year. For this reason our readers are urged to contribute as much to the fund as they possibly can afford. Contributions are badly needed.

The Editor is pleased to announce that the largest contribution received was $180 from Mr. John A. Gardner, a television engineer from Camden, N. J. We were very gratified to receive this very fine donation and RADIO-ELECTRONICS greatly appreciates Mr. Gardner's effort.

Keep up the good work by sending your contributions, even the smallest one will be very welcome.

Make all checks, money orders, etc., payable to Herschel Thomason. Please address all your letters to:

Help-Freddie-Walk Fund
c/o RADIO-ELECTRONICS
25 West Broadway
New York 7, N. Y.

Balance as of October 23, 1950	$3491.56
Louis Abad—Rego Park, N. Y.	1.00
Adam—Los Angeles, Calif.	2.00
W. R. Adams—Clarks Hill, Ind.	1.00
Administrative Department of Owens Corning Fiberglas Corporation—Newark, N. J.	5.00
Anonymous—Glendale, Calif.	1.00
Anonymous—New Augusta, Ind.	2.00
Anonymous—Fort Thomas, Ky.	1.00
Anonymous—Lawrence, Mass.	2.00
Anonymous—Worcester, Mass.	10.00
Anonymous—Poughkeepsie, N. Y.	4.00
Anonymous—Rochester, N. Y.	5.00
Anonymous—Columbus, Ohio	5.00
Anonymous—Fairborn, Ohio	6.40
Anonymous—El Paso, Texas	2.00
Anonymous—El Paso, Texas	2.00
Anonymous—Cheyenne, Wyo.	5.00
M. B.—Flushing, N. Y.	1.00
Barber Motor Company — Worthington, Minn.	2.00
James H. Baskerville, Amityville, N. Y.	5.00
Mr. & Mrs. N. A. Basso—Morgantown, W. Va.	5.27
B. L. Brown—Carlsbad, N. Mex.	5.00
F. Cardinal—Schenectady, N. Y.	1.00
Mr. & Mrs. Leo I. Chaisson—Athol, Mass.	1.00
Class E56-58, Crescent School of Radio & Television—Brooklyn, N. Y.	8.50
W. Cooper—Schenectady, N. Y.	1.00
Ralph Cramer—Bellmore, N. Y.	3.00
William T. Curtis—Syracuse, N. Y.	1.00
David's Radio Service—Church Point, La.	3.00
Dow Radio, Inc.—Pasadena, Calif.	10.00
Bruce E. Duff—Bedford, Ohio	2.00
Dutchess & Butch—East Orange, N. J.	2.00
Kenneth R. Elliott—Dayton, Ohio	2.50
Albert Evangelista—Belleville, N. J.	5.00
Luis C. Fargel, Jr.—Johnsonburg, Pa.	2.50
Harry Fersch—Jersey City, N. J.	3.00
John A. Gardner—Camden, N. J.	180.00
Charles Godleski—Utica, N. Y.	2.00
Mabel Goetz—Monroe, Wisc.	25.00
Nathan L. Goetz—Monroe, Wisc.	10.00
T. Goldie—Schenectady, N. Y.	1.00
Harold T. Goodfellow—St. Albans, N. Y.	15.00
Harry E. Hall—Detroit, Mich.	1.00
Paul Heine—St. Louis, Mo.	5.00
J. F. Holton—Valdosta, Ga.	1.00
W. Kelly—Schenectady, N. Y.	1.00
Susan & Henry Jr. Kiertscher—Downers Grove, Ill.	2.00
Tom E. Kokovikos, WØOLJ, Tom's Radio Shop, Morris, Minn.	5.00
W. J. Kreps—Glenford, Ohio	5.00
Luigi & John—Washington, D. C.	2.00
John McDonnell, WINWP—Jamaica Plain, Mass.	3.00
Joseph Markowiak—Toledo, Ohio	10.00
Dr. Curtis A. Mertz—Ashtabula, Ohio	5.00
Merwin Company—Jensen Beach, Fla.	2.00
Morvin E. Nulsen—Indianapolis, Ind.	2.00
Dr. Ing. Nino Erald Pellegrini—Biella, Italy	1.00
Mrs. Mabel C. Piper—Long Beach, Calif.	1.00
Princess Theatre—Parkersburg, Ia.	2.00
Wm. G. Quaster—Sausalito, Calif.	2.00

