LATEST IN TELEVISION · SERVICING · AUDIO

RADIO — ELECTRONICS

K

NEW CIRCUITS IN 1951 TV RECEIVERS

—

TELEVISION SERVICE CLINIC

HUGO GERNSBACK, Editor

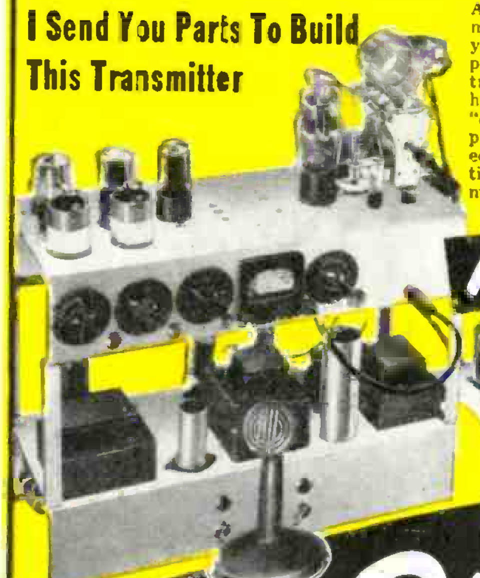
DEC 1950

30¢ U. S. and CANADA

CHRISTMAS PACKAGE FOR FUTURE HAMS — SEE AMATEUR SECTION

You Practice COMMUNICATIONS

I Send You Parts To Build This Transmitter



As part of my Communications Course you build this low power broadcasting transmitter, learn how to put a station "on the air," perform procedures demanded of Broadcast Station operators, make many tests.

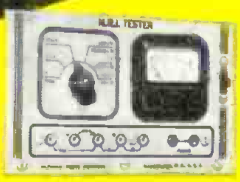
You Practice Radio SERVICING

On This Modern Radio You Build With Parts I Send

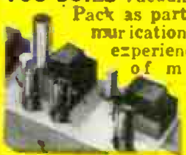
As part of my Servicing Course, I send you the speaker, tubes, chassis, transformer, loop antenna, EVERYTHING you need to build this modern, powerful Radio Receiver! I also send parts to build other Radio circuits, see below. You use for practical experience and to earn EXTRA money in spare time.

BE A RADIO-TELEVISION TECHNICIAN

Learn Servicing or Communications by Practicing in Spare Time with KITS OF RADIO PARTS I Send



YOU BUILD this Tester with parts I send early in my Servicing Course. Helps you fix neighbors' Radios and EARN EXTRA MONEY in spare time.



YOU BUILD Vacuum Tube Power Pack as part of my Communications Course; get experience with packs of many kinds. Learn how to correct Power Pack troubles.

YOU BUILD this A. M. Signal Generator as part of my Servicing Course. It provides amplitude-modulated signals for many tests and experiments.

J. E. SMITH, President
National Radio Institute

Do you want good pay, a job with a bright future and security? Would you like to have a profitable shop or store of your own? If so, find out how you can realize your ambition in the fast growing, prosperous RADIO-TELEVISION industry. Even without Television, the industry is bigger than ever before. 81 million home and auto Radios, 2,700 Broadcasting Stations, expanding use of Aviation and Police Radio, Micro-wave Relay, Two-way Radio for buses, taxis, etc., are making opportunities for Servicing and Communications Technicians and FCC-Licensed Operators.

Television is TODAY'S Good Job Maker

In 1949, ~~almost 3,000,000~~ TV sets sold. By 1954, 20,000,000 TV sets estimated. 100 TV Stations now operating. Authorities predict 1,000 TV Stations. This means more jobs, good pay for qualified men all over the United States and Canada.

Many Soon Make $10 Extra a Week in Spare Time

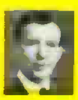
Keep your job while training. Hundreds of successful RADIO-TELEVISION TECHNICIANS I trained had no previous experience, some only a grammar school education. Learn Radio-Television principles from illustrated lessons. Get PRACTICAL EXPERIENCE—build valuable multitester—experiment with circuits common to Radio and Television. Keep all equipment. Many students make $5, $10 extra a week fixing neighbors' Radios in spare time. SPECIAL BOOKLETS start teaching you the day you enroll.

Send Now For 2 Books FREE—Mail Coupon

Send now for my FREE DOUBLE OFFER. You get actual Servicing lesson to show you how you learn at home. Also my 64-page book, "How to Be a Success in Radio-Television." Read what my graduates are doing, earning; see equipment you practice with at home. Send coupon in envelope or paste on postal. J. E. SMITH, President, Dept. ONX, National Radio Institute, Washington 9, D. C. Our 37th Year.

I TRAINED THESE MEN

"I have been operating my own Servicing business. In two years I did $14,000 worth of business; net profit, $6,850. Have one full time employee, an N.R.I. Student."—PHILLIP G. BROGAN, Louisville 8, Ky.



"Four years ago, I was a bookkeeper with a hand-to-mouth salary. Now I am a Radio Engineer with a key station of the American Broadcasting Company network."—NORMAN H. WARD, Ridgefield Park, N. J.

"When halfway thru the N.R.I. course, I made $5 to $8 a week fixing sets in my spare time. Am now selling and installing Television sets and antennas."—E. J. STREITENBERGER, New Boston, Ohio.

"My first job was operator with KDLR, obtained for me by your Graduate Service Dept. I am now Chief Engineer of Police Radio Station WQOX. I never hesitate to endorse N.R.I."—T. S. NORTON, Hamilton, O.

Veterans YOU MUST ACT FAST

G. I. Bill gives you valuable training benefits. For each 3 months of training eligibility, you can get a full year of N.R.I. Training. Keep your job while learning. But Act Now! Time is running out!

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MR. J. E. SMITH, President, Dept. ONX,
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Mail me Sample Lesson and 64-page Book about How to Win Success in Radio-Television. Both FREE. (No Salesman will call. Please write plainly.)

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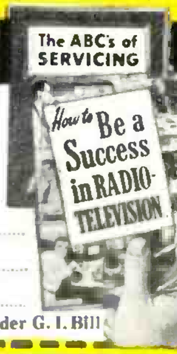
☐ Check if Veteran Approved for training under G. I. Bill



RADIO — ELECTRONICS

Incorporating
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RADIO & TELEVISION
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CONTENTS — DECEMBER, 1950

ON THE COVER: Larry Le Kashman and his daughter Patricia in a Christmas scene at his station W2IOP. *Kodachrome by Avery Slack.*

WATCH FOR THE JANUARY ANNUAL TELEVISION NUMBER

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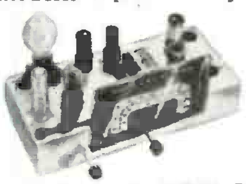

NOW! NEW PROFESSIONAL MULTITESTER INCLUDED

This versatile testing instrument is portable and complete with test leads. Simple to operate, accurate and dependable. You will be able to quickly locate trouble and adjust the most delicate circuits. You can use the Multitester at home or on service calls. It is designed to measure AC and DC volts, current resistance and decibels. You will be proud to own and use this valuable professional instrument.

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National Schools Master Shop Method Home Training gives you basic and advanced instruction in all phases of Radio, Television and Electronics. Each lesson is made easy to understand by numerous illustrations and diagrams. All instruction material has been developed and tested in our own shops and laboratories, under the supervision of our own engineers and instructors. A free sample lesson is yours upon request—use the coupon below.

TELEVISION TRAINING A complete series of up-to-the-minute Television lessons is an integral part of your course, covering all phases of Television repairing, servicing and construction.

Here are just a few of the interesting facts you learn with the
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3. Converting signal curr sound.
4. How the R-F transforr the signal.
5. How the tuning cirr
6. The Radio "bands

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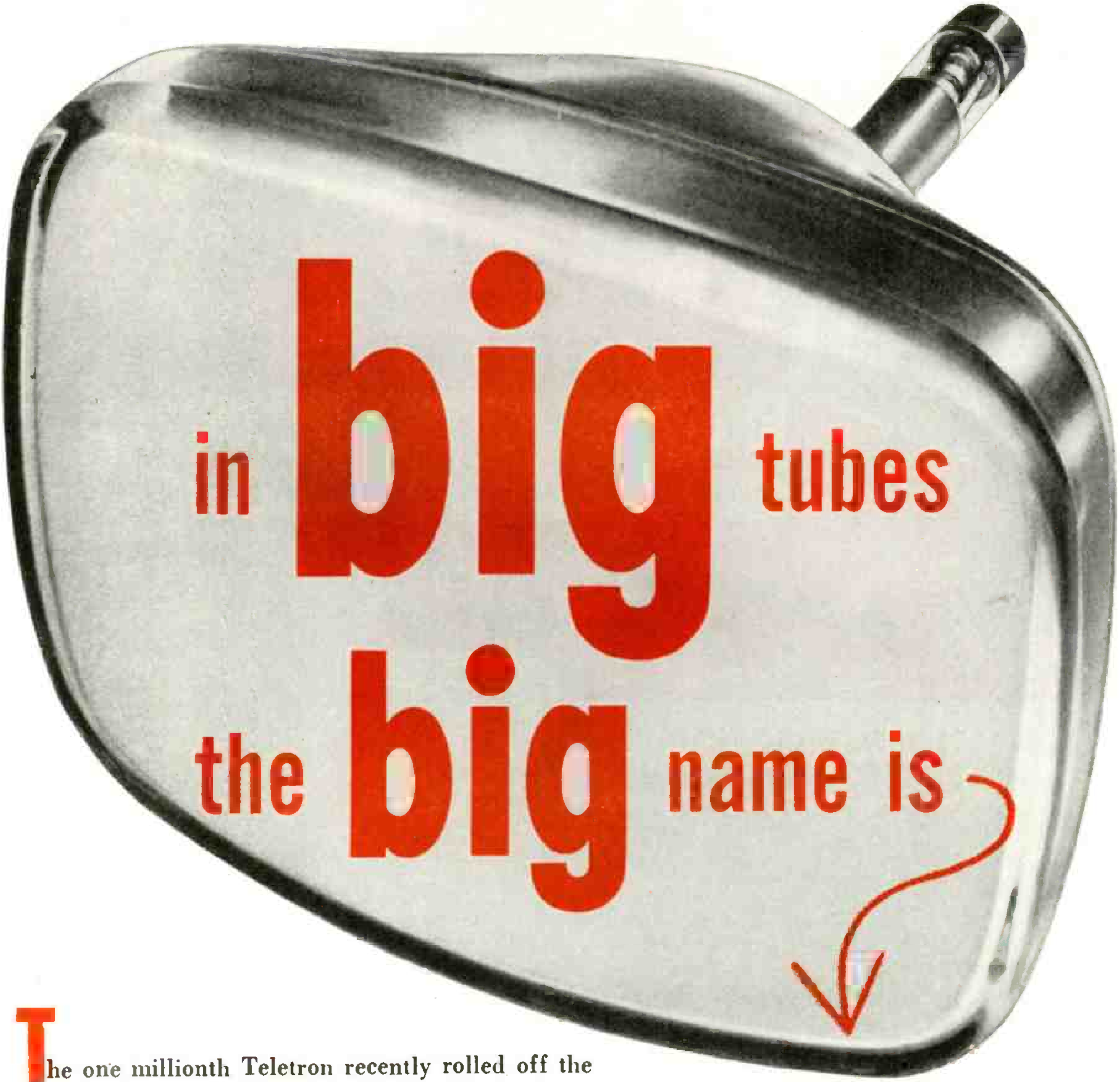

The one millionth Teletron recently rolled off the production line. It was all in the day's work for Du Mont's vast Allwood plant geared to over a million TV picture tubes a year. Yet that tube established a unique record, because it represented the one millionth BIG TUBE. No other manufacturer has made that many BIG TUBES.

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Mont has pioneered BIG TV TUBES. While others
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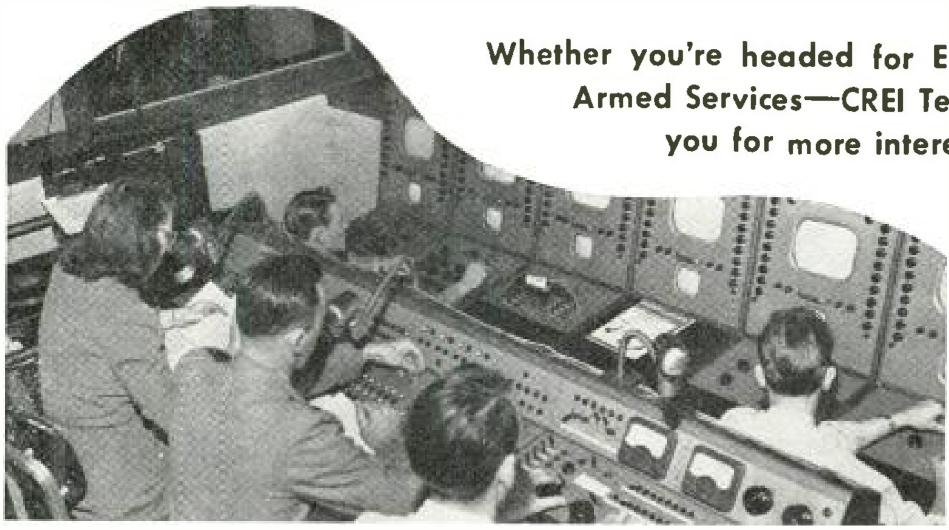

Whether you're headed for Essential Industry—or the Armed Services—CREI Technical Training qualifies you for more interesting jobs at better pay!

Television technicians are in demand in stations, factories, research labs; in installation and trouble-shooting jobs. In the Armed Services, the men who know electronics are sure of interesting, supervisory jobs.

CREI Home Study can help you step ahead!

By E. H. Rietzke
President CREI

YOUR future success can best be assured by the steps you take today to prepare for it. No field offers a properly qualified young man greater opportunity than electronics. In the Armed Services, electronics gives rockets "brains" to make scientific observations, gives airplanes "eyes" and "ears" to navigate, gives explosives target directions.

In industry, electronics prepares the vast number of devices utilized by the Armed Services—the countless radars, two-way radios, and communications equipment used by modern armies, fleets, and planes. In peace, electronics provides good jobs for trained engineers and technicians. Television's fantastic growth from 10,000 sets in 1945 to 8 million by the end of 1950—with set production currently at the rate of 6 million—is typical of the speed at which the electronics band-wagon is moving. It is the *new* field, where know-how is rewarded with excellent jobs and lifetime careers. And authorities are agreed that the one sure way to acquire this training is from a good school.

How can a young man select a "good school"? By its reputation in the industry . . . the professional standing of its faculty . . . the quality of its courses . . . the length of time it has been in existence . . . and its accomplishments.

CREI invites investigation and comparison. An accredited technical institute founded in 1927, CREI's home-study graduates today fill important engineering, research, and radio-TV posts through the industry. While CREI makes no job promises to its graduates, the Placement Bureau generally has on hand more requests than it can fill. During World War II CREI trained thousands of technicians for the Army, Navy and Coast Guard. Hundreds of thousands of special CREI technical texts were used in the Navy's own training program. Leading industrial firms—RCA Victor, United Air Lines, TWA, Pan American Airways, All America Cables & Radio, Inc., Sears Roebuck & Co., to name only a few—have selected CREI for technical training for their technicians *at company expense.*

CREI, through home study, offers *practical* training that starts with basic principles and goes step-by-step through the more advanced subjects of TV and its related fields. Each student is grounded thoroughly in the fundamentals required for development work in TV, guided missiles, communications and industrial electronics. You study Optics; Pulse Techniques; Deflection Circuits; RF, IF, AF and Video Amplifiers; FM; Receiving Antennas; Power Supplies; Cathode Ray, Iconoscope, Image Orthicon and Projection Tubes; UHF Techniques, TV Test Equipment, and many other subjects.

There are three basic CREI courses: Practical Radio Engineering (fundamental course in all phases of radio-electronics); Practical Television Engineering (specialized training for professional radiomen); Television and FM Servicing (streamlined course for men in top third of field). Courses are also available at the Residence School in Washington, D. C.

Write immediately for complete information. The cost is within reach of all, the terms easy. *Mail this coupon at once.*

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Check the Field of Greatest Interest: ☐ PRACTICAL TELEVISION ENGINEERING. ☐ PRACTICAL RADIO ENGINEERING. ☐ TV, FM & ADVANCED AM SERVICING. ☐ AERONAUTICAL RADIO ENGINEERING. ☐ BROADCAST RADIO ENGINEERING (AM, FM, TV). ☐ RADIO-ELECTRONICS IN INDUSTRY.

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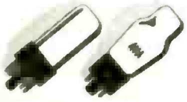
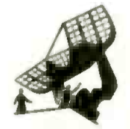
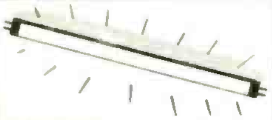


Radio Tubes . . . 25 years' experience in building high quality tubes for every radio and television need.

Electronics . . . wide experience in designing radar and electronic equipment for war-time and post-war commercial use.





Phosphors . . . production of white and colored phosphors for the "Finest in Fluorescent Lighting."

Lighting . . . half a century of research and manufacture of incandescent and fluorescent lamps to meet longest life and highest vision standards.

This unique combination of experience naturally fits Sylvania for top position in the TV Picture Tube field.

Maintaining this leadership is a continuing program of research and engineering. A Sylvania engineer, for example, invented the famous "Ion Trap," now licensed to numerous other picture tube makers.

Sylvania achievements in fluorescent powders, tungsten wire, and precision parts are some of the other reasons which lie behind the consistent color, greater clarity, and longer life of all Sylvania TV Picture Tubes.

Backing up each Sylvania advance is a rigid system of quality control . . . of checking and rechecking every step of every process . . . so that TV set owners everywhere will continue to look to Sylvania for the finest performance possible. New booklet gives information concerning the complete line of Sylvania Picture Tubes. Write for your copy today. Address Sylvania Electric Products Inc., Dept. R-1012, Emporium, Pa.

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Here's the REAL THING!