Walter Raymond, Raymond Music Co.—Leavenworth, Kansas	2.00
Wilfred Rhodes—Burbank, Calif.	2.00
E. F. Robinson—Dayton, Ohio	1.00
Sandy's Radio Service—Long Beach, Calif.	2.00
Kathryn K. Scatchard—Philadelphia, Pa.	2.00
F. W. Schamu—Liverpool, N. Y.	6.00
Anton Sears—Ft. Harrison, Mont.	1.00
A. Sikorsky—Alexandria, Va.	2.00
Mr. & Mrs. J. Simrin—Bronx, N. Y.	2.00
Thurman L. Slater—Fort Wayne, Ind.	5.00
Mrs. R. A. Smith—Charlestown, Mass.	1.00
Henry Stackhouse—Portland, Me.	1.00
Vernon Tyo—Tupper Lake, N. Y.	2.00
Mr. & Mrs. E. Raymond Ur—Pottstown, Pa.	2.00
C. E. D. Varcoe—Detroit, Mich.	4.00
Mc and Frances Vaughan—Port Arthur, Texas	1.00
Charles C. Watkins, W2RVP—Bridgeton, N. J.	1.00
Wickell's Radio Service—Fulton, Mo.	3.00
Irving Wilson—Twin Falls, Idaho	1.00
Mrs. Leo Wiman—Lubbock, Texas	1.00
Harold & Charles Wisker—Hastings, Nebr.	2.00
Charles E. Young—Fort Wayne, Ind.	5.00
T. Zak—Schenectady, N. Y.	1.00

Total contributions received to November 17, 1950—$3945.73

Radio Thirty-Five Years Ago
In Gernsback Publications

HUGO GERNSBACK
Founder

Modern Electrics	1908
Electric Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931
Wireless Association of America	1908

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

JANUARY, 1917 ELECTRICAL EXPERIMENTER

The Radio Obliterator
The Presidential Amateur Radio Relay
New Wireless Law Planned
Election Returns Flashed by Radio to 7,000 Amateurs
New Audion and Radiophone Apparatus
Long Distance Radio Without Aerials
Radio Detector Development, by H. Winfield Secor
Action of Detectors in Wireless Telegraphy, by Wilder D. Bancroft, (Cornell University
Marconi Company Sues the U.S. for $1,000,000 Damages, by A. Press, B. Sc.
The How and Why of Radio Apparatus
How to Make Any Audion Oscillate, by Edgar Felix
Marconi-Type Rotary Gap, by F. F. Lambert
New Audion Apparatus for Radiophony and Amplifying

RADIATION-PROOF GLASS SHIELDS ATOMIC WORKERS

Neutron-absorbing glass, containing cadmium borosilicates with fluorides, is a result of research directed by Dr. Alexander Silverman, head of the University of Pittsburgh's chemistry department. The glass will be used in goggles to protect the eyes of atomic workers, and in peepholes.

Another new glass has X-ray absorbing powers. Tungsten phosphate produces this effect and the glass will not discolor on exposure to high-energy X-rays or gamma rays. By making a composite lens with a layer of each of the two absorbent glasses, the glass will shield against both kinds of radiation.

MICROEXAMINATION

Capable of a 500-power magnification, the shadowgraph in the photo is used at Sun Radio and Electronics Co. of New York to examine phonograph stylus wear. The stylus appears on the screen as a sharply defined 6 x 9-inch shadow. This checkup service is offered free to those who bring in their cartridges.

Correction

The grid resistor of the first 6SJ7 in the high-gain amplifier described in the September, 1950 issue should be 220,000 ohms instead of 220 ohms as shown on the circuit, Fig. 1

ELECTRONIC LITERATURE

Any or all of these catalogs, bulletins, and periodicals are available to you if you write to us on your letterhead (do not use postcards) and request them by number. Send coin or stamps where cash is required. We will forward the request to the manufacturers, who in turn will send the literature directly to you. This offer void after six months.

JA-1—AUDAK BROCHURE

The latest brochure issued by the Audak Co. describes their line of Polyphase and Tuned-Ribbon reproducers, tone arms, and recording cutters.—*Gratis*

JA-2—RADIO-TV PARTS CATALOG

A 34-page catalog issued by Greylock Electronics Supply Co. lists test equipment, tubes, components, antennas, and other equipment used by service technicians, engineers, and constructors.—*Gratis*

JA-3—RADIO SHACK CATALOG

Radio Shack Corp. of Boston, Mass., has published its 1951 catalog of electronic parts, complete equipment, and kits. Containing 172 pages, the catalog has major sections devoted to test instruments, public-address and high-fidelity music systems, amateur radio equipment, and electronic components and fittings.—*Gratis*

JA-4—PARTS CATALOG

Containing approximately 36 pages of switches, connectors, couplers, rectifiers, resistors, capacitors, special transformers, and hundreds of relays, the 1950 catalog issued by Wells Sales, Inc. is a source of special components for new equipment or replacement in military electronic equipment.—*Gratis*

JA-5—CONTROLS AND RESISTORS

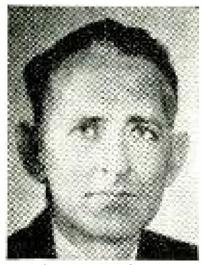
Most types of standard and special controls and resistors are listed in the new Clarostat catalog. Potentiometer-type controls having special shafts, high-voltage couplers, and other features are included along with the standard line of ballasts; Potentiometers; rheostats; fixed, adjustable, and flexible wire-wound resistors; and attenuators.—*Gratis*

JA-6—AUDIO HANDBOOK

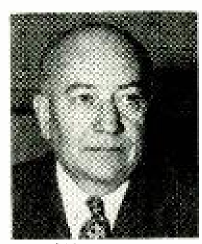
A new edition of Sun Radio's audio equipment handbook is being distributed. A 38-page section is devoted to answering the layman's queries on high-fidelity reproducing equipment for the home. This section is illustrated with photographs and drawings of typical custom installations and includes working drawings showing the construction of typical bass-reflex and corner-type speaker enclosures. The catalog section lists pickups, amplifiers, speakers and enclosures, and other audio equipment.—*Gratis*

Walter A. Buck, vice-president and general manager of RCA Victor Division, was elected to the board of directors of the RADIO CORPORATION OF AMERICA. He succeeds **Edward J. Nally** who retired. Mr. Buck joined RCA in 1948 upon his retirement as a rear admiral in the U.S. Navy. He was president of the Radiomarine Corporation of America until July 7, 1949, when he was elected operating vice president of RCA Victor Division.

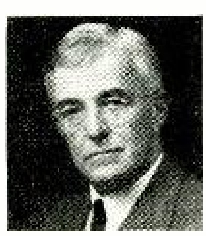
M. A. Acheson, former chief engineer of the SYLVANIA RADIO TUBE DIVISION, was transferred to the staff of E. Finley Carter, vice president in charge of engineering in New York. **R. P. Clausen,** former assistant chief engineer, succeeds him as chief engineer. Sylvania also announced the appointment of **Walter R. Seibert** as controller. Mr. Seibert was formerly assistant to the controller.


M. A. Acheson

W. S. Parsons, vice president in charge of sales at the Centralab division of GLOBE-UNION, INC., announced the following promotions: **Wickham Harter** to sales manager of mechanical-electronic products, including the sales activities of the variable resistor and switch divisions; **Douglas Thatcher** to sales manager of ceramic-electronic products; and **Robert A. Mueller** to sales assistant to Mr. Harter.