Use REAL commercial-type equipment to get practical experience

Your future deserves and needs every advantage you can give it! That's why you owe it to yourself to find out about one of the most COMPLETE, practical and effective ways now available to prepare AT HOME for America's billion dollar opportunity field of TELEVISION-RADIO-ELECTRONICS. See how you may get and keep the same type of basic training equipment used in one of the nation's finest training laboratories . . . how you may get real STARTING HELP toward a good job or your own business in Television-Radio-Electronics. Mail the coupon today for complete facts — including 89 ways to earn money in this thrilling, newer field.

ABOVE: Build and keep a real 16 INCH commercial TV receiver. Optional after completing regular training at slight additional cost.

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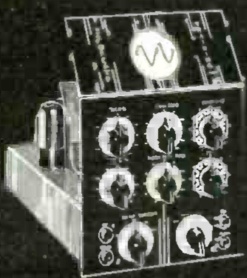
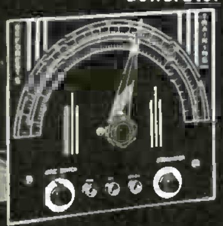
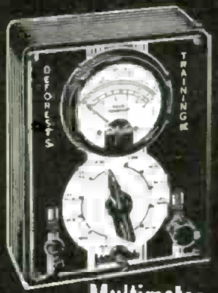


Oscilloscope

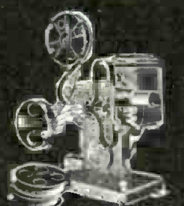


R-F Signal Generator



Multimeter

6-Tube Radio



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In addition to easy-to-read lessons, you get the use of HOME MOVIES — an outstanding training advantage — plus 16 big shipments of Electronic parts. Perform over 300 fascinating experiments for practical experience. Build and keep real commercial-type test equipment shown at left.

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

WAVELENGTHS are under discussion by committees of the seven-nation North American Regional Broadcasting Conference. Delegates to the conference are from Canada, Cuba, the Dominican Republic, Haiti, Mexico, the United Kingdom (on behalf of the Bahamas and Jamaica), and the United States.

Facing the conference is the problem of dividing up the 108 channels of the broadcast band (540 to 1620 kc) among 3,000 stations, some 2,000 of which are in the United States. An earlier agreement lapsed in March, 1949, but some of the conference members are still abiding by the old terms. However, Mexico and Cuba have complained that their broadcast needs have so increased that new allocations are necessary.

GENERAL ELECTRIC CO. opened the new home of its research laboratory October 9 last. Dedication of the new building coincided with the anniversary of the founding of the laboratory, which came into existence 50 years ago in the barn of Charles Steinmetz, electrical and mathematical genius.

The new laboratory is five stories high, with the lower two stories below ground level. It houses 107 laboratory rooms, an auditorium, various special and office areas and extensive shop space. Movable steel partitions permit considerable flexibility in size and number of laboratory rooms.

Besides the main building, there are four other structures: the low-temperature laboratory; a chemical pilot plant; a radiation laboratory, which will house a 300-million-volt synchrotron; and a heating plant.

Dedication of the laboratory also marked the opening of the annual autumn meeting of the National Academy of Sciences, which commenced technical sessions in the auditorium of the new laboratory on the morning of Tuesday October 10 and continued till Thursday afternoon. It was the first time in its 88-year history that the Academy held one of its regular meetings at an industrial laboratory.

VIDEOGNOSIS may some day bring big city medical specialists practically to the bedside of patients in rural hospitals. The technique consists of transmitting X-ray pictures via television and has already been worked successfully by Dr. J. Gershon-Cohen and associates of the Jewish Hospital of Philadelphia.

The patient's own physician and the specialist can consult by telephone while viewing the X-ray picture and its TV image. The TV image is said to be better in some respects than the original because the contrast can be adjusted for easier reading.

TV MEMORY TUBE may bring a radical improvement in television receiving apparatus within the next two years. Similar to the memory tubes used in computing machines, the device was described recently by Philo T. Farnsworth, vice-president of the Capehart-Farnsworth Corporation.

Doing away with the present interlace system, the tube will receive two frames every 1/60 second, store these until the picture is complete, and then project the completed picture only once each 1/60 second.

The tube will virtually eliminate flicker because the scan lines are not used. The only movement seen is the change from one complete image to the next, and this takes place so fast that it is not apparent. Another advantage is that the image brilliancy will be up to 5,000 times as great as in present tubes, thus making better projection television possible.

TV CONJUNCTIVITIS is a new ailment resulting from the rigors of modern life. Ben Payne Sr. of Columbus, Ohio, watched his set from 6 to 10 pm one evening with no breaks. When his eyes finally began to smart he went to bed. He woke up after midnight and found that he couldn't open his eyes and his head ached. At the hospital the doctors diagnosed his case as television conjunctivitis or looking too long.

An overall view of G-E's new research laboratory building at Schenectady N. Y.

ALARMING SHORTAGE of engineers is predicted by the American Society for Engineering Education. Based on enrollments of engineering schools, the forecast estimates that the present freshman class of engineering students is only about half what it should be.

300,000,000-VOLT synchrotron to be installed at the General Electric Laboratory at Schenectady, N. Y., works on a new principle.

Dr. James L. Lawson, manager of the Electron Physics divisions of the laboratory, gave details of the new machine, called a "non-ferromagnetic synchrotron," to members of the National Academy of Sciences at their autumn meeting in October.

In the usual synchrotron, a stream of electrons, originating from a heated filament, is accelerated to high energy in a doughnut-shaped vacuum tube between the poles of a powerful iron-core electromagnet. The magnetic field gives them their original acceleration, until they are moving at nearly the speed of light. As they receive further increase in energy, by passing a strongly electrified metal gap, the magnetism guides them in their orbit. At full energy they hit a metal target, generating a beam of X-rays, which emerges from the tube.

In the non-ferromagnetic synchrotron, as developed by Dr. Lawson and his associates, the necessary magnetic fields are produced by current-carrying coils rather than by iron-core electromagnets. There are sets of coils to provide the field for initial acceleration of the electrons (up to about 2.5 million volts) and to continue guiding them as they are further energized by passage through the electrified gap. The high fields which are possible from such coils results in a very compact machine compared with those of conventional type, in some of which the iron core of the magnet may weigh up to hundreds of tons.

SUBSCRIPTION TV began a series of test broadcasts over station WOR-TV in New York recently. Called Subscriber-Vision, the system is being tested by the Skiatron Electronic and Television Corporation, and these first on-the-air trials will be observed by the FCC.

Television receivers will not be able to get a picture from the subscription broadcasts unless equipped with a special decoder. The decoder is equipped with a plastic card which is identical within 1/10,000 inch to one used at the transmitter. These cards control the scrambling and unscrambling of the TV signal, and no telephones lines are needed. These tests will not interfere with WOR-TV's regular programs.

TEST PILOTS will no longer have to risk their necks, thanks to TV. The Air Force stated that planes under test would be equipped with TV cameras focussed on the instrument panel, while the pilot operated the plane by remote control from the ground. The new method will make it possible to get data never before obtainable.

Two war surplus planes equipped with the system are now under test. So far the results indicate that the use of TV is entirely practical and it may even be used on some of the new super high-speed planes.

MULTIPLEXED FM was demonstrated recently by the Multiplex Development Corporation of New York when they transmitted two separate sound programs simultaneously over a single FM station channel. For part of the demonstration, two microphones were used to pick up the program at the transmitter, the sound was divided between the two channels, and was reproduced over two loudspeakers at the receiving end. It was said to give a stereophonic, or presence effect at the receiver.

The system was also used to send program material over one channel and facsimile signals over the other, with no noticeable cross interference.

Scientists make some preliminary tests on G-E's new high-energy synchrotron.

H. J. FOY, PRESIDENT — CY HOOD, SECRETARY

FOY ELECTRIC COMPANY, INC.

305 SOUTH MINT STREET — TELEPHONE 3-4834

CHARLOTTE 6, N. C.

August 21, 1950

Hytron Radio & Electronics Corp.,
Salem, Mass.

Dear Sirs:

It is with great pleasure that I write you at this time to compliment you on the superior performance of the Hytron 16RP4 cathode ray picture tube.

I have just purchased one of the NEW ________ 16" table model television sets, model _____, for my own personal use. I was not pleased with the brown spot which is often found in the rectangular tubes so I replaced this new _______ picture tube with one of Hytron's. The result? Amazing! Actually clearer and sharper pictures, more brilliance and no brown spot.

We are authorized service for about 11 different makes of TV sets and ________ is one of the factories we serve. From now on we shall insist upon Hytron for all picture tube replacements.

Yours truly,

J. A. Gupton, Jr.
Service Dept. Manager

WHY MR. GUPTON PREFERS HYTRON RECTANGULARS...

Thanks to Mr. Gupton. His unsolicited appreciation naturally warms our heart More important, he gives all service-dealers an excellent reason for picking Hytron rectangulars.

Does he choose Hytron: Because the rectangular is Hytron's baby . . . the original leader? Because Hytron's picture-tube plant is the most modern in the country? Because nine out of ten leading TV set makers choose Hytron? Because more and more service-dealers show equal shrewdness?

He has an even better reason: experience. His own experience proves Hytron better. Hytron rectangulars give him amazingly clearer, sharper, more brilliant pictures. They'll do the same for you. Demand original Hytron rectangulars. Prove by your own tests that Hytron is also *your* best choice.

OLDEST MANUFACTURER OF RECEIVING TUBES
HYTRON
RADIO AND ELECTRONICS CORP.

MAIN OFFICE: SALEM, MASS.

Merchandising & Promotion

Sprague Products Co. issued a new revised edition of its Tell-U-How wall chart. Color lithographed, the chart measures 22 x 28 inches. It gives service data on capacitors; descriptions of common circuit troubles and their remedies; color codes on capacitors, transformers, and resistors as well as electrical formulas and other useful service information. The chart is available to radio and television service technicians without charge from Sprague distributors or directly from the company for a 10¢ handling charge.

Littelfuse, Inc., introduced a counter card display for their Snap-On TV Fuse

Holder. The colorful card holds 24 fuse holders and may be used as either a counter display or wall chart.

Allen B. Du Mont Laboratories, Inc., announced a stepped-up sales training campaign for TV dealers. As a follow-through, the company inaugurated an extensive educational advertising program for service technicians, trade papers, and magazines. The first of the series was devoted to the Du Mont Sensituner.

The Radio-Television Manufacturers Association set up a 16-man committee of radio-television set sales managers which drafted a proposed code of ethics for selling and advertising TV sets. Copies of the code were distributed among members for comment and criticism. The RTMA also announced plans for publicizing the fact that the association has established standards for measurement, manufacture, and rating of microphones, speakers and amplifiers.

Brach Manufacturing Corp. is under way on a nation-wide campaign to acquaint TV dealers with the new Brach antennas and the sales potential of the Brach Mul-Tel System. In each area, local Brach jobbers arrange the showings.

Servicing Business

New York Better Business Bureau reported a marked improvement in radio and television advertising and selling practices since the adoption of its fair practice standards. The Bureau has already distributed over 100,000 of its consumer booklets on TV receivers.

The Television Service Contractors Association of Detroit was successful in delaying an action by the Detroit City Council to regulate TV installation and servicing companies. The association objected to a clause in the ordinance proposing the licensing of TV service technicians.

Television Associates, Inc., a Washington, D. C., organization of service firms, has requested the District of Columbia License Committee to consider licensing service firms in the District.

The Television Contractors Association of Philadelphia has directed a campaign to the leaders of the television industry pointing up the critical shortages of skilled service technicians in civilian occupation. It suggests that leaders in manufacturing, broadcasting, servicing, and government meet to prevent the disintegration of TV servicing.

Production

The RTMA reported a peak production in August of 702,287 TV sets, bringing the industry total for the first eight months of 1950 to 4,146,602, already 1,100,000 higher than for all of 1949. The RTMA pointed out further that 3,107,000 TV sets had been shipped to dealers during the first seven months of 1950.

The RTMA estimated radio set production at 1,203,447 for August and 8,750,965 for the first eight months of 1950. Breakdown of the radio production figure for August showed 754,232 home radios, 320,960 auto radios, 128,255 portables.

Radio receiving tube sales hit an all-time high in August—36,269,435 bringing the year's total to 227,773,373 as against 198,753,295 for the entire year of 1949. Tube sales were 28,202,620 for new sets in August and 7,017,115 for replacements. The balance were used for export or for government agencies.

August sales of 767,051 TV picture tubes to manufactures more than doubled July sales, the RTMA announced. 87% were 16 inches or larger and 51% were rectangular. Sales of transmitting, communications, and radar equipment to the government increased from $30,640,943 in the first quarter of 1950 to $33,393,093 in the second. Government orders went up from $41,305,390 to $61,701,467.

New Plants and Expansions

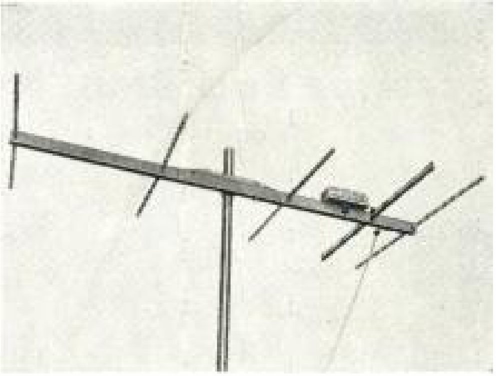
RCA Victor Division announced the purchase of the Cincinnati plant of the Rich Ladder & Manufacturing Co. for the manufacture of miniature receiving tubes.

Simpson Electric Co., Chicago, opened its new plant No. 5 in Aurora, Ill. The new 30,000-square-foot plant will be devoted to the manufacture of panel meters.

La Pointe-Plascomold Corp. purchased an entire new plant in Windsor Locks, Conn. The plant will provide 105,000 sq. ft., doubling the company's facilities for the manufacture of Vee-D-X television antennas and accessories.

PERFECT *Fringe Area* RECEPTION

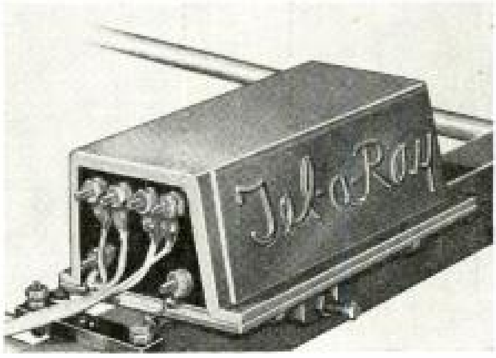
IS AS SIMPLE AS A



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.

B

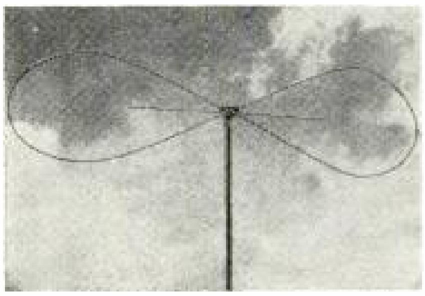
To your Model T antenna, mount the new, powerful Tel-a-Ray Pre-Amplifier. This amazing new product of the Tel-a-Ray Research Department eliminates, or greatly reduces, "snow." Because it mounts right to the antenna, it has a high signal-to-noise ratio, bringing you stronger, clearer pictures with less 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.



C WITH THE COMPLETE *Tel-a-Ray System*

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.

FOR PRIMARY AREAS



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.

Sylvania Electric Products, Inc., Parts Division, constructed a new plant for the production of plastic and plastic-metal components for the radio, television, and lighting industries. The new plant in Warren, Pa., will provide 30,000 sq. ft. of production space.

Altec Lansing Corp. moved to new and larger quarters in Beverly Hills, Cal. The new plant gives the company an additional 20,000 sq. ft. and enables it to consolidate all three factories under one roof.

Oak Ridge Products moved to a larger plant in Long Island City, N. Y.

Financial Reports

	1950	1949
Allied Electric Products (Year to June 30)		
Earnings	$160,814	$2,354
Sales	$4,126,700	$1,658,365
Hallicrafters Co. (Year to August 31)		
Earnings	$1,167,905	$403,050
Sales	$28,513,540	$14,572,008
Hytron Radio & Electronics Corp. (Third quarter)		
Earnings	not reported	
Sales	$13,350,000	$3,950,000
Oak Manufacturing Co. (Quarter to Aug. 31)		
Earnings	$417,018	$134,543
Sales	not reported	
Raytheon Manufacturing Co. (Quarter to Aug. 31)		
Earnings	$568,885	$546,774 (loss)
Sales	$17,834,124	$9,003,700
Standard Coil (First Half)		
Earnings	$3,135,393	$2,571,779 (entire year)
Sales	$16,038,859	$16,594,626 (entire year)

Dividends

Clarostat declared a dividend of 8¢ on common stock.
Cornell-Dubilier announced a special 15¢ extra dividend on common stock.
Hallicrafters authorized a 15¢ dividend on common stock.
Hytron declared a regular quarterly dividend of 12¢ on preferred stock.
Tung-Sol Lamp Works ordered a $1.25 dividend on common stock.

Business Briefs

RCA Tube Department issued a new edition of the RCA Receiving Tube Manual. . . . RTMA approved membership applications of five new companies: Celco (Constantine Eng. Labs.); General Ceramics & Steatite Corp.; Tele-Tone Radio Corp.; Trad Television Corp.; Wright-Zimmerman, Inc. . . . RCA Service Co. established a special government service division to expedite government requests for technical personnel and the installation and servicing of electronic equipment. . . . Trad Television is making giant TV sets for military and naval training centers. . . . A bill centering all Air Force electronic development activities in Rome, N. Y., was passed by Congress and approved by the President.

Testing for sound lost between telephone receiver and ear. Many subjects were used in these tests.

How to compensate for a curl . . . and add to your telephone value

Bell scientists know that the telephone is not used under ideal laboratory conditions. There is never a perfect seal between receiver and user's ear. A curl may get in the way, or the hand relax a trifle. And ears come in many shapes and sizes. So some sound escapes.