W. Harter

Dr. Irving Langmuir, recently retired associate director of the GENERAL ELECTRIC RESEARCH LABORATORY, was awarded the John J. Carty Gold Medal of the National Academy of Sciences for noteworthy contributions to the advancement of science. The award may not be made more often than once in two years. Dr. Langmuir also holds the Nobel Prize in Chemistry, the Faraday Medal of the British Institute of Electrical Engineers and many other awards.


I. Langmuir

Glen McDaniel of RCA was appointed Chairman of the RTMA Defense Profits Tax Committee, which will consider effects of the proposed excess-profits tax on the radio-TV industry. Other members of the committee are: **Max F. Balcom,** SYLVANIA; **J. E. Cain,** P. R. MALLORY; **B. L. Graham,** DU MONT; **Herbert C. Hamilton,** HYTRON; **Raymond Herzog,** EMERSON; **Edward L. Hulse,** GENERAL ELECTRIC; **W. Myron Owen,** AEROVOX; **M. G. Paul,** PHILCO; **Ernest Searing,** IRC; **Robert C.**

OPPORTUNITY AD-LETS

Advertisements in this section cost 25c a word for each insertion up to and including the March 1951 issue. Beginning with the April 1951 issue the rate will be 35c a word for each insertion. Name, address and initials must be included at the above rate. Cash should accompany all classified advertisments unless placed by an accredited advertising agency. No advertisement for less than ten words accepted. Ten percent discount six issues, twenty percent for twelve issues. Objectionable or misleading advertisements not accepted. Advertisements for February, 1951, issue, must reach us not later than December 24, 1950.

Radio-Electronics, 25 W. Broadway, New York 7, N.Y.

Tait, STROMBERG-CARLSON; **Robert C. Sprague**, SPRAGUE PRODUCTS.

James M. Toney, advertising manager of RCA Victor home instruments department, was promoted to the post of director of public relations of the RCA Victor Division. **Thomas J. Bernard** continues as assistant director of public relations. RCA also announced the promotion of **Warren E. Albright** to the post of manager of the general materials division for the company's home instrument department. **M. S. Klinedinst** was named manager of the industrial equipment sales section of the RCA engineering products department.

Lawrence C. F. Horle, prominent in the standardization of radio enginering and equipment, died in St. Barnabas Hospital, Newark, N. J., at the age of 58. Mr. Horle was best known for his work in the field of standardization of terminology and ratings. He was a past president of the IRE and more recently chief engineer and director of the data bureau of the RMA (now RTMA).

Personnel notes

. . . **Charles Edward Wilson**, president of GENERAL ELECTRIC Co., was named by President Truman to the 24-man National Science Foundation for the encouragement of basic research.

. . . **Brig. Gen. David Sarnoff** was appointed national chairman of the 1951 Red Cross Fund Campaign.

. . . **Larry F. Hardy**, president of PHILCO's radio and television division, was elected chairman of the RTMA Public Relations Committee.

. . . **Charles W. Creaser** and **Kenneth S. Brock** were appointed special products sales manager and commercial sales manager of WORKSHOP ASSOCIATES, INC.

. . . **Shannon C. Powers** was named general sales manager of RUSSELL ELECTRIC CO., a subsidiary of RAYTHEON MANUFACTURING CO.

. . . **C. M. Breckenridge** was appointed assistant to the controller of the SIMPSON ELECTRIC CO.

. . . **Owen K. Lindley** and **James H. Sweeney** were named sales managers for electronic heaters and germanium diodes in the commercial equipment division of GENERAL ELECTRIC.

. . . **Dr. Vladimir K. Zworykin**, vice president of RCA LABORATORIES, was awarded the 1950 Progress Medal of the Society of Motion Picture and Television Engineers, the society's highest award, for contributions in a new field.

. . . **John Wood** and **William Newitt** have joined the engineering staff of ELECTRO-VOICE, INC.

. . . **Hulbert C. Tittle** was promoted to assistant chief engineer of the Radio & Television Division of SYLVANIA ELECTRIC PRODUCTS in Buffalo, N. Y.