Now, sound costs money. To deliver more of it to your ear means bigger wires, more amplifiers. So Bell Laboratories engineers, intent on a thrifty telephone plant, must know how much sound reaches the ear, how much leaks away. They mounted a narrow "sampling tube" on an ordinary handset. The tube extended through the receiver cap into the ear canal. As sounds of many frequencies were sent through the receiver, the tube picked up a portion, and sent it through a condenser microphone to an amplifier. That sampling showed what the ear received.

As a result, Bell scientists can compensate in advance for sound losses—build receivers that give *enough* sound, yet with no waste. That makes telephone listening always easy and pleasant.

It's another example of the way Bell Telephone Laboratories work to keep your telephone service one of today's biggest bargains.

Automatic recorder plots sound pressures developed in the ear canal at different frequencies.

BELL TELEPHONE LABORATORIES

Working continually to keep your telephone service big in value and low in cost.

take it from EXPERTS

renew with N.U.

premium quality tubes

PAT REID SAYS:

Salesmanager, United Radio Supply, Inc.
Portland and Eugene, Oregon

"Our 379 servicemen and dealers tell us N. U. tubes are best, because their own experience has proved N. U. tubes are reliable, uniform, and above all are properly designed for interchangeability. What's more, costly call-backs are minimized by N. U.'s proven quality control. That's why we've featured N. U. tubes for 15 years. They mean good business for all of us.

- RADIO AND TELEVISION RECEIVING TUBES
- VIDEOTRON TELEVISION PICTURE TUBES
- PANEL LAMPS
- TRANSMITTING AND SPECIAL PURPOSE TUBES

NATIONAL UNION RADIO CORP.

Main Office: 350 Scotland Rd., Orange, N. J.
Research Division: Orange, N. J. • *Plants:* Newark, N. J.—Hatboro, Pa.

Choleric Color TV

. . . Color television should be allowed to evolve normally . . .

By HUGO GERNSBACK

ON October 11 the Federal Communications Commission threw a bombshell into the television industry by approving the Columbia Broadcasting System's non-compatible mechanical color television method, as the standard for commercial color telecasting.

As must be well known by this time, the CBS color system consists of a three color spinning disc which when placed in front of the television tube screen gives the viewer color television.

RADIO-ELECTRONICS finds no fault with the CBS system any more than with a Ford Model T. *Both work—both are archaic.* Nor can we imagine that ten years hence a mechanical gadget with a spinning disc will be found in our future television sets.

Indeed, television started in 1884 with the famed Nipkow rotating disc. In 1928 the English television pioneer Baird produced color television with the selfsame spinning disc.

To us—as it does to most responsible radio engineers—it seems that the F.C.C. decision is most unfortunate because in the end we will have *electronic*—not mechanical—color television without any doubt whatsoever. It is true that the C.B.S. system *today* produces color television, with better definition than several of the proposed electronic systems. But, tomorrow it is certain that this condition will reverse itself, as it must.

What then will become of the public's investment in the cumbersome spinning disc color television receivers?

Worst of all, at present the CBS system can only produce 10½ inch pictures. To have color television on a 19-inch screen you would require a rotating disc at least 38 inches in diameter, which would increase the television cabinet size by three to four feet—a monstrosity. Such a television set would occupy more room, or almost as much width as a grand piano! Obviously, such a contraption is not evolution—it's a throwback.

Most of the responsible television manufacturers will have none of the revolving disc television sets because they realize that they will not prevail in the future.

Why did the FCC take such an ill-advised step? As a government agency, the FCC felt that it could not stand by idly while millions upon millions of black-and-white television sets were manufactured which the Commission honestly believed would become obsolete on the advent of color. This to us is fallacious thinking. The coming of color—as engineered in the near future—need do no such thing and *we are certain that it will not play havoc with existing television sets.*

In our considered opinion black-and-white sets will always be with us in television, or at least for a long time to come.

We have excellent parallels to the present disturbing situation. It is possible today to print every newspaper as well as every magazine in full color. It has been possible to do so for several generations. *Yet, how many magazines or newspapers are printed in full color?* Only a very small percentage.

Nor are we certain that every reader would want color to the exclusion of black and white, even if it were no more expensive.

The same argument can be made with motion pictures. There is no question that the quality of color in motion pictures today has reached a high state of perfection. But even today with television competition making inroads on motion pictures we only have 14¾ per cent of color motion pictures. It seems that color motion pictures are not universally demanded by the public; otherwise the studios would furnish color exclusively. Furthermore, color motion pictures are more tiring to the eye for most people, particularly when the picture runs for more than one hour.

Perhaps the same reasoning will hold true for future color television as well.

In the meanwhile a most unfortunate situation has arisen in the television industry in that the average layman has become so befuddled on television color that he has no clear idea of what it is all about. The average man believes that if he buys a black-and-white set today it will be obsolete tomorrow. So he refrains from buying.

Actually, in spite of the FCC, no such thing will happen, in all probability.

We have been of the opinion right along that color television—when properly developed—will not disturb in any way our present black-and-white sets. Just as you can take three magazine cover plates and print red, blue and yellow on top of each other to produce a color picture, so you can take the same plates running them in a single color—black—on top of each other. This will produce a good black-and-white picture. Exactly so will your present-day television set continue to receive black-and-white even if "color" is broadcast from every TV transmitter in the land.

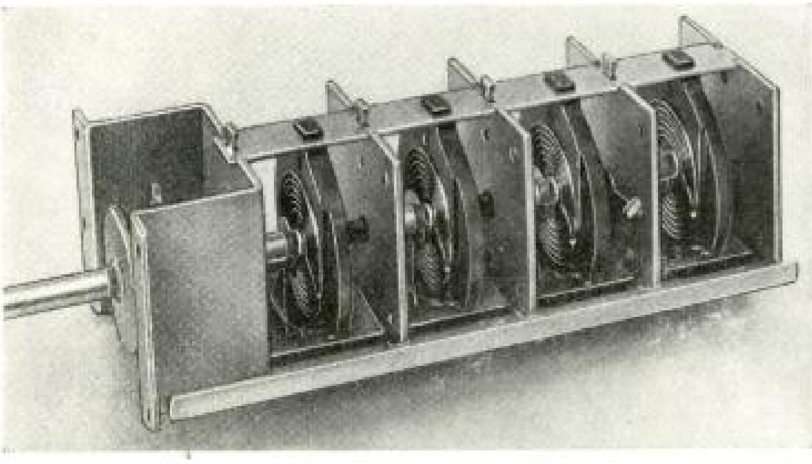
As we go to press, Robert C. Sprague, president of the Radio Television Manufacturers Association, predicts a new system in a very short time *which does not require adapters for TV sets for black-and-white reception as the CBS systems now does.* We quote from his statement:

"The vast majority of the engineers and scientists in the electronic field believe that there will be available within a reasonable length of time a satisfactory commercial color system which is *compatible*, i.e. a system which can be received in black-and-white on present day black-and-white sets without any change in or addition to these sets whatsoever."

With such a system, in the near future, when all stations transmit color exclusively you can still use your black-and-white set or you can buy a color receiver. The latter will also have a switch so you can change the color picture to black and white, or switch back to color again.

To repeat, all the present day black-and-white sets will not be affected and will give service as they do now. Television should be allowed to evolve in a normal manner just as did radio. Using forceps to force a premature birth may mutilate the color television child for life.

Radio Set and Service Review



4-gang spiral inductance used in the front ends of current Du Mont TV sets.

Improved circuits in Du Mont's 1951 receivers aim for better performance

By RICARDO MUNIZ*

PRESENT Du Mont television receivers have many interesting circuits, some of which are unique with Du Mont, and all of which contribute to uniform and better performance. Better performance implies better pictures. Better pictures must have high definition, sharp focus, full contrast range, freedom from noise, stable synchronization with immunity to noise impulses, high brilliance, freedom from spurious responses, freedom from interfering signals, and many other characteristics.

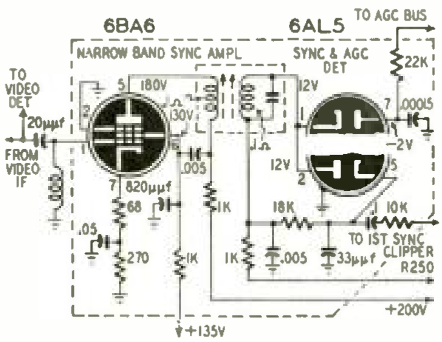


Fig. 1—The narrow-band sync amplifier circuit and sync and a.g.c. detectors.

The circuits discussed in this article are: the narrow-band sync circuit which provides both synchronization and automatic gain control signals with unusual freedom from noise impulses and spurious responses; the cathode drive of the kinescope with a single video amplifier which is free from white compression commonly found in single-stage video amplifiers; a d.c. restoring circuit for the cathode drive; link coupling from the tuner to the first video i.f. stage to provide for use of a u.h.f. tuner and to make lead length and lead dress less critical; double- and triple-tuned video i.f. amplifier stages for minimum phase distortion and maximum skirt selectivity; cathode-coupled vertical blocking oscillator and sawtooth generator to furnish vertical sweep free from oscillator transformer ringing; and continuous tuning for low noise figure, low susceptibility to FM harmonics, and low oscillator radiation.

Narrow-band sync[1]

Fig. 1 is the circuit of the narrow-band sync circuit as it is used in the Du Mont model RA-112 TV receiver chassis. The full video bandwidth of the video i.f. amplifiers is not needed to amplify the sync signals adequately. By using a sync amplifier with a considerably smaller bandwidth, the amplified signal will have a lower noise content. Noise is further reduced by grid cutoff and plate saturation limiting in this stage. This tends to increase the sync stability of the picture and, since the a.g.c. voltage is also derived from this amplifier, the a.g.c. is more stable.

The i.f. signal which is applied to the video detector is also amplified by 6BA6 sync and a.g.c. amplifier and then is passed through a 1-mc wide, double-tuned transformer centered on the video carrier. Two detectors then detect the signal: a peak detector for the a.g.c. voltage, and a video detector for the sync signals. The sync detector is much more efficient than the usual video detector because its bandwidth need be only 0.5 mc.

The smaller bandwidth of the interstage transformer reduces the noise content of the signal before detection but has adequate width to reproduce the sync signal as the receiver is tuned across the picture carrier. There is no sync signal or a.g.c. except close to the optimum tuning point. This means that the set owner cannot have his receiver mistuned by very much and therefore cannot receive with degraded sound and picture quality.

Cathode drive

Several of the current Du Mont models use cathode drive on the picture tube with a single-tube video amplifier. Fig. 2 shows this circuit as it is used in model RA-113. The diode video detector is not linear and has a rather sharp curvature as the voltage goes toward zero or, in the case of a TV signal, toward white. This causes the white portion of the video signal to be compressed as shown in Figs. 3-a, 3-b, and 3-c. If this voltage can be counteracted by the grid-voltage-plate-current char-

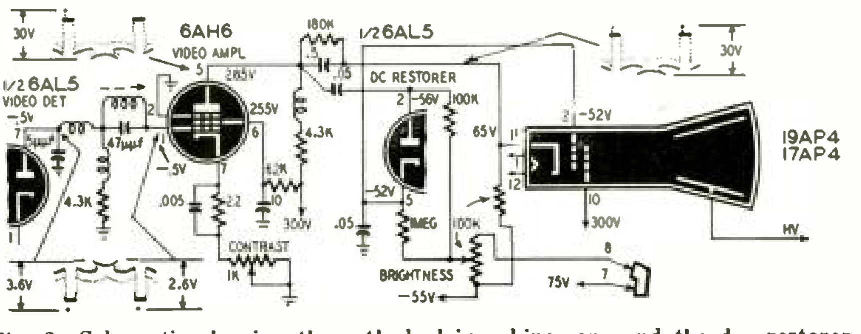


Fig. 2—Schematic showing the cathode-driven kinescope and the d.c. restorer.

*General Manager Television Receiver Mfg. Div. Allen B. Du Mont Laboratories acteristic of the video amplifier, the over-all characteristic will be more nearly linear and the white compression caused by nonlinearity of the detector is minimized as indicated by Figs. 3-d and 3-c.

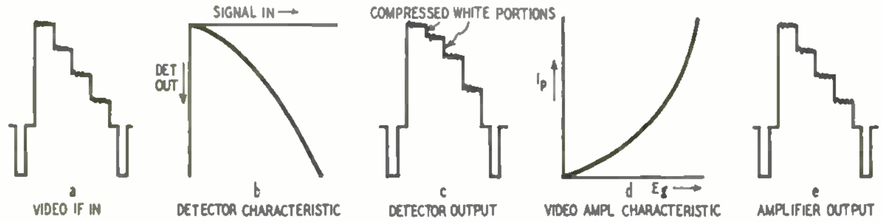


Fig. 3—How tube characteristics are combined to reduce white compression.

White compression on a TV receiver is most noticeable at the bull's-eye center of a test pattern. Fig. 4-a shows a test pattern with the gradations as they should be, and 4-b shows white compression which appears as a lack of difference in shading between the two outer and lighter rings. When viewing a picture, white compression shows up as a lack of "snap" or crispness in the picture which leaves the viewer vaguely dissatisfied but not quite sure what's wrong.

D.C. restorer

The conventional d.c. restorer circuits being ineffective with cathode drive, the circuit shown in Fig. 2 is used. D.c. coupling is used between the video detector and the video amplifier. The plate of the video amplifier is also coupled directly to the cathode of the picture tube. This tends to put a high positive voltage on the cathode which may exceed the heater-cathode rating of the tube. To avoid this, a negative voltage is applied directly to the cathode to make the positive voltage on the cathode 65 at no signal. A negative voltage is also applied to the grid of the cathode-ray tube, the net effect being to keep the screen at a gray level when no signal is present. When a signal is applied, the screen becomes black at the black parts of the picture. The d.c. restoration is applied to the grid of the cathode-ray tube because the cathode circuit impedance is too low for efficient operation.

Link-coupled tuner

Link coupling is used between the tuner and the i.f. amplifiers for greater flexibility in chassis layout and to make the circuit adaptable to a u.h.f. tuner in place of or in addition to the v.h.f. tuner normally delivered with these receivers. Neither this low-impedance link coupling, the lead dress, nor the lead length is critical. Fig. 5 shows the circuit from the plate of the mixer tube to the grid of the first video i.f. stage.

Winding L2 is closely coupled to the mixer plate winding L1, and varying L3 varies both the coupling and the bandwidth between the two circuits. Fig. 6 is an equivalent circuit of the coupling network which shows how L3 provides an effective shunt inductance to vary the coupling and bandwidth.

The video i.f. stages

Fig. 7 is the circuit of the video i.f. amplifier. T2, T3, and T5 are top capacitance-coupled transformers. T4 is a triple-tuned stage of which one section is a 21.75-mc sound trap. The 6BC5 is used in the last stage to get more signal at the video detector before sync compression takes place than is possible with a 6AU6. An interesting feature of the top capacitance-coupled stages is that the variable capacitance coupling is achieved by a wire inserted a varying distance in a ceramic sleeve mounted in the i.f. transformer as shown in Fig. 8.

A block diagram of the i.f. amplifier is shown in Fig. 9. Below the blocks are the individual bandpass characteristics achieved in production alignment. This i.f. circuit is designed to get a maximum bandpass with minimum phase distortion and maximum skirt selectivity.

Vertical sweep generator

One of the big problems of vertical sync circuits is furnishing a vertical sawtooth voltage that is free from the ringing or damped oscillations that usually appear in blocking oscillator transformer windings. Fig. 10 is the circuit of the vertical sawtooth generator used on Du Mont chassis models RA-112 and RA-113.

This circuit is a typical blocking oscillator except that one side of the transformer is in the cathode circuit of the tube. This isolates the sawtooth voltage at the plate from the ringing voltage that appears in the transformer winding when the tube is in the cutoff condition. This is not true when the transformer winding is in the plate circuit.

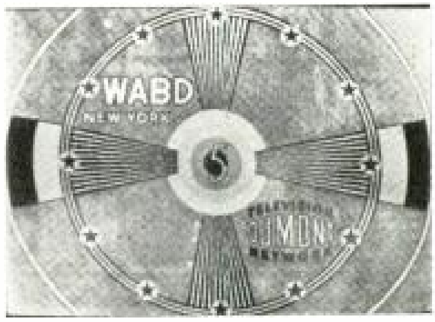


Fig. 4-a, top—Normal tone gradation from black to white at the bull's-eye. Fig. 4-b, bottom—Compression of whites.

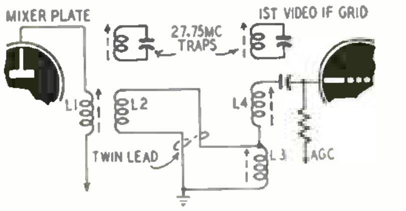


Fig. 5—Link coupling circuit from the mixer plate to the video i.f. amplifier.

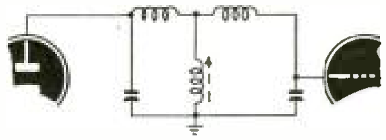


Fig. 6—Equivalent circuit of the link coupling to show how the tuning works.

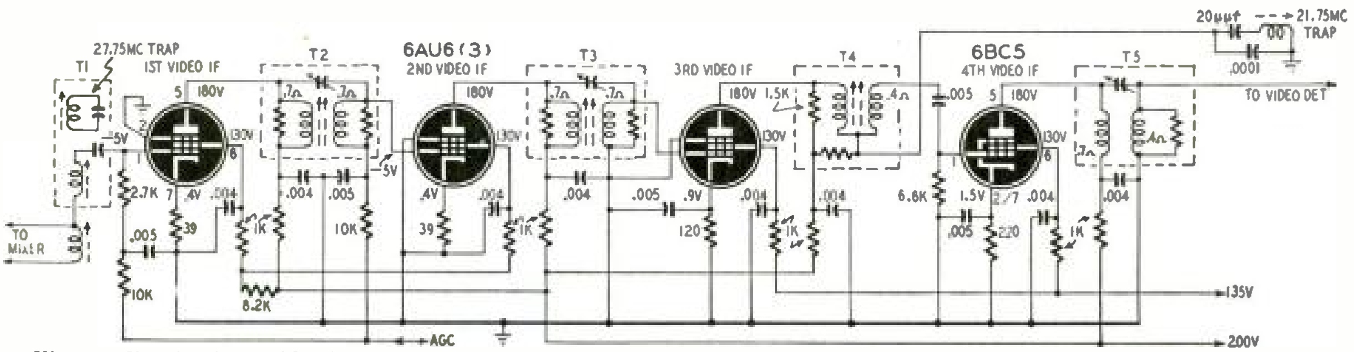


Fig. 7—Circuit of the video i.f. amplifier. The 6BC5 i.f. output is used to get more signal at the video detector before sync compression takes place. The top capacitance coupling of T2, T3 and T5 is varied by the novel method shown in Fig. 8.