TELE SERVICE DATA SLOW

Dear Editor:

Several months ago I finished a course in radio and television, and am now doing part time work in radio with the ambition to go into it full time. I have not been able to obtain servicing data for several new sets of different manufacture without a great waste of time. If manufacturers would make servicing data available, we could service some of the more difficult sets quickly, saving the owner time and money, and make these same owners proud to do a lot of advertising for the manufacturers, instead of grumbling how much it costs to service their sets.

I wish to give you my heartfelt thanks for all you have done, especially your recent editorial, "Manufacturers vs Service Technicians," and hope that you will continue.

EMIL KALAR
South International Falls, Minn.

SEPARATE MEN FROM BOYS?

Dear Editor:

Those technicians who argue that there are too many articles on TV in your magazine make me think of those who argue against the code test as a requirement for an FCC license. If these groups of people would expend one-tenth the energy in studying TV or code that they waste in fighting it, they would get off much easier and know a lot more to boot. Moreover, they would be increasing their earning power and enabling themselves to stay in the electronics field instead of being "washed out" and relegated to repairing electric irons and 117-volt cords.

On the other hand, it may be just as well. TV, code, etc., may be the instruments by which the men in electronics are separated from the boys!

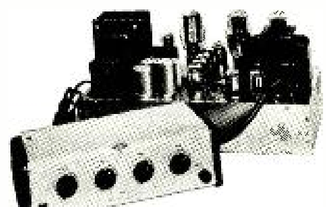
PETER N. SAVESKIE
Baton Rouge, La.

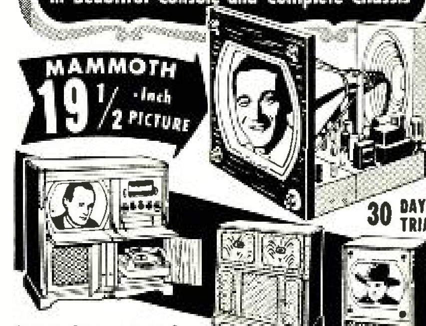
CORRECTION

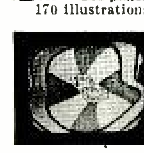
The value of resistor R7 was not given on the diagram of the remote amplifier on page 26 of the October, 1950, issue. This resistor is a 150,000-ohm, ½-watt unit. The value of R8 is incorrect on the diagram. The correct value is 50,000 ohms, 10 watts.

We thank the author, Mr. R. G. Finkbeiner, for this correction.

The author of the article "A High-Gain Amplifier," in the September, 1950, issue is listed as James Rundo. His correct name is John Rundo.







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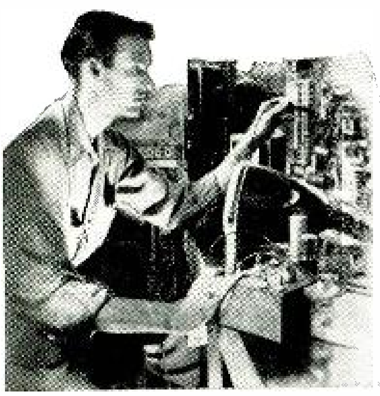

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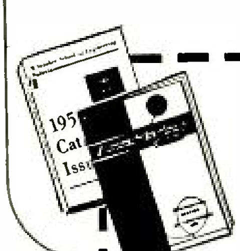

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TELEVISION, VOLUMES V and VI, edited by Alfred N. Goldsmith, Arthur F. Van Dyck, Robert S. Burnap, Edward T. Dickey, and George M. K. Baker. Published by RCA Review, Princeton, N. J. 6 x 9 inches. Vol. V, 461 pages; Vol. VI, 422 pages. Price $2.50 per volume.

The two volumes contain a collection of papers by RCA research workers, and cover practically all RCA's published work on the subject over the years 1947-1950. In some cases summaries are given.

The two volumes represent an originally projected Volume V, which was to cover 1947-49, but the tremendous amount of work on television (including color) during that period produced far more material than could be contained in a single volume. The period was extended to June, 1950, and two volumes were published.

RADIO AND TV INDUSTRY RED BOOK. Replacement Parts Buyers Guide (Second Edition). Compiled and published by Howard W. Sams & Co., Indianapolis, Ind. 11 x 8½ inches, 623 pages. Price $3.95.

Like the first edition which appeared in 1948, this book is designed to give the service technician in one volume instant reliable data on replacement parts. It lists parts for approximately 20,000 sets made from 1938 to 1950.

The format is the same as for the first edition. Model numbers are listed down the left side of each left-hand page and repeated on the right side of the opposite page, leaving a 19-inch line for listing replacement parts. Divided into seven sections: Tube Complement and Dial Light, Capacitors, Transformers, Phono Cartridges, I.F. Coils, Speakers, and Controls. The line lists the part numbers of one to four manufacturers, including the original replacement part number. Thus the part or its equivalent can be ordered from the most convenient source. The equivalent listings may be very useful in the face of parts shortages.

ADVERTISING INDEX

RADIO SCHOOL DIRECTORY
(Pages 146-147)

Radio-Electronics does not assume responsibility for any errors appearing in above index.

RADIO AND TELEVISION, AN INTRODUCTION, by Giraud Chester and Garnet R. Garrison. Published by Appleton-Century-Crofts, Inc. 6½ x 9½ inches, 550 pages. Price $4.75.

This rather original book is divided into two sections: the first deals with the social aspects of radio, and the second with radio and television broadcasting from the studio and program point of view. Its dual nature is the result of a need for a college text to assist in "training students in radio skills and supplying them with a body of information about the field."

Part I begins with a survey of radio in the United States and continues with historical and topical information on programming, stations and networks, international broadcasting, advertisers and agencies, and the FCC, with a specially interesting chapter "What Constitutes the Public Interest?" The second part deals with radio and television broadcasting from the point of view of the student actor, program director, and announcer.

OUTLINE OF RADIO, TELEVISION AND RADAR, a symposium by R. S. Elven, T. J. Fielding, E. Molloy, H. E. Penrose, C. A. Quarrington, M. G. Say, R. C. Walker and G. Windred. Published by Chemical Publishing Co., Brooklyn, N. Y. 6 x 8¾ inches, 688 pages. Price $12.00.

As implied in the title, this is an outline, beginning with "What Is Electricity" and ending with "A Survey of Radar." The contributors are eminent in the British radio world, and the book as a whole is carefully written. The first eleven chapters apply to fundamental theory and components and there are seven dealing with receivers, their circuits and stages. The rest of the thirty-five chapters cover a range of subjects from accumulators to direction finders.

ADVENTURE INTO THE UNKNOWN, by Laurence A. Hawkins. Published by William Morrow & Co., New York, N.Y. 6¼ x 9½ inches, 150 pages. Price $3.50.

Adventure into the Unknown is a history of the General Electric research laboratory at Schenectady, from its first home in the barn of the late Charles P. Steinmetz to its present group of specially designed buildings on the shore of the Mohawk, and from the GEM lamp of Willis R. Whitney to the rain-producing silver iodide crystals of Bernard Vonnegut.

The story is told by one of the laboratory staff, who for 36 years was either assistant to the director or executive engineer of the laboratory. He has an independent claim to fame as the author of the "-tron" system of naming and indicating the characteristics of vacuum tubes that de Forest humorously dubbed "Greco-Schenectady."

All the important achievements of the laboratory during the 50 years of its existence are chronicled, together with vignettes of its chief workers, for whom the author has unbounded admiration.