Continuous tuning

The Du Mont Inputuners[2] used in the current TV receiver production use the same principle of continuous tuning by inductance variation as in older models but have some electrical and mechanical improvements. Among these are an additional tuned circuit without increase in size and a skip tuning device which automatically bypasses the unwanted part of the spectrum between the FM band and channel 7.

The new Inputuners have a sliding-contact gang inductor called the Inductuner[3]. The latest Inductuner uses flat spiral inductors which allow room for four tuning sections in less space than was used by three sections in the older type. The added section is hooked up between the antenna and the r.f. tube to give better rejection of unwanted signals and to improve gain and signal-to-noise ratio. The circuit of the r.f. assembly is shown in Fig. 11.

The r.f. gain increase is in the order of 2 to 1. Image rejection is improved by five to ten times over that of previous tuners. I.f. rejection is increased by over 100 times due to the trap action of the coupling circuits.

The band-skip feature reduces the number of turns of tuning motion from six to four and improves the tuning curve over the high-frequency channels. This jump from the FM band is accomplished by the design of the contact mechanism in the tuner.

The continuous tuning assures optimum picture and sound setting because the input circuits and the oscillator are shifted together as vernier adjustment is made.

Other than the spiral inductance tuning, the r.f. circuit has no unusual features. A 6J6 triode is used as the r.f. amplifier. This tube generates less noise than a pentode. While more gain could be achieved with a 6CB6 or similar pentode, the added section of the spiral tuner makes this unnecessary. The parallel-connected triode gives the r.f. stage adequate gain.

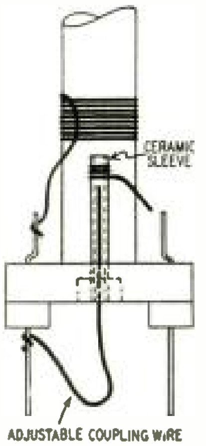


Fig. 8—The i.f. capacitance coupling is varied by moving the coupling wire.

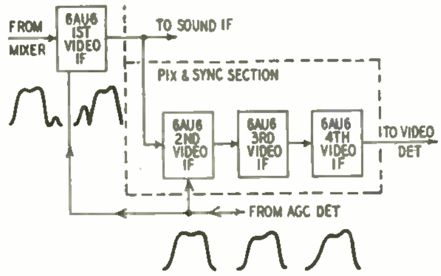


Fig. 9—Block diagram of the video i.f. stages showing alignment waveforms.

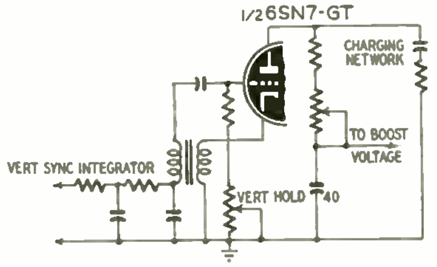


Fig. 10—The circuit of the cathode-coupled vertical blocking oscillator.

1. Patent applied for.
2. Trademark.
3. Exclusive trademark of P. R. Mallory & Co., and manufactured under Mallory-Ware patents.

The author acknowledges the cooperation of Mr. B. Hegeman of the Television Receiver Manufacturing Division Engineering Department, Mr. S. D. Prensky of the Television Receiver Manufacturing Division Publications Department, and Mr. B. V. K. French of the Electronic Parts Division in collecting material for this article.

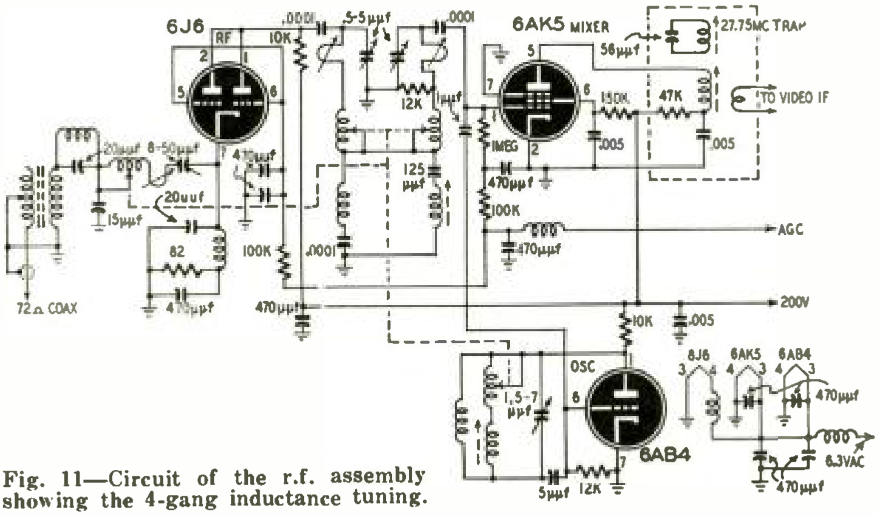


Fig. 11—Circuit of the r.f. assembly showing the 4-gang inductance tuning.

ADVICE TO TV OWNERS CUTS NUISANCE CALLS

To cut down the number of nuisance service calls on TV sets, the Akron (Ohio) Merchants Association is distributing a Television Card to set owners with suggestions for checking the set's operation. Compiled by the Television Committee of the Electric Institute of Washington, the list contains this advice:

Before you call your Television Serviceman—

1. If the set is completely dead, is the line cord plugged into the electric outlet? If the cord is plugged in, unplug it and try a lamp in the same outlet. If the lamp lights try the set when plugged in again.
2. Look at the antenna wire on the back of the set. Make sure the leads are firmly connected to the terminals on the set and that the bare leads are not touching each other.
3. If the sound is normal, but you have no picture, turn the brightness and/or contrast control full on and also try another channel.
4. If the picture is normal, but you have no sound, adjust the "fine-tuning" control with the volume control turned full on. Also try another channel.
5. In suggestions 3 and 4, if only one channel is affected, allow the station time to announce any technical difficulty which might have occurred.
6. If sound is normal and picture tube has light with the brightness control full on, but the picture is rolling, tearing out or no picture on all channels, adjust the "horizontal hold" or "vertical hold" controls. Try reducing contrast or picture control and readjust tuning.
7. If sound is weak and noisy, and the picture has excessive snow, see if the antenna is still installed in its original position. Also recheck suggestion No. 2.

After following these seven suggestions, if the trouble has not been corrected, call your service dealer.

Many set owners have very little idea of the complexities of a television receiver. When something goes wrong they will call the service technician whether they need him or not. The seven rules printed above will make both parties happier.

The committee might have included an additional rule: If you get four images at once on the screen when adjusting the hold controls, don't worry—you are picking up a color broadcast.

NEW STEEL FOR TUBES

Larger rectangular picture tubes are promised as a result of a new stainless steel having a heat expansion rate practically the same as that of glass. Developed by the Carnegie-Illinois Steel Corporation, the new alloy retains all the desirable characteristics of stainless steel for picture tubes, but will not crack the glass when the tube heats up.

Fundamentals of Radio Servicing

Part XXII–How to Trap a Signal

By JOHN T. FRYE

WE ARE ready to try out the broadcast receiver we have been studying stage by stage for the past several chapters. What is needed now is a live signal to make our radio set perform. Since the air is filled with transmissions from many broadcast stations, all we have to do is to intercept one of these signals and lead it into the signal grid of our mixer tube. We know what will happen to it from there on.

Before we set out to trap a signal we should, like any good trapper, have some idea of the characteristics and habits of the game we are after. The "trapee" in this instance is a transmitted radio signal; and, while its characteristics are somewhat more complicated than the rules for playing post-office, they are by no means beyond comprehension.

We already know that, when a 60-cycle alternating current flows through a wire, the conductor is surrounded by a panting magnetic field. Part of the electrical energy is alternately stored in this field and then returned to the wire. If the frequency of the alternating current is increased to 10,000 cycles a second and beyond, some of the energy delivered to the field about the wire does not return to the conductor but sails off into space as radiated energy. When a transmitting antenna is substituted for our conducting wire and certain other favorable conditions are established, vast encouragement is given to the high-frequency alternating current to leave home and to keep going.

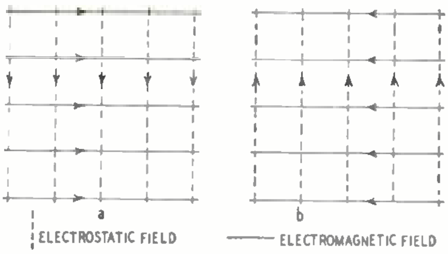


Fig. 1—Patterns showing the electromagnetic and the electrostatic fields of force of a radiated electric signal.

Fig. 1-a gives us a head-on view of this free-wheeling radio wave as it zips through space directly toward us at a speed of 186,000 miles a second. Notice that there are really two fields, which share the energy of the wave equally between them: an electrostatic or "voltage" field, and an *electromagnetic* or "current-inducing" field. These two fields are as inseparable as Siamese twins, and they always act at right angles to each other, and both operate at right angles to the direction of travel.

Broadcast-band waves ordinarily have their electrostatic fields producing lines of force in a vertical direction with regard to the earth and are said to be "vertically polarized." Television stations in the United States send out waves whose electrostatic stress is exerted parallel to the earth and are called "horizontally polarized" waves.

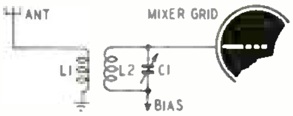


Fig. 2—A simple antenna circuit with inductive coupling to the mixer grid.

At the instant pictured in Fig. 1-a, the electrostatic stress is from top to bottom, and the electromagnetic stress is from left to right. Fig. 1-b pictures the same wave passing the same place at a time interval equal to one-half wavelength later. Note that by now the electrostatic stress is from bottom to top and the electromagnetic stress is from right to left.

The thing to keep clearly in mind is that these two fields are *moving* and that as they move past a stationary portion of space they produce stresses in that space. For example, as the electrostatic portion of the wave encounters two points in space, one directly above the other, first the top point will be positive with respect to the bottom point and then the bottom point will be positive with respect to the top point. If the two points are connected by a length of wire, an alternating current will flow in this wire as the radio wave zips past it.

Snaring the signal

Fig. 2 shows how we take advantage of this fact to trap a signal for use in our receiver. A vertical wire is connected through coil L1 to the earth. The top of this antenna and the earth constitute the two "points in space" mentioned in the foregoing paragraph. The current flowing in L1 is inductively coupled to the tuned circuit L2-C1. By resonating this tuned circuit to the signal we want to receive, we can reject all other signals flowing in the antenna circuit and allow only the wanted one to appear on the grid of our mixer tube.

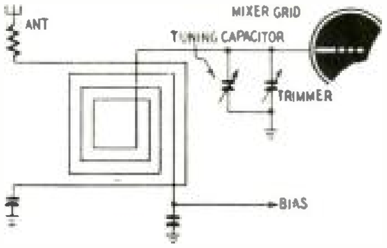


Fig. 3—A high-impedance loop antenna is formed when the antenna transformer is wound in the form of a large helix.

This "outside" antenna provides a good method of intercepting a radio signal, but it has some disadvantages. First, since its effectiveness depends to a large degree on its height, it is difficult to install; second, special precautions must be taken to prevent this elevated antenna from extending the welcome-mat to a bolt of lightning; third, few antennas of this kind do anything for the appearance of a home; and fourth, a radio used with such an antenna is more or less rooted to one spot near where the lead-in is brought into the house.

This last item was particularly exasperating to those housewives—and their name is legion—who dearly love to shuffle the furniture around the house every few weeks. The little women demanded a radio that could be moved! So, the radio engineers sighed, picked up a candle, and disappeared into their attic of discarded electronic lore. A few hours later they reappeared

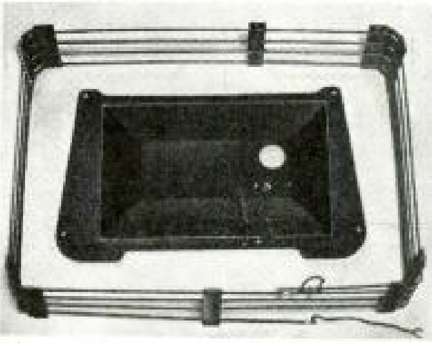


Photo showing examples of low-impedance and high-impedance loop antennas.

triumphantly clutching a dusty and cobwebbed "loop" antenna that they had wrested from one of the earliest console battery receivers.

As can be seen from Fig. 3, the modern *high-impedance loop antenna* is really just an expanded antenna transformer. Instead of occupying only a couple of inches of space, the secondary of the transformer is wound in the form of a spiral or large diameter helix so that it has an area of many square inches. In this enlarged form, it can intercept a sizeable portion of the field of a radio wave and so provide sufficient signal for the receiver without being connected to an outside antenna.

Directional properties

Such a loop antenna is directional; that is, it will receive a signal much better when the loop is arranged so that its plane is paralleled to the line of transmission of the radio signal than it will when this plane is at right angles to the line of transmission. If you will look at the simplified one-turn loop

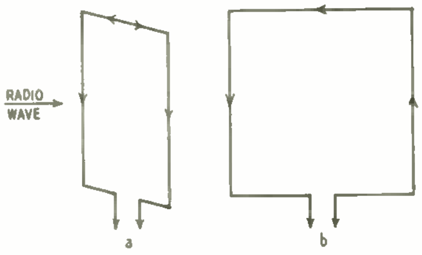


Fig. 4—This diagram shows the directional properties of the loop antenna.

shown in Fig. 4, you can see why. At 4-a the incoming signal strikes both sides of the loop at the same instant. The currents induced in the two sides of the loop by the passing magnetic field—the loop depends upon the electromagnetic field of the radio wave for its action—are equal and opposite in phase; so they simply buck each other out and the signal is received very weakly if at all.

At 4-b, however, the wave strikes one side before the other. If you keep in mind that, as the wave moves through space, its fields are constantly shifting back and forth, you can see that the direction and intensity of the current induced in the first leg of the loop cannot be identical with the direction and intensity of the current induced in the second leg, because the wave has traveled through space between these two encounters and the electromagnetic field that produces the current has changed somewhat during that short trip. Since the two currents are not identical, they cannot balance each other out, and we shall have an alternating current flowing in our loop. Do not think that the two currents are *in phase* when the loop is parallel to the line of transmission—the loop would have to have its two sides a half-wavelength apart for that—but they are not 180 degrees out of phase as they are when the plane of the loop is at right angles to this line. This slight shift away from the 180-degrees-out-of-phase condition is all that is needed to let a signal be received.

The voltage pickup, as can be easily understood, is proportional to the loop area. The farther the loop is located from the chassis or any other large metal object, the lower is its distributed capacitance, the higher is its Q, the sharper it tunes, and the more directional it is. Unfortunately, the usual small receiver permits the loop to be placed only an inch or so from the chassis.

One way of overcoming some of these disadvantages is to have the loop detachable from the receiver and arranged so that it can be held in the best position by suction cups.

Improved loop antennas

An approach that is more electronic and less mechanical is diagrammed in Fig. 5. Here a loading coil L is used in series with the loop. This loading coil has a very high Q and a low distributed capacitance. Since the distributed capacitance of the loop circuit is thus reduced, the tuning range of the loop is extended for use with a given capacitor. Raising the Q of the tuned circuit gives sharper tuning and better signal response. In many receivers, this loading coil is slug-tuned for best tracking over the tuning range.

Provisions are usually made for connecting an outside antenna to these loops for receiving distant or weak stations. A low-cost way of doing this is to place a single turn of wire around the loop at the low-potential side as is shown in Fig. 3. Such an arrangement tends to favor the high-frequency end

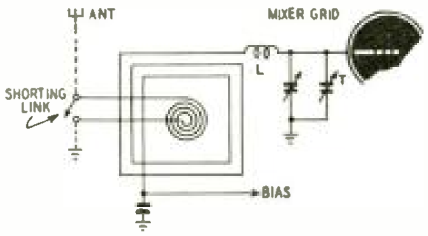


Fig. 5—Adding a loading coil L to the loop antenna gives it better response.

of the band, but that can be overcome by inserting a resistor of 500 or 1,000 ohms in series with the single turn. If too much coupling is provided, the signals tend to be hum-modulated and the selectivity suffers.

A high-impedance primary, such as that shown in Fig. 5, gives a more uniform coupling than does the single-turn job of Fig. 3, but it is guilty of the cardinal sin of manufacturing: it costs more! When such a high-impedance primary is used, it is usually provided with a shorting link to be used when an external antenna is not connected. This is to prevent the absorption of energy by the primary coil at its resonant points that fall in the broadcast band.

One manufacturer has still another system for getting around the disadvantages of the high-impedance loop. He uses a low-impedance loop, as shown in Fig. 6, which consists of two to four turns of large-diameter wire. This is inductively coupled to the grid of the mixer tube through a very high-Q autotransformer. The low-impedance loop is relatively insensitive to capacitance effects and to calibration changes due to changing its position. Both the Q and the response are practically uniform throughout the broadcast band. An external antenna, when used, is connected directly to the high-potential side of the loop.

Many of the better receivers place loop antennas inside electrostatic shields. This serves the double purpose of cutting down on much man-made interference and of insuring uniformly distributed capacitance effects for the loop.

These directional properties of a loop antenna are very fine for cutting down on interference, either from an unwanted radio station or from a noise source that occupies a single point in space, but like most good features it also has a few drawbacks.

Even those who do understand the operation of a loop are loath to be twisting the set about every time a station is tuned in. When the set is a large console and has a fixed-position loop, taking advantage of its directional properties requires the energy of a fox terrier and the physique of a piano mover.

Fortunately, a lot of movement is not required. The "null" or no-reception points of a loop are very narrow compared to the arcs through which reception can be had. Moreover, all except the cheapest consoles provide some method of varying the position of the loop through a few degrees without moving the cabinet.

While it must be admitted that the loop antenna is not the most efficient device for snatching radio signals out of the ether, there can be no doubt that it is the most popular with radio receiver owners today. Because of the number and power of broadcasting stations, the majority of receiving locations are blanketed with powerful signals that make it unnecessary to have an antenna system of maximum efficiency. A loop antenna will usually pick up enough energy for satisfactory reception—and remember, the little woman can move a loop set to her heart's content!

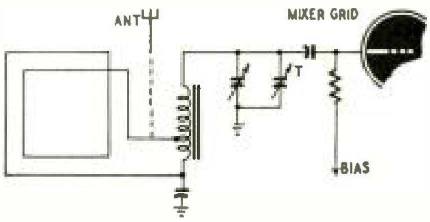


Fig. 6—By using only a few turns on the loop but coupling it to the mixer through a high Q autotransformer, the antenna response can also be improved.

Television DX Reports

READERS of this column have noted that in the last three months, the dx reports have all been for the low channels. Dx on the high bands scarcely ever goes over about 300 miles.

This month we do have three reports of dx on the high band. One is from F. J. Glaub of East Moline, Ill., who picked up WHIO-TV in Dayton, Ohio on channel 13, and station WKRC-TV in Cincinnati, Ohio on channel 11 September 5. The airline distance in both cases is about 370 miles. The receiver is an Admiral 30C1 and the antenna a Taco stacked dipole 20 feet off the ground and aimed at Chicago.

The second high band report is from E. Swanson of Rockford, Ill., who received WSPD-TV, channel 13, in Toledo, Ohio, on September 6 and 7. In this case the receiver is a G-E Model 805, the booster an Anchor, and the antenna a 4-bay Radiart conical. The distance is about 300 miles.

One reader in Halifax, Nova Scotia reports several dx receptions, of which three were over 1,000 miles on the low band, and one high band reception of 450 miles. This report includes an interesting observation on cloud formations and their effects on dx receptions.

Apparently dx reception is possible at this location only when alto-cumulus or cirro-cumulus clouds are in the sky. The alto-cumulus, a fleecy cloud formation often seen in flocks or rows, seems to give the long hops; and the cirro-cumulus, clouds in small round masses at high altitudes and usually in lines (called a mackerel sky), seems to give the double hop. An interesting feature of this report is that the strongest signals were received from the most distant stations.

What really happens in these long distance receptions is still not fully understood by the engineers. Part of the radiated energy from the transmitting antenna goes up toward the sky at anywhere between 3 and 90 degrees with the horizontal. These waves soon reach the ionosphere, a region about 70 miles above the earth's surface which contains large concentrations of charged particles, both free electrons and ions, as well as neutral molecules.

The prodigal sky wave may or may not be reflected back to the earth when it hits this region. This depends on several conditions, of which the most important are the angle at which the sky wave hits the ionosphere, the frequency of the wave, and the concentration of the charged particles of the ionosphere. While the first two of these can be determined exactly, the third is a largely unknown factor which is continually changing. This, of course accounts for the unpredictability of TV dx.

The reason the high band dx is less frequent is that the higher frequencies are not as readily reflected as the lower. It is likely that some of the waves will reflect from cloud formations, as the letter from our reader in Nova Scotia indicates. What seems more likely, is that the cloud formations are an indication of the condition of the ionosphere. In any case, much more must be known about the propagation of radio waves before anything certain can be said.

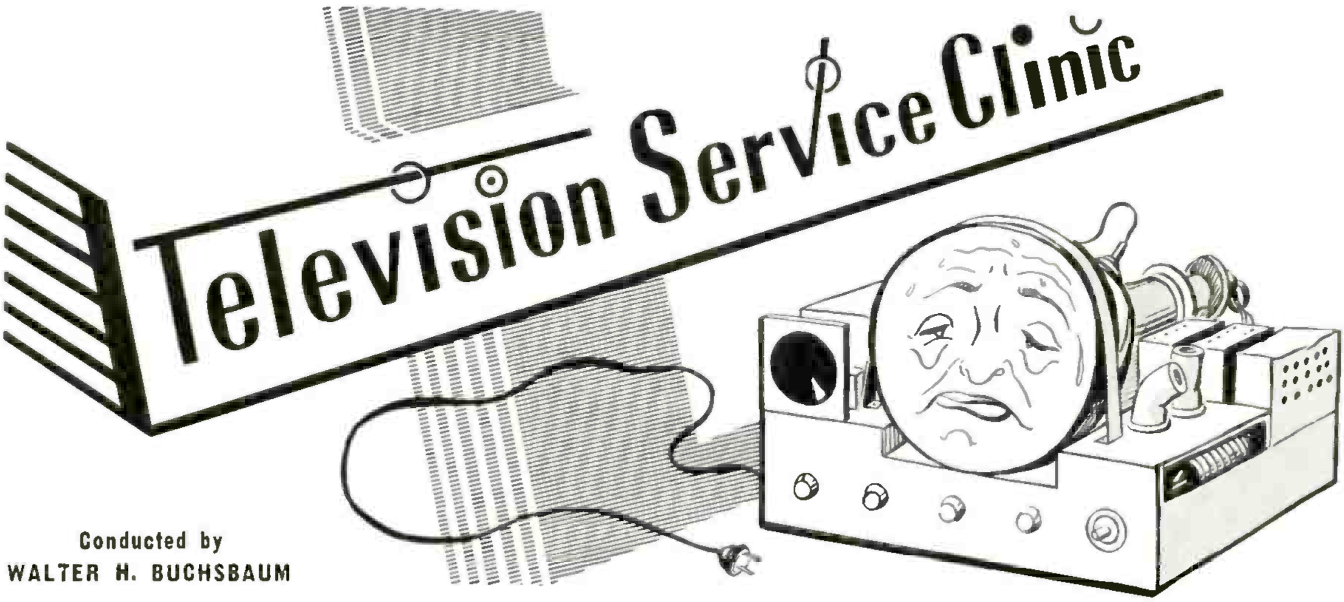
The low band reports of over 1,000 miles are shown in the two tables below as in the past, and again we thank those who have sent in their dx records.

TABLE I — REPORT OF RECEPTION

STATION	REPORTED BY	TIME RECEIVED	MILEAGE
KEYL-TV Channel 5 San Antonio, Tex.	H. Brink	6 18	1,000
KOB-TV Channel 4 Albuquerque, N. M.	W. R. Henry	5 24, 9:45-10 pm	1.200
KPRC-TV Channel 2 Houston, Tex.	K. D. Anderson	7 13, 7 14	1,000
KRLD-TV Channel 4 Dallas, Tex.	Mrs. W. Callan A. C. Olberg	8 1, 10:30 pm 6 18, 1-1:30 pm	1,120 1,060
WAGA-TV Channel 5 Atlanta, Ga.	A. C. Olberg	7 7, 7-8 pm	1,010
WBAP-TV Channel 5 Fort Worth, Texas	A. C. Olberg	6 18, 1-1:30 pm	1,060
WBRC-TV Channel 4 Birmingham, Ala.	A. C. Olberg	7/7, 7-8 pm	1,080
WBTV Channel 3 Charlotte, N. C.	A. C. Olberg	7 12, 4-5 pm	1,030
WBZ-TV Channel 4 Boston, Mass.	R. Roland	7/16, 12-2:30 pm	1,125
WCBS-TV Channel 2 New York, N. Y.	A. C. Olberg K. D. Anderson R. Roland	7 31, 2:45-4:15 pm 7 15, noon 7 16, 12-2:30 pm 8/5, 12:30 pm	1,100 1,000 1,035
WDSU-TV Channel 6 New Orleans, La.	A. C. Olberg K. D. Anderson	6 10, 6-6:30 pm 7/11, noon	1,250 1,000
WFIL-TV Channel 6 Philadelphia, Pa.	R. Roland	7 16, 12-2:30 pm	1,000
WFMY-TV Channel 2 Greensboro, N. C.	A. C. Olberg	7 12, 11 am-2:30 pm	1,000
WKY-TV Channel 4 Oklahoma City, Okla.	Mrs. W. Callan	8 1, 10-10:30 pm	1,050
WMAR-TV Channel 2 Baltimore, Md.	A. C. Olberg K. D. Anderson	7/14, 5-5:15 pm 7/15, noon 8/5, noon	1,075 1,000
WMBR-TV Channel 4 Jacksonville, Fla.	T. E. Rowe A. C. Olberg	7 22 7/12, 5-5:45 pm	1,300 1,380
WNBT Channel 4 New York, N. Y.	R. Roland	8 5, 12-2:30 pm	1,035
WOAI-TV Channel 4 San Antonio, Tex.	K. D. Anderson W. E. Bennett	7/13, 7 pm 7 7, 8, 12	1,000 1,000
WPTZ Channel 3 Philadelphia, Pa.	A. C. Olberg K. D. Anderson R. Roland	7 9, 3:45-4:10 pm 7 15, noon 7/16, 12-2:30 pm 8 5, 12:30 pm	1,100 1,000 1,000
WTVJ Channel 4 Miami, Fla.	T. E. Rowe	7 22	1,580

TABLE II — RECEIVER DATA

NAME	LOCATION	RECEIVER	BOOSTER	ANTENNA
K. D. Anderson	Kerkhoven, Minn.	Emerson	Masco	Trio Lazy H
W. E. Bennett	Augusta, Ga.	Tech Master Kit		4-bay conical
H. Brink	Dixon, Ill.	Muntz	Anchor	Folded dipole
Mrs. W. Callan	Altoona, Pa.	Philco 51-T-1443B		double Vee
W. R. Henry	Warner Robins, Ga.	Midwest		two 5-element Yagis
A. C. Olberg	Clearbrook, Minn.	Arvin 5300	home-made	18-element
R. Roland	Perry, Ia.	Motrola 9L1		folded dipole
T. E. Rowe	Aurora, Minn.	Hallicrafter	Astatic	JFD stacked conical



Television Service Clinic

Conducted by
WALTER H. BUCHSBAUM

CONVERSION business is becoming an important part of our readers' work, to judge from the increasing number of letters being received. Many small-screen TV sets now require a replacement for the picture tube and naturally the owners want a larger picture. In many cases a tube can be made without changing the switch from a 10- to a 12-inch picture cabinet. Sometimes a rectangular 14- or 16-inch tube can be mounted with only minor changes in the cabinet. Many service dealers are accepting older TV sets as trade-ins and reselling them with a larger tube and a new cabinet.

RADIO-ELECTRONICS has featured several articles on converting TV sets to larger picture tubes, the most recent and comprehensive in the January, 1950, issue. Conversion kits are available at radio supply houses, each with a detailed circuit description. It would be repetitious to go into details of all these circuits, but the principles of converting TV receivers deserve some discussion.

Most of the larger screen tubes differ in two main aspects from the 10- or 12-inch tube found in older sets. First, the new tubes require a higher second-anode voltage for proper brightness and sharp focus. The second requirement is additional deflection, especially horizontal. More horizontal sweep is required because of the higher second-anode voltage and because the new tubes are relatively short and therefore have a larger deflection angle. An illustration of the effect on bulb length and deflection angle is given in Fig. 1. The deflection angle for all 10-inch tubes is 52 degrees and for most 12-inch tubes it is 55 degrees, which permits direct substitution whenever plenty of horizontal sweep is available for the 12-inch tube. The larger screen picture tubes, however, have a deflection angle ranging from 63 to 70 degrees and 90-degree tubes are being developed. To deflect the wide-angle tubes, the deflection yokes must be shorter and designed to eliminate neck-shadow as shown in Fig. 2.

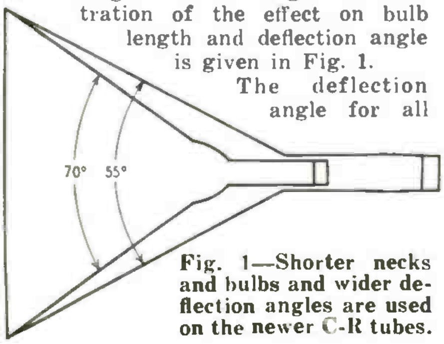


Fig. 1—Shorter necks and bulbs and wider deflection angles are used on the newer C-R tubes.

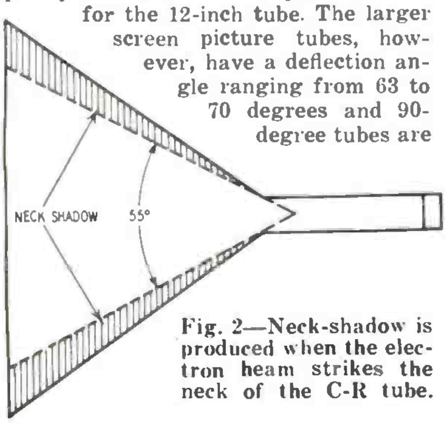


Fig. 2—Neck-shadow is produced when the electron beam strikes the neck of the C-R tube.

The vertical deflection circuits of most receivers have enough reserve power to sweep the new tubes, but in some cases the vertical circuit must be changed. Connecting the plate of the vertical output amplifier to a higher voltage, usually the boost obtained from the horizontal damper tube, or increasing the sawtooth driving the output amplifier is the simplest way to increase vertical sweep.

To get more high voltage and at the same time more horizontal sweep it is necessary to use a suitable flyback transformer and deflection yoke. Most of these transformers are of the high-efficiency type, containing not a powdered iron but a ceramic core which gives higher Q and more permeability. Such a transformer is the G-E 77J1 or its counterparts from other manufacturers. To match the transformer the deflection yoke is of special design, usually also containing a ceramic core and specially shaped windings. The inductance of most of these yokes is higher than the original 8.3 mh, ranging from 10 to 18 mh. The circuit used

Picture-Tube Conversion Data

Tube Size (inches)	Defl. Angle (degrees)	Anode Volts (kv)	Ion Trap	Remarks
10	52	9.5	double pole	10FP4 needs no ion trap.
12	55	9.5	double or single	Different types of ion traps required. Some need no trap.
14 rect.	63	12	double or single	14CP4 uses single-pole trap.
16 round	63	12	double or single	16AP4 (metal) has 55° angle. 16GP4 (short metal) has 70° angle.
16 rect.	70	12	double or single	Various bulb shapes and lengths available.
17 rect.	70	12	double or single	Same as 16-inch rect. except for screen size.
19 round	70	12-15	single pole	Glass and metal tubes almost identical electrically.
20 round	55	12	none	Obsolete.
20 rect.	70	12-15	single or double	Similar to 16-inch rect.
30 round	90	15	single	Now under development.

with the G-E 77J1 and similar flyback transformers requires a special width-control coil.

In addition to requiring changes in the flyback circuit and the deflection yoke, many of the large screen picture tubes also require more focusing flux. This is obtained by using a larger focus coil or by installing one of the new combination EM-PM units. Lately some all-PM focusing rings have appeared on the market which could be used for some large-screen tubes. Many of the new tubes have a tilted electron gun which needs a single-pole magnet ion trap as compared with the double-pole magnet used on the 10BP4 or the 12LP4. The table shows the different picture tubes and the requirements for conversion.

Horizontal pull

I have especially bad horizontal pull on a 630-type TV set when a close-up appears. I also have a white smear running down the left side of the picture. Tubes and voltages appear to be correct.—E. B. N., San Francisco, Cal.

The best way to find the fault is to observe the different waveshapes on an oscilloscope and compare them with those shown in the RCA instruction manual. If you can improve the condition somewhat by lowering the bias on the 6SK7 sync amplifier, the trouble may lie in the video or the d.c. restorer circuit. Measure the bias voltages on the 6AU6 and 6K6 video amplifier carefully and replace the 6AL5 d.c. restorer with a new tube.

Both slugs on the synchrolock transformer must be properly adjusted before any other circuit can be checked. Also try replacing the 6AL5 sync discriminator and the 6AC7 reactance tube. Emission checks are not good enough with these tubes. As a last resort, replace the synchrolock transformer itself, as it may have some shorted turns.

Poor contrast

I own a 16-inch Transvision TV receiver. The contrast is poor. The picture tube is a 16DP4. Will this tube work with 13.5 kv on the second anode?—S. C. L., Philadelphia, Pa.

The contrast depends on the gain of the receiver, especially the video amplifier. If the i.f. sensitivity is satisfactory, you may need a new video amplifier tube. As a last resort, a higher value plate resistor in the video output tube will give you more contrast.

The 16DP4 may be operated with 13.5 kv on the second anode without damaging it.

Hash

Many 630-type receivers which have been converted for larger picture tubes and keyed a.g.c. have a faint hash. This appears on weak stations and I feel sure that it is not an external interference.—H. W., Brooklyn, N. Y.

There are several possibilities. It may be a 4.5-mc beat which becomes more apparent when a direct connection is made from the detector to the first video amplifier, necessary for keyed a.g.c. A 4.5-mc trap in the last video amplifier will eliminate this.

The hash may also come from i.f. misalignment, especially the traps. Realignment is necessary when a.g.c. is added to the 630. To disable the a.g.c., simply shunt a 3-volt battery across the bias source with the negative side to the bias and the positive side grounded.

A third possibility is that the hash may not be apparent on the smaller screen, but only on the larger picture tube. However, some a.g.c. circuits alter the video amplifier response curve and cause a loss of detail. In that case the fault is not in the a.g.c., but in the values of the video peaking coils. It may be necessary to use new coils.

No picture

I have an RCA 730 TV2 on which I can't get a picture. Sound and raster are O.K. All tubes check good.—E. S., Chicago, Ill.

If sound and raster are O.K., the trouble must be either in the picture i.f. amplifier, the video detector, or the video amplifier. While tubes may check good in a tester, it is better to check them by substituting new ones. This is especially important in the case of the 6AL5 video detector.

Barring tube failure, a close inspection for broken leads, poor tube socket contacts, charred resistors, etc., in the i.f. and video amplifiers may show the defect. Next measure all plate voltages. If the defect still is not apparent, check each coupling capacitor by shunting it with one known to be good. If you have an oscilloscope, you can trace the picture from the second detector to the defect. Measure the detector output. A small d.c. voltage should be developed across the diode load resistor as the set is tuned from one active channel to another. If no change occurs, the trouble can probably be localized in the video i.f. amplifier.

Distorted picture

An Emerson model 571 takes a few minutes before the test pattern becomes round. After another 5 minutes, the picture at the left side stretches while at the right it remains normal. Changing tubes in the horizontal deflection circuit did not help.—B. F., Brooklyn, N. Y.

A defective capacitor is probably the fault. This is most likely one of the coupling capacitors going to the horizontal output amplifier grid. Checking such a capacitor with a meter is not sufficient as it apparently goes bad only when heated up. The best method is to substitute a good capacitor for each coupling capacitor and for the charge and discharge capacitor (C-59) in the plate circuit of the horizontal discharge or sawtooth generator tube.

Paper and electrolytic capacitors are more likely to become leaky than micas or ceramics, although the latter may become intermittent.

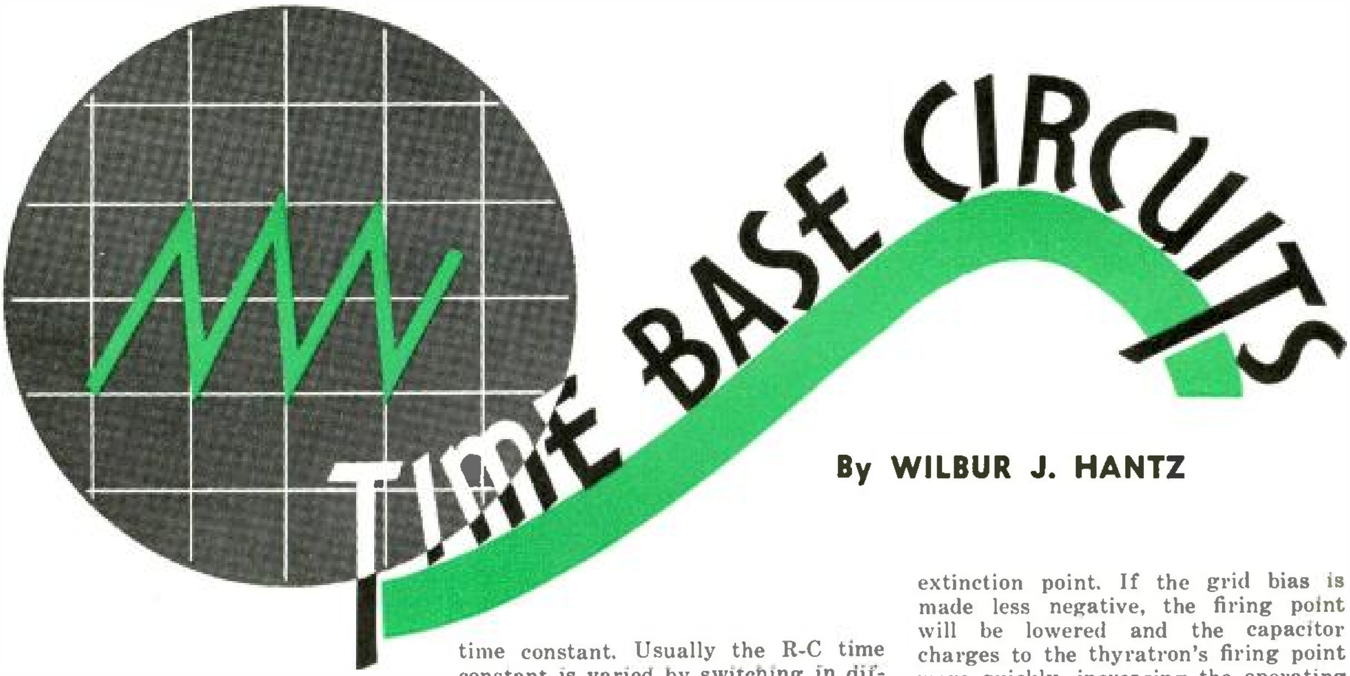
Airplane flutter

Whenever an airplane passes over my house, a diagonal white line appears and the picture moves on my De Wald BT100 TV set, chassis 630.—N.B., Elizabeth, N. J.

This set does not have a.g.c., and therefore you get the airplane flutter. When a plane passes over rapidly, the reflected TV signals change slightly in frequency. Unless you are willing to add a special tube and make several wiring changes, you cannot get rid of this effect on your present set.

A special keyed a.g.c. is used in many 1950 TV sets to compensate for airplane interference. Tech-Master Products offers a Keyed A.G.C. Kit, available in most radio supply houses, to eliminate airplane flutter in 630-type sets. This kit contains all parts and mounting brackets to eliminate the need for additional holes in the chassis and major circuit changes. Complete instructions are furnished with the kit.

Suggested by Charles L. Beck, Detroit, Michigan



TIME BASE CIRCUITS

By WILBUR J. HANTZ

THE time-base generator is an important part of the cathode-ray oscillograph. The signal to be investigated usually must be plotted as some function of time. This is done by feeding the signal to one pair of deflecting plates while a second voltage, proportional to time, is fed to the other pair. The circuit that generates this latter voltage is called a sawtooth time-base generator. Not only used in oscilloscopes, the saw-tooth generator is essential to TV because it separates the picture for transmission and puts it back together at the receiver.

To better understand the sawtooth generator, suppose we analyze a simple form using a neon bulb as in Fig. 1. The capacitor C charges through R from the supply voltage at a rate depending upon the R-C time constant (the time required for the voltage on the capacitor to reach 63% of the ap-

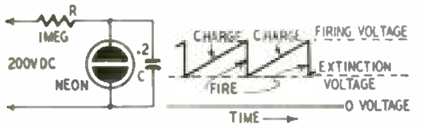


Fig. 1—This neon lamp circuit is the simplest form of time base generator.

plied voltage) which is the product R×C or 200,000 microseconds. During the charging time, the neon bulb is an open switch. If the conducting point of the neon bulb is 100 volts, it will fire when the capacitor charges to that value and discharge the capacitor. Then this process repeats, charging and discharging the capacitor. The output voltage waveshape is in the shape of a sawtooth due to the capacitor charging voltage rising along a logarithmic curve to the conducting point and then discharging rapidly to the extinction point. These intervals continue as long as the voltage is applied. The frequency depends upon the supply voltage, the ignition voltage of the lamp, and the R-C time constant. Usually the R-C time constant is varied by switching in different capacitor values, providing a rough frequency control, while R is varied for a fine adjustment. However, the neon sawtooth generator is not often used because it is difficult to synchronize.

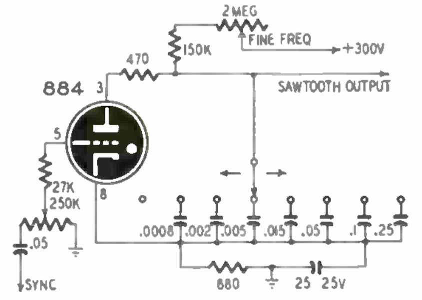


Fig. 2—A thyratron sawtooth generator with frequency from 20 cycles to 30 kc.

In Fig. 2 is shown a circuit that operates in the same way but uses an 884 thyratron. The charging capacitor C consists of a number of capacitors of which any one can be switched in to provide a frequency range of 20 cycles to 30 kc. The higher frequencies are reached by the smaller capacitors. The grid bias may be used to control the firing point but it cannot control the extinction point. If the grid bias is made less negative, the firing point will be lowered and the capacitor charges to the thyratron's firing point more quickly, increasing the operating frequency. The 884 is easily synchronized by applying part of the observed signal to its grid. If the signal frequency is very nearly a multiple of the frequency of the sawtooth wave, the gas triode will be forced to lock in and the observed pattern will be stationary.

Single sweeps

In some cases the signal to be observed exists only for a short time and then disappears. This is called a transient. If the ordinary sawtooth generator is used for such a signal, the electron beam moving across the face of the cathode-ray tube is independent of the beginning of the transient and there is no way to determine when it occurs. This problem is solved by using a single-stroke sweep generator that generates a time base only when the transient occurs. The sweep is started by the transient itself or some identical signal voltage applied to the sync input terminals.

An ordinary thyratron sweep circuit can be used for this purpose without much change.

In the circuit of Fig. 3, the plate of a diode-connected 6C5 is connected to the plate of the 884 thyratron through a small resistor. The cathode of the diode

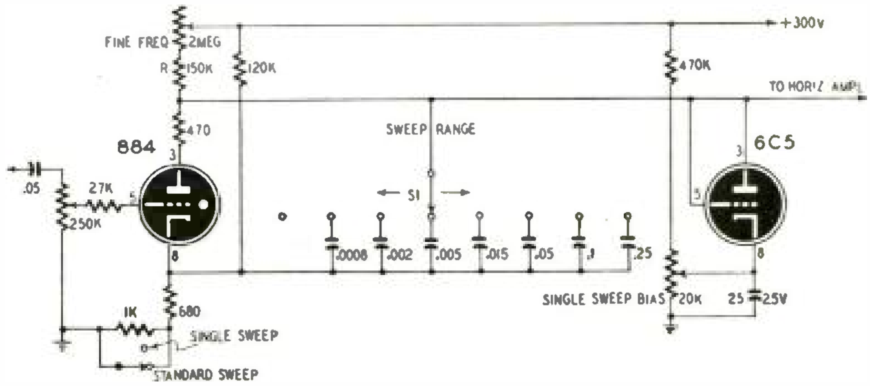


Fig. 3—A thyratron single sweep circuit for observing transient signals.

cally charged particles for their part repel the point with the same force with which they are in turn repelled by it. This is the basis of the electric windmill (Fig. 3).

In denser air the electric wind blows slowly, though this is compensated by a greater impulsive force or impact, compared with the energy used. In thinner air its velocity is higher, but the impulsive force is less compared with the energy produced. In denser air the electrically charged particles (charged molecules, ions, or electrons) pass between the uncharged molecules of the medium and drag them along, at the same time, of course, the particles' initially very rapid flight being thereby slowed down. Accordingly, if there is a great deal of air around the charged particles, a large mass of air is set in motion—but with only a small velocity; if the air is thin, the charged particles encounter fewer uncharged molecules, and the velocity of the gas streaming away is correspondingly higher. In a highly evacuated Geissler tube, for example, the molecules and atoms which fly from the anode develop mean velocities of 30 to 250 miles/sec, whereas in contrast to this the cathode emits free electrons for the most part which, because of their small mass, can reach velocities of 56,000 miles/sec.

For a given quantity of energy supplied, the recoil action increases with the increase in the quantity of matter repelled, but the velocity of repulsion diminishes. This is also true in a vacuum where all the repelled particles are

Table I—c and m_0/m_1 if $v_1-v_0=6.5$ km/sec

(km/sec)	2	3	4	5	6	10	15
$\frac{m_0}{m_1}$	26	8.6	5.1	3.6	2.96	1.94	1.39

electrically charged and the latter no longer drag along any uncharged molecules in their flight. In this case, when there is very little matter repelled, the electricity carried along will accumulate to form a high potential—causing a more rapid flight of the particles. When more particles are present, one will

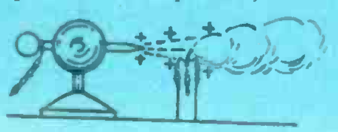


Fig. 2—If the electric charge on the point is strong enough, it creates a wind that will blow out the candle.

soon come along which will carry off the charge unit brought in, the potential will no longer rise as high, and the particles will move slowly, but in compensation for this, the current strength increases.

Furthermore, the recoil effect on an electric windmill is greater the denser the air medium. In the case of denser air or lower potential, the particles which are flung off nevertheless remain longer in the neighborhood of the rotating wheel, and therefore have more time in which to exert their repulsive force on it.

Accordingly, as indicated in equation (1), it is possible with the same consumption of material to develop a greater recoil momentum in highly rarefied gases, as a result of the high recoil velocities (though at the cost of greater expenditure of energy).

A perceptible electric wind arises only when enough electrically charged molecules are set in motion. In dense air the electric wind can be produced only in the vicinity of charged points where the charge density is very large, unless the potentials are millions of volts. But if we are dealing with high rarefaction of the surrounding gas, the electric density is sufficient to charge a suitable percentage of the surrounding air molecules; in which case the electrodes need no longer be pointed, and the charged particles are emitted from rounded or flattened surfaces and proceed in a direction perpendicular to the surface.

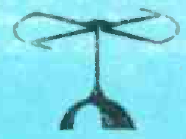


Fig. 3—An electric windmill. Charges leaking off the points create a reaction force that makes the vanes of the mill rotate.

If air or other gases are completely absent, such a stream of particles can be generated only if the electrodes themselves supply the particles. This is the case, for example, of the hot cathode which surrounds itself with a cloud of electrons, of the potassium-containing photo cell which upon irradiation with ordinary light emits charged particles, or of anodes which either liberate gases or which consist of fused salts as in the von Gehrke-Reichenheim method and from which individual ions are torn loose, etc.

Electrodes

Accordingly, the electrodes of the electric spaceship might look like the model in Fig. 4. This shows a cylinder whose walls and one end are impermeable to both gas and electricity, but the other end of which is fitted with a permeable material. This end can be either porous or at least permeable so far as the contents are concerned. In the cylinder is a substance which, if the end piece is porous, had best be a liquid, though it can also be a solid if its vapor tension is high enough (solid carbonic acid or ice). This material, or at least its vapor, oozes through the porous end of the cylinder. Since the cylinder is highly charged, the charged particles fly off with considerable velocity.

The quantity of matter which trickles through the porous end of the cylindrical electrodes depends on the nature of the porous material and on the chemical nature and temperature of the contents of the cylinder. It would be most useful to provide the electrode with an electric heating device, which would keep the temperature at the desired level. Then the velocity of efflux and acceleration could be regulated.

Up to now everything pertaining to the invention of the electric spaceship

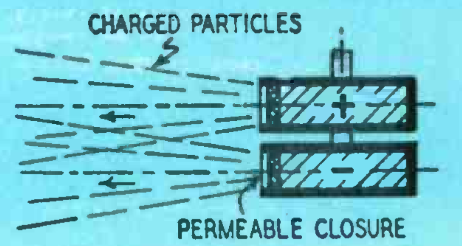


Fig. 4—Electrodes for the spaceship. Charged particles oozing through the end are repelled by the charge within.

WHO IS DR. OBERTH?

Modern rocket research may be said to have two "fathers", the American Prof. Robert H. Goddard and the German Prof. Hermann Oberth. Chronologically the priority belongs to Goddard; he was born in 1882, Oberth in 1894. Goddard published his first work on rocket theory in 1919, Oberth in 1923. The important and significant difference was that Goddard called his book *A Method of Reaching Extreme Altitudes*, while Oberth boldly wrote *The Rocket Into Interplanetary Space* on his title page. The "two fathers" of modern rocket research are, therefore, the fathers of cousins: Goddard got the theory of rockets underway, Oberth the theory of space travel.

Having been associated with Oberth in his "early days" I find it difficult to write just a short introduction about him. Mention of his name naturally invokes countless memories. Of evenings spent at the shore of the Baltic Sea, looking for the planets and talking about their surfaces. Of night walks through the *Tiergarten* in Berlin, discussing long range rockets. Of discussions of moving under lunar gravity, taking place in the shifting sands of the enormous moonscape which Fritz Lang had built in the *Ufa* studios in Neubabelsberg near Berlin for the film *The Girl in the Moon*, all copies of which were hastily called back later by the Nazis when the research institute in Peenemünde was organized.

Whether you want to call Prof. Oberth a German, an Austrian or a Rumanian depends entirely on the definition you have in mind. He was born in the city of Hermannstadt in Transylvania on June 25, 1894. The people in that area constituted a German "colony" much like our so-called Pennsylvania Dutch. Since his father was a physician it seemed indicated that the son would be one too. But, at the University of Munich, where he went to study medicine, he also studied physics and astronomy, gradually with more and more emphasis on their mathematical aspects. When the first World War broke out he was drafted into the Austrian army and finally assigned to the Medical Corps. The periods of idleness to which every man in uniform is subjected were the times when Oberth first thought about space ships and when the foundations of space travel theory began to form in his brain.

After the war he wrote his book *Die Rakete zu den Planetenräumen*. Almost simultaneously with its publication he got his first job: that of professor of mathematics in Mediash, Transylvania. The book was a small one, as far as volume is concerned, not quite a hundred pages of mostly mathematical type. Judging in retrospect over a quarter century of time one can be sure that it will later be said that this book changed human history, as profoundly as Columbus' trip across the ocean.

After having helped Fritz Lang with his movie and some experimental work on rockets in Berlin in 1929-30, Oberth had to return to Transylvania since nobody then saw any reason for spending money on rocket research. After the Nazis had taken power in Germany Oberth was called to Germany and after several and long delays was finally sent to the rocket research institute at Peenemünde, where the V-2 rocket was created. But while Oberth found many of the principles he had first worked out embodied in that rocket, he also found a virtually finished rocket on arrival, and did not contribute directly to the V-2.

Herr Oberth is the Honorary President of the German Space Travel Society which was re constituted after the war. He was the first to win the French REP-Hirsch Prize before the war. He was the first man to be made an Honorary Fellow of the British Interplanetary Society. And—most important of all—he was the first who took the idea of space travel out of the realm of dreams and transferred it to the department of science.—*Willy Ley.*

is quite clear. But in the second part of this article, I shall make several reservations. Problems arise which can be solved only when enough measurements and data concerning the nature of interplanetary space are available.

For example, the behavior of the electrodes of Fig. 4 can be predicted only when the effect of various radiations which are absorbed by our atmosphere on the processes taking place at the porous end of the electrode is known. It is therefore pointless to introduce detailed calculations based only on the experience gained from Geissler tubes.

One possibility

This uncertainty is particularly large in the selection of the source of current. It appears that a thermopile would be the simplest and most suitable device. Fig. 5 shows a piece of the thermopile on an enlarged scale and in a rather schematic representation.

The dashed arrows indicate the incident rays of the sun. One junction of the thermopile is turned to the sun and is also irradiated by reflected sunlight from below: the other junction is in the shade. The sheet-metal strips can be soldered together on the earth and wound on a drum in such a way that they are bent in the proper position on the upper side, which can be done very easily mechanically. If one wants to go further, one can either roughen the strips in those places shown in black in the diagram or paint them black, and at the same time polish the places shown in white. The effectiveness of the arrangement will be increased by this operation. From measurements of the temperature of the surface of the moon it is possible to calculate that the side turned to the sun will be heated to about 140° C., while the side in the shadow will drop to a temperature of 100° C. below zero.

The potential difference between two adjacent metal strips is only of the order of a hundredth of a volt, but when several hundred thousand of these are soldered together in series, a marked difference of potential between the ends can be obtained. These connected strips could be wound about the spaceship in a helical line, and, since the acceleration of the spaceship is small, as has been brought out above, it would hardly be necessary to reinforce or stiffen this helix.

The question now, however, is whether it will fulfill its function; for it is possible that certain cosmic radiations might cause an equalization of the potential difference between the metals at the ends of the thermopile, somewhat in the way the electron cloud about a hot cathode tends to bring about the same result. It is also possible that the traces of gases found in cosmic space might discharge the electric charge built up in some other way than the desired one (though I do not believe this will happen), and so on.

Ulinski, the first to suggest such a thermopile (though his design was not very promising), thought of providing it with an insulating coat. But an application of this sort would have considerable weight and would tend to prevent the warming and cooling of the proper junctions. Furthermore organic materials would soon be destroyed by

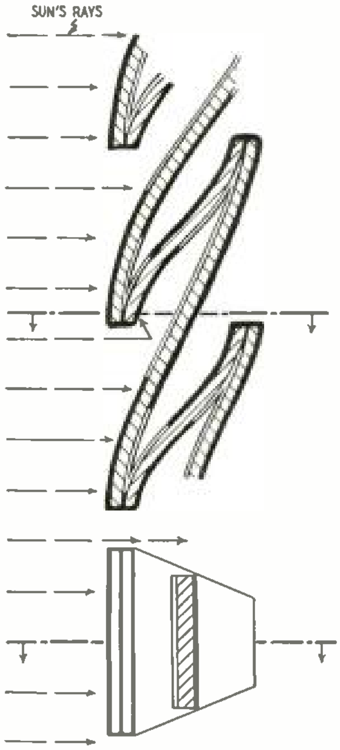


Fig. 5—Series-connected thermopiles have been proposed as a method of collecting energy to drive the spaceship.

the cosmic radiations, an insulating coat of glass or some ceramic material would easily crack and split off, because of the temperature difference and the corrective bending of the metal helix, etc. I do not mean to imply that Ulinski's suggestion cannot be realized, but simply wish to indicate that many questions regarding it remain unanswered, and that the final result might very well be far less promising than it appeared at first sight.

In Part 2 of this article we shall consider the detailed description of a feasible spaceship and its powerplant.

MATHEMATICAL ANALYSIS

The principles of rocket propulsion are interesting to contemplate.

If the mass of the material expelled each second with a velocity c_1 is m_1, then the recoil momentum is measured by:

$$P_1 = m_1 c_1 \qquad (1)$$

However, the total energy which must be expended on this propellant in each second to set the mass m_1 in motion with the velocity c_1, to get this recoil effect, is:

$$E_1 = \tfrac{1}{2} m_1 c_1^2 \qquad (2)$$

If we consider another mass m_2 with the velocity c_2, then the corresponding equations are:

$$P_2 = m_2 c_2 \qquad (3)$$

$$E_2 = \tfrac{1}{2} m_2 c_2^2 \qquad (4)$$

If the source of energy does the same work in both cases, then

$$E_1 = E_2$$

and from equations 2 and 4 we have:

$$m_1 c_1^2 = m_2 c_2^2 \qquad (5)$$

If we now eliminate m_1 from equations 1 and 5, then divide the result by equation 3 we get:

$$P_1 : P_2 = c_2 : c_1 \qquad (6)$$

This means that for equal work performed by the source of energy, the recoil effect is inversely proportional to the velocity of efflux. That is, the smaller the velocity of efflux, the greater the recoil itself.

But it follows from equation 5 that the loss of material depends on the square of the velocity of efflux. This means, in agreement with equation 1, that the mass of propellant is consumed more sparingly the higher the velocity of efflux, but this is at the cost of greater energy consumption.

For example, if the electric spaceship expels 10 tons of matter at the rate of 10 km/sec and during this time it reaches a velocity of 2 km/sec, it would be able to expel only 2.5 tons of propellant and reach a velocity of only 1 km/sec with a velocity of expulsion of 20 km/sec. But if it worked four times as long, it would again consume the original mass of 10 tons, but would then reach a velocity of 4 km/sec.

We are dealing here with an inverse relationship. For a given amount of energy, the more rapidly the mass is expelled, the smaller is the amount which can be expelled in unit time, and the slighter is the recoil and hence the acceleration. But, using the same quantity of propellant, the spaceship can continue to accelerate for a longer period of time. This longer period of time has the same ratio to the shorter period as the square of the higher velocity of efflux has to the lower velocity of efflux. Therefore the spaceship reaches a velocity at the end of the longer period of acceleration which has the same ratio to the velocity reached in the shorter period as the higher velocity of efflux has to the lower.

The electric spaceship is certainly not very exacting as to the fuel it would use. Anything might serve as propellant—if it will diffuse readily through the porous end of the cylinder and if it is sufficiently inert so it will not attack the walls of the electrodes.

1. Other figures are frequently given for both the distance of the orbit above the earth and for the velocity of rotation. This is due to the fact that the authors concerned have failed to take into account the fact that this station would not travel about the earth in one solar day of 24 hours, but in a sidereal day, if it is to remain over the same meridian.

Relays Do Simple Arithmetic

Part III—How to use relay adding circuits for subtraction and multiplication in the binary system

By EDMUND C. BERKELEY* and ROBERT A. JENSEN

IN THE two earlier articles we have seen how an electric brain can:

1. store information in a register;
2. transfer information from one register to another; and
3. add two numbers expressed in binary notation (the scale of two).

Being interested in constructing a relay calculator, in this article we shall consider subtraction and multiplication using relays.

We shall keep to binary numbers for the present for three reasons: It is easy to carry out the operations we are interested in. Also, binary notation is good for electron-tube calculating circuits as well as relay calculating circuits. Finally, it is a good introduction to the circuits needed for calculating in the decimal scale.

Suppose we wish to subtract the binary number 101 (read "one-oh-one," meaning one 4 plus no 2's plus 1, or 5) from the binary number 1110 (read "one-one-one-oh," and meaning one 8 plus one 4 plus one 2 plus no 1's, or 14). We write 101 under 1110 and subtract:

```
 1110
  101
 ----
 1001
```

How do we manage to subtract? We recall the binary addition table:

	0	1
0	0	1
1	1	10

Then we say under our breath, for the first column at the right: "1 from 0 does not go, borrow 1; 1 from 10 (read "one-oh" not "ten") is 1. write down 1." For the next column, we say, remembering the borrow: "0 from 0. write down 0." For the third column: "1 from 1 is 0, write down 0." For the last column: "nothing from 1 is 1, write down 1." The result is 1001 (read "one-oh-oh-one," meaning one 8 plus no 4's plus no 2's plus one 1, or 9) just as we would expect it to be.

We could set to work and design a circuit which would reproduce this process and give the precise result we desire. But isn't there an easier way?

There is an easier way to subtract—by using the addition circuit shown in the last article, and using the mathematical fact that subtracting a number is the same as adding the complement.

To make the idea of complement clear, let us return for a moment to decimal notation (the scale of 10) and consider a desk adding machine having just five columns. Suppose we consider a number 864 (eight 100's plus six 10's plus four 1's). Suppose we set the machine at 0 and subtract 864. We will obtain 99136. This is called the *complement* of 864 (also called the *tens complement* of 864). For, if we take 864 and 99136, and add them, we get 100,000; but the extreme left-hand digit (the 1) being beyond the capacity of the five-column adding machine, it vanishes and the result is 00,000 or zero. (In a machine of ten columns instead of five the complement would be 9,999.999,136, correspondingly.)

Now to subtract 864 from any number—suppose it is 3,145—we add the complement:

```
 3145          3145
− 864       + 99136
 ----       -------
 2281        102281
```

The extreme left-hand digit in 102,281 will disappear off the machine, giving 2,281 as the result, which is correct.

The complement (such as 99,136) is easily found for any number (such as 00,864) by two rules:

1. take each digit away from 9 (obtaining what is called the *nines complement*, in this case 99,135);
2. add 1 to the result (obtaining in this case 99.136, the *tens complement*).

What is the analogue in binary notation to these complements in decimal notation? In decimal notation we have a *nines complement*, nine being one less than ten, the base of the scale of notation; so, in binary notation, we shall have a *ones complement*, since one is one less than two, two being the base

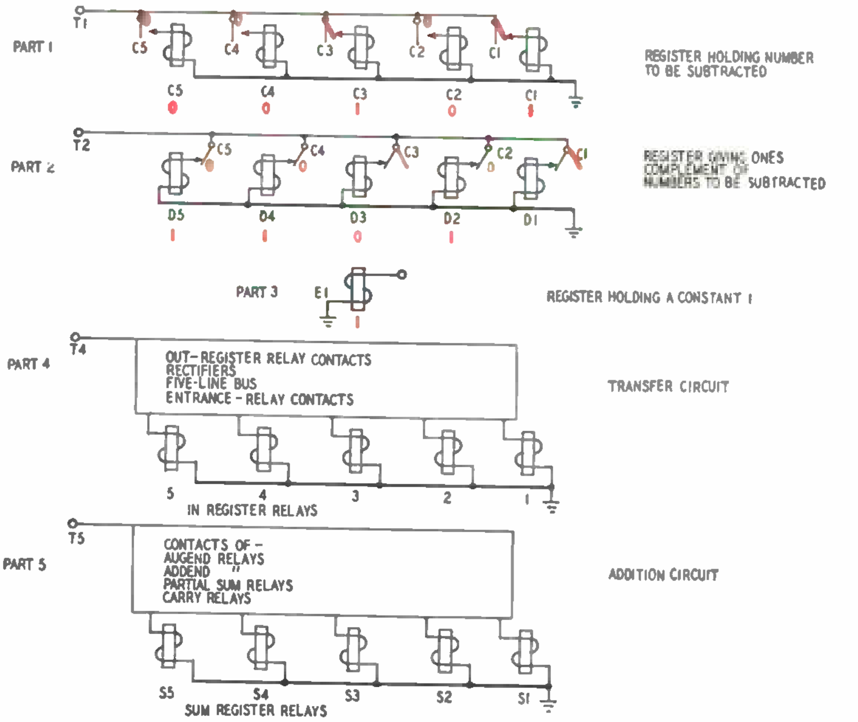


Fig. 1—A relay circuit that subtracts by first obtaining the twos complement.

* Author: Giant Brains

of the scale of notation. We obtain the *ones complement* of a binary number by taking each of its digits away from 1. The *twos complement* is then equal to the ones complement plus 1.

So to subtract in binary:

1. find the *ones complement* of the number, by taking each digit away from 1;
2. obtain the *twos complement* by adding 1 to the ones complement;
3. add the *twos complement*, and discard the extreme digit on the left.

Suppose we do this arithmetically first, and then examine a series of circuits which will produce the same result. Let us return to the example of subtracting 101 from 1110. Let us assume that we have a five-column binary calculator. The *ones complement* of 101, then, is 11010; adding 1, we get the twos complement, 11011. We add:

$$\begin{array}{r} 1110 \\ +\ 11011 \\ \hline 101001 \end{array}$$

The extreme left-hand digit 1 vanishes ("goes off the keyboard") and the result is 1001, the same result as before, as would be expected.

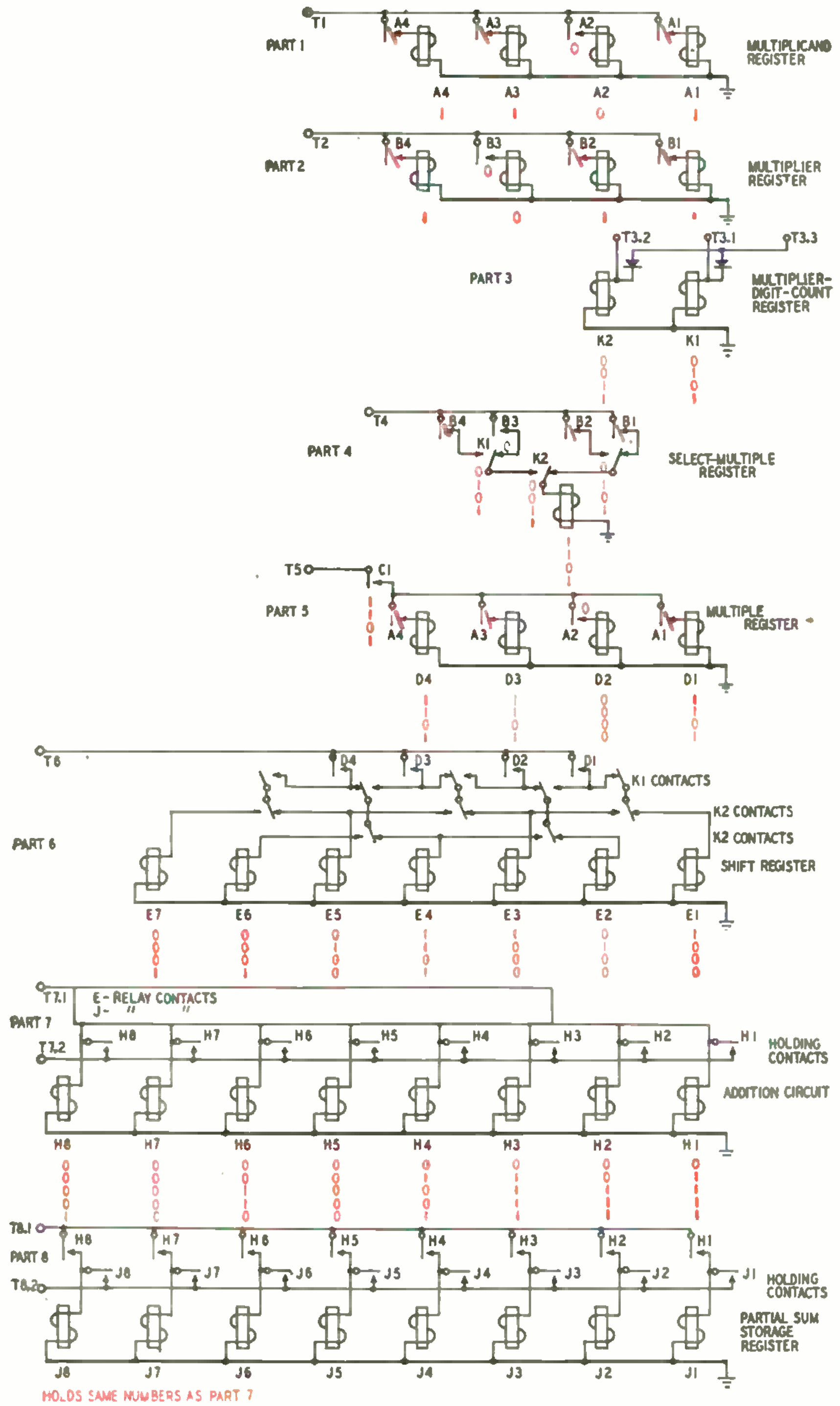


Fig. 2—A relay multiplication circuit. It is really an adding circuit which shifts successive multiples of the multiplicand to the left and adds them.

Subtraction circuits

A series of circuits for subtraction is shown in Fig. 1. First (see part 1), the number to be subtracted is stored in the C register in relays C5 to C1. The example shows 101 stored (or 00101) where the first 0 tells us the number is positive. The C3 and C1 relays only are energized as shown in red. At Time 1, terminal T1 holds these relays energized through their hold contacts.

At Time 2 (see part 2), the ones complement of the C number is obtained, by reading out from terminal T2 through normally closed contacts of the C relays, into the D relays. Hence, the number stored in the D relays is 11010, precisely the ones complement of 00101.

All the rest of the calculation is "reduced to the previous case," as the mathematicians say: reduced to transfers and additions, which have been described in earlier articles but are as follows:

The D number—the ones complement —(see part 2) is transferred via the transfer circuits of part 4 into the augend relays of the addition circuits (see part 5). A constant 1 stored in the relay E1 (see part 3) is transferred (see part 4) into the addend relays of the addition circuits (see part 5). The sum obtained in the sum register, the S relays (see part 5), is routed back via the transfer circuits of part 4 (and perhaps via an extra temporary storage register) into the addend relays of the addition circuits. So at this point we have the twos complement of the number to be subtracted, stored in the addend of the addition circuit.

Next, the number to be diminished is transferred from whatever register it is stored in via the transfer circuits of part 4, into the augend relays (see part 5) of the addition circuit.

Then finally we pulse the addition circuit a second time, and the result of the subtraction is produced in the sum register of the addition circuit.

Note that the transfer circuits of part 4 are here assumed to transfer a five-digit binary number from a five-relay register via a five-line bus into another five-relay register. The transfer circuits of Article I of this series show only two-relay registers and a two-line bus; but the extension should give no difficulty.

Plus and minus numbers

At this point we start thinking again and say to ourselves, "It is foolish to have a calculator that can only handle positive numbers. Our calculator should handle both positive and negative numbers. How shall we arrange that?"

A good answer, though not the only one, is to agree that the extreme left-hand digit of the number will tell the sign of the number, whether *plus* or *minus*. For example, in decimal notation, with a five-column calculator, we would stop using the fifth column from the right for showing digits. Instead we would say: "If it holds 0, the other four digits are a positive number; if it holds 9, the other four digits are the complement of a negative number." For example, 09136 would mean +9136, but 99136 would mean −864. As a result, the machine would be unable to express any number greater than +9999 or less than −9999.

In binary notation we can do almost the same thing. We say, "If the extreme left-hand digit is 0, the remaining digits make a positive number. If that digit is 1, the remaining digits are the complement of a negative number."

We need to adjust our calculating circuits for adding two numbers which are both positive, or both negative, or one positive and one negative. We also need to adjust our calculator to ring an alarm in cases where the result is beyond the capacity of the calculator—that is, beyond +9999 or −9999 in terms of the example given above. A third consideration is the decimal point or, in binary notation, the "binal" point. In fact, there are a number of little adjustments needed. But it is probably better to neglect them at this stage, and go on to the next main process, multiplication.

Multiplication

In binary notation, the multiplication table becomes simply:

	0	1
0	0	0
1	0	1

or, in other words, 0 times 0 is 0, 0 times 1 is 0, and 1 times 1 is 1. Multiplication becomes either adding or not adding, and shifting.

For example, let us multiply two binary numbers, 1101 (one-one-oh-one: 8 plus 4 plus 1, or 13) and 1011 (one-oh-one-one: 8 plus 2 plus 1, or 11):

```
    1101
    1011
    ----
    1101
   1101
  0000
 1101
 -------
10001111
```

The result is 10001111 (one-oh-oh-oh-one-one-one-one, or, one 128 plus no 64's plus no 32's plus no 16's plus one 8 plus one 4 plus one 2 plus one 1, or 143), which is of course what we would expect from ordinary multiplication of 13 and 11.

Fig. 2 shows circuits with energized relay contacts in red. Fig. 3 is the timing chart, showing how the circuits are to operate one after another, and over again, for successive digits of the multiplier. These circuits are preliminary, and not final.

We have assumed that the multiplicand (the number to be multiplied) is the four-digit binary number 1101, and the multiplier is the four-digit binary number 1011. They are stored in the A register (see part 1) and the B register (see part 2).

The general method we have used for obtaining their product is: choose multiples of the multiplicand, either 1101 or 0000, according to the successive digits of the multiplier 1011 taken from right to left 1, 1, 0, 1 (see parts 3, 4, 5); shift these multiples over to the left (see part 6) according to the successive positions of the multiplier digits (0, 1, 2, 3, or in relay language, 00, 01, 10, 11); with an addition circuit and storage register, add successively the shifted multiples (see parts 7, 8).

Proceeding now to examination of the parts of the circuit in detail, let us begin with a look at part 4. The select-multiple circuit (controlling relay C1 in part 4) operates on the multiplier 1011. This circuit yields at different times the successive digits 1, 1, 0, 1 that select the multiple of the multiplicand. How is this made to happen? In part 3, the K relays are energized in the pattern 00, 01, 10, 11, (0, 1, 2, 3 in binary) at successive times.

In part 5, the multiple of the multiplicand is selected. Its successive values are 1101; 1101; 0000; 1101. The contacts used are a contact of the C relay (see part 4) and four contacts of the A relays (see part 1); the multiple is recorded in the D relays.

In part 6, the selected multiple, recorded in the D relays, is shifted 0, 1, 2, or 3 spaces over, according to the position of the multiplier digit, recorded in the K relays (see part 3). The numbers produced by the E relays accordingly are:

0 0 0 1 1 0 1,
0 0 1 1 0 1 0,
0 0 0 0 0 0 0, and
1 1 0 1 0 0 0.

In Part 7, the addition circuit is indicated in block diagram, since it was treated in full in Part II, of this series. The storage register (part 8) is needed to transfer the result of the addition from the output of the addition circuit back into one of its inputs. Using these two circuits, the shifted multiples are added one after another as indicated in Table I.

The timing of the circuits is shown in the timing chart of Fig. 3. A good deal of useful information is summarized in this chart.

Successive time intervals, 1, 2, 3, 4, etc., are shown from left to right. The different terminals are shown from top to bottom, together with the relays they energize.

Opposite each terminal, the horizontal line begins at the time when the terminal is energized and stops when the terminal ceases to be energized. For example, the three terminals that energize the K relays T3.1, T3.2, and T3.3 are energized from time 6 to 9, from time 11 to time 14, and from time 16 to 19, respectively. The following parts then complete the multiplication in four similar cycles.

Sections of different horizontal lines are connected by vertical lines showing X's and O's. These vertical lines with their marks summarize the functional relation of circuits. X marks the relays that are energized at a certain time, and O's mark the relay contacts through which these relays are energized. For example, at times 3, 8, 13,

Table I — Multiplication Sequence

Name	Number	Relays
Partial sum	0000000	H to J
1st multiple	0001101	D
New partial sum	0001101	H to J
2nd multiple	0011010	D
New partial sum	0100111	H to J
3rd multiple	0000000	D
New partial sum	0100111	H to J
4th multiple	1101000	D
Final sum	10001111	H to J

and 18, the D relays of circuit 5 are energized by current flowing from terminal T5 through contacts of the A relays and the C relay. For another example, at time 2, terminal T4 is energized, and the C relay is picked up, reading through B relay and K relay contacts. The K contacts at this time have not been energized; but this is correct, because the first multiplier digit has the position 0.

It should be emphasized once more that there are many ways of condensing and improving these circuits. For example, parts 4, 5, and 6 can be combined, and the C and D relays eliminated. But the resulting circuit would have been harder to understand than the separate circuits here shown.

(To be continued)

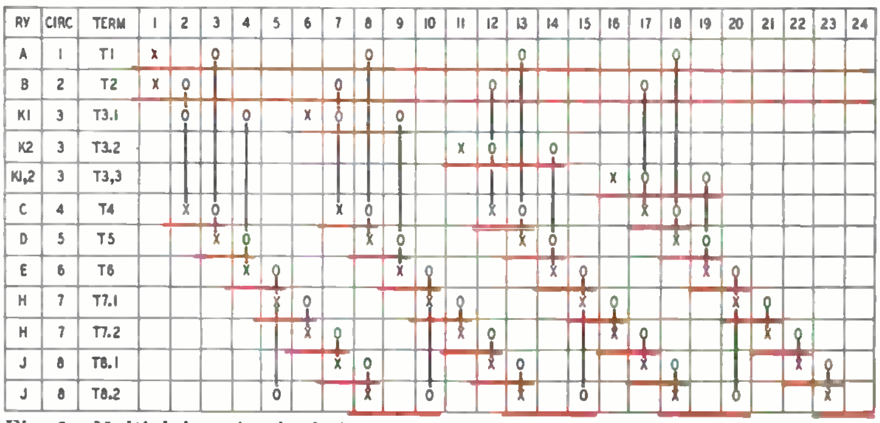


Fig. 3—Multiplying circuit timing chart which shows the sequence of operation.

Electronics and Music

PART VI

A nonresonant frequency divider to make a one-octave instrument cover the whole audio-frequency spectrum

By RICHARD H. DORF*

VERY few electronic musical instruments of the monophonic or melody type are manufactured commercially. The best known is the Hammond Solovox, which uses a system of master oscillator and frequency dividers to obtain its musical range. A complete article will be devoted to the Solovox in a future issue; meanwhile we shall discuss another frequency divider invented by Nicholas Langer (of neon-tube organ fame) and assigned to Central Commercial Co., maker of the Lowrey Organo, which will also be described in a coming issue. The patent describing the dividers is No. 2,486,039, granted in October, 1949.

The complete circuit diagram of a three-stage divider appears in Fig. 1. This circuit takes oscillations generated by a master oscillator at a frequency one octave above the highest note desired in the instrument and derives from that notes of the top and two successive lower octaves. Additional stages may be added to give as many octave divisions as desired. In a monophonic instrument, the master oscillator would have a variable frequency over at least one octave. Depending on the switching system used, the corresponding notes of the lower octaves would then be heard, either one octave at a time or several octaves in unison.

*Audio and Television Consultant

How the divider works

Unlike many divider circuits, this one is aperiodic or nonresonant, and is very nearly independent of actual frequency. It will work over almost the complete audio range without any changes. Circuit constants of the three stages are alike, so that a description of the first suffices also for the others.

The input signal is furnished by a master oscillator which should generate a nonsinusoidal waveform. A sawtooth oscillator would be suitable, as would any other furnishing a wave high in upper harmonics. A neon oscillator would do, but like any other source used, its frequency must be stable. The signal at the input to the circuit of Fig. 1 should have predominantly negative pulse form, which in the case of a sawtooth generator would merely require that polarity be appropriate. If necessary, a crystal rectifier could be placed in the circuit to short out the positive parts of the wave.

C1 and R1 form a simple differentiator circuit. Essentially it is a highpass filter which, when fed a complex wave, tends to remove the fundamental and lower harmonic components and leave only the higher harmonics; the result is a rather sharp waveform.

The triode sections of the first 6SN7-GT form a pair of cross-connected amplifiers. The plate of the second feeds the grid of the first, and the plate of the first feeds the grid of the second. When the unit is first turned on, therefore, and there is no signal, the first slight electron flow in one tube starts the action. Let us assume that this takes place in V1 and that the grid becomes slightly positive with respect to the cathode. There is, then, a small plate-current flow through V1, which makes its plate become more negative. This negativeness is transferred to the grid of V2, decreasing V2 plate current and making the plate more positive. The positiveness is transferred to the grid of V1, adding to the positiveness there at the start. The whole action snowballs in a very short time until V2 is completely cut off and V1 is conducting strongly. At that point, the grid of V1 is receiving the full 150 volts positive which the 150-volt supply is placing on the plate of V2 in the absence of plate current. At the same time it is polarized 100 volts negative by the bias supply. Its net voltage is therefore plus 50 volts, and there the circuit is in equilibrium—V1 conducting and V2 cut off.

Now let us apply a negative pulse from the master oscillator to the input terminals. Passing through the C1-R1

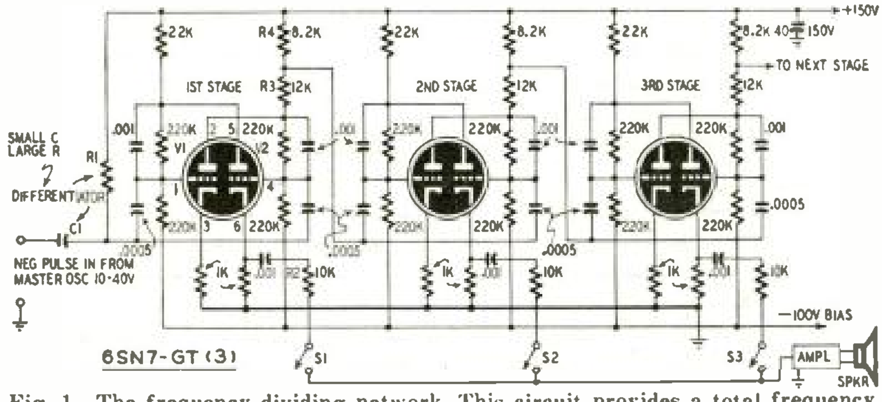


Fig. 1—The frequency dividing network. This circuit provides a total frequency range of three octaves if the master oscillator has a range of only one octave.

network, the pulse is sharpened and transferred through the two 500-μμf capacitors simultaneously to the grids of both triodes. Since V2 is already cut off, it has no effect on V2 plate current. The negative pulse, when applied to the V1 grid, however, reduces the positive potential there, and as a result V1 plate current instantly decreases. The plate of V1 thus produces a positive pulse; transferred to the grid of V2 the positive pulse starts plate-current flow, making the V2 plate negative. The negative voltage at the V2 plate is applied to the V1 grid, assisting the original negative pulse from the master oscillator. Again the action snowballs, until V1 is cut off and V2 is fully conductive.

The next negative pulse from the master oscillator reverses the situation again. It is apparent, then, that each time a negative pulse is applied, the two triodes change states.

The cathode resistors of 1,000 ohms do not change this explanation appreciably. They are there merely to provide an output point of reasonably low impedance which can be connected to outside circuits without harming operation of the divider.

A full cycle of output from a single triode includes one "on" and one "off" of plate current. Since it takes two negative pulses from the master oscillator to make a triode go through this one cycle, obviously the output of the divider is at half the frequency of the master oscillator. Output is taken in Fig. 1 from the cathode of V2 through a d.c. blocking capacitor and a 10,000-ohm isolating and leveling resistor R2.

An additional output is taken from the plate of V1 by effectively tapping down on the plate resistor R3-R4. This output is fed to the grids of the next similar frequency divider, and so on.

Each of the cathode outputs is of substantially square waveshape and contains large amounts of odd harmonics. It may be fed to following amplifiers and tone controls, in which rectifiers may be provided to give some even harmonics.

Switching systems

There are three principal ways in which switching may be arranged with the Langer frequency-divider circuits, though not all of them are suggested in the patent itself.

If the master oscillator itself can be varied over a range of several octaves without losing stability, the scheme of Fig. 1 may be used. Here S1, S2, and S3 select the ranges which are to be sounded. If, for instance, the oscillator covers the top three octaves of the piano keyboard, notes 52 through 88 (see frequency chart on page 42 of the August, 1950, issue), then, if S1 is closed, notes 40 through 76 will be heard. S2 will bring in notes 28 through 64 and S3 will cover notes 16 through 52. The range in which the instrument will work at any given time may thus be selected with the three "stop" switches. Since two or all three of them may also be closed at a time, the player may bring in unisons with a maximum of three octavely related notes at once.

Fig. 2 shows a switching circuit to be used with master oscillators that cover only one octave. Each playing key actuates two s.p.s.t. switches. The lower switches substitute different tuning components in the master oscillator (shown in the figure as a neon lamp). The upper ones connect the output of the correct divider to the amplifier. This is not a very flexible system, as each key will only sound one note at all times. If there are to be more than the three octaves shown in Fig. 2, as many keys as there will be notes in the instrument must be furnished.

A third system, shown in Fig. 3, utilizes nine relays to make a three-octave keyboard effective over a five-octave range when the oscillator is kept within a one-octave variation range. (This latter condition is often necessary for stability with many types of oscillators. Large tuning range and stable operations do not usually go together.)

As in Fig. 2, the lower bank of keying switches tunes the master oscillator over its one-octave range. The top bank, however, energizes relay coils. Three relays each are provided for high, low, and middle ranges. With the high-range selector switches (the lower three-ganged units) closed, pressing any key draws sound from its own frequency divider. With the middle-range switches closed, each key draws sound from a divider giving a tone an octave lower. And the low-range switch sounds the lowest-octave dividers. One, two, or all three switches may be closed at once for unison effects. A system like this will give much the same effect as the Solovox, and as a matter of fact an earlier model of the Solovox did use a relay system somewhat like this one.

The relays must, of course, act quickly and quietly. The diagram provides for 6.3-volt a.c. coils, which might well be amateur keying relays. These may be too noisy, however, and it may be better to substitute some small sensitive relays. These normally operate in the plate circuits of vacuum tubes and require very little actuating current. The gaps being small and the armatures light, they make almost no noise.

With next month's article we shall discuss vacuum-tube tone generator systems for use in polyphonic instruments—those which, like the organ, can produce complete harmony.

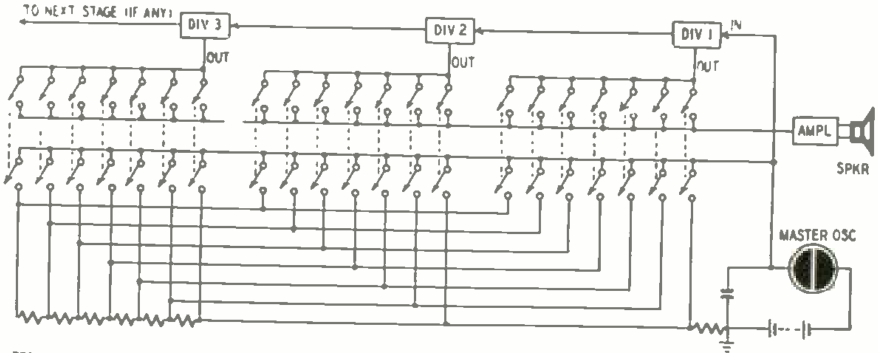


Fig. 2—Switching circuit for a master oscillator that covers only one octave.

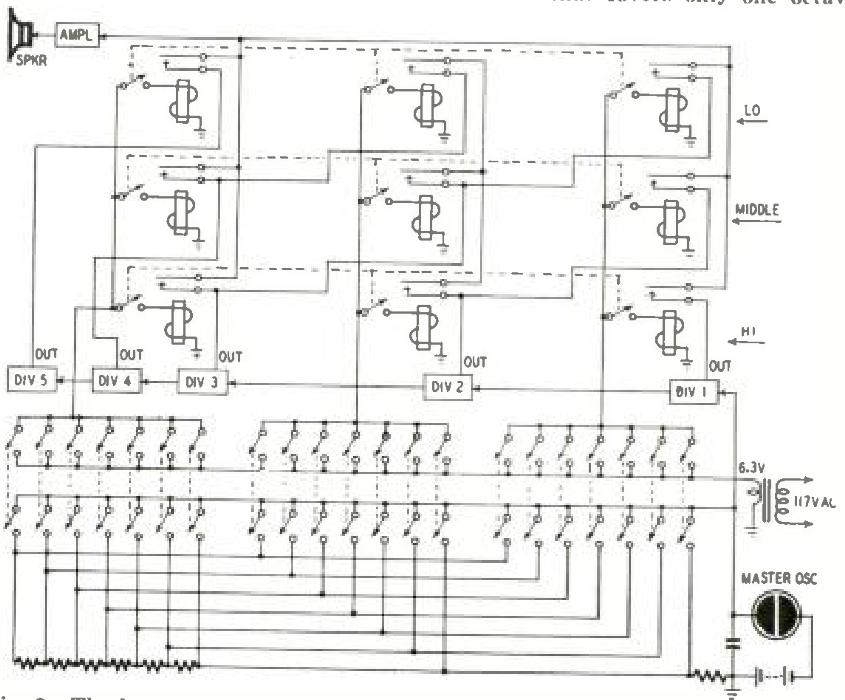