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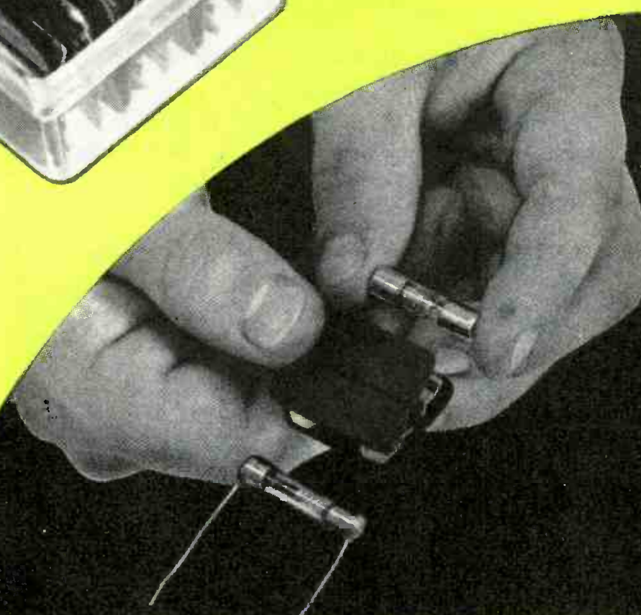

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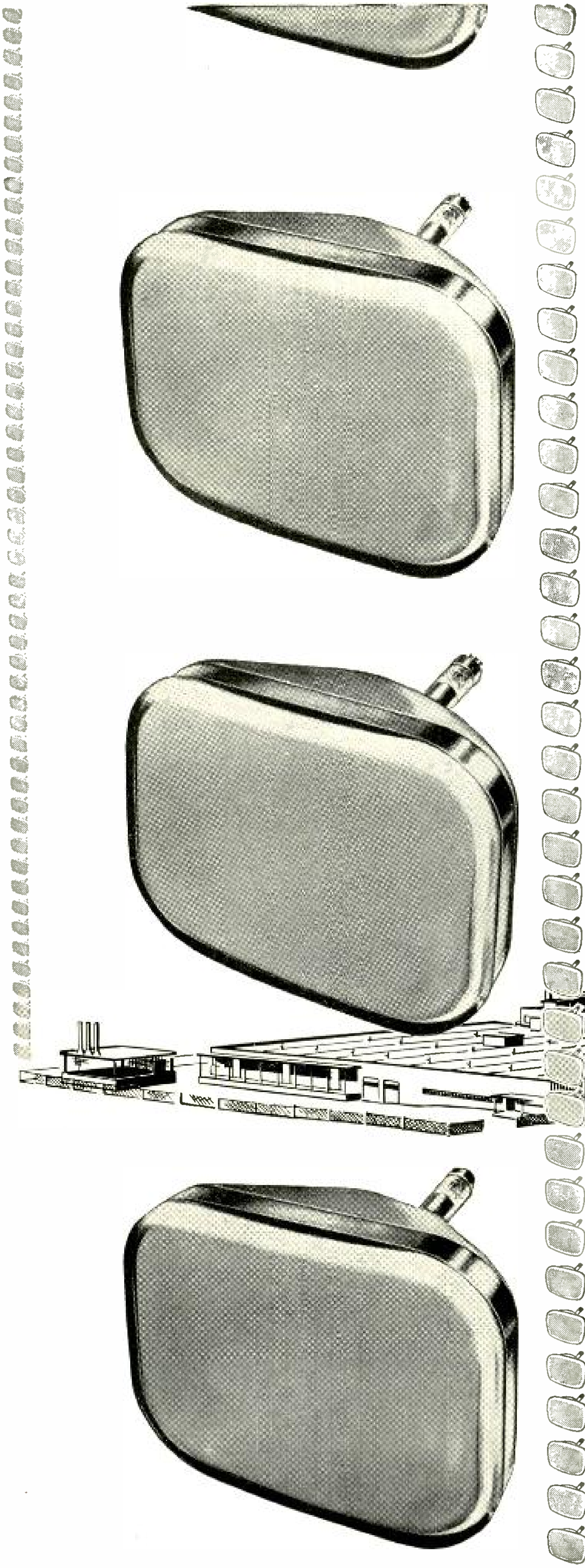

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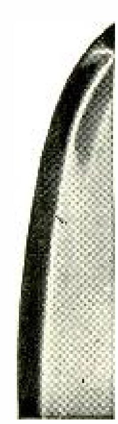

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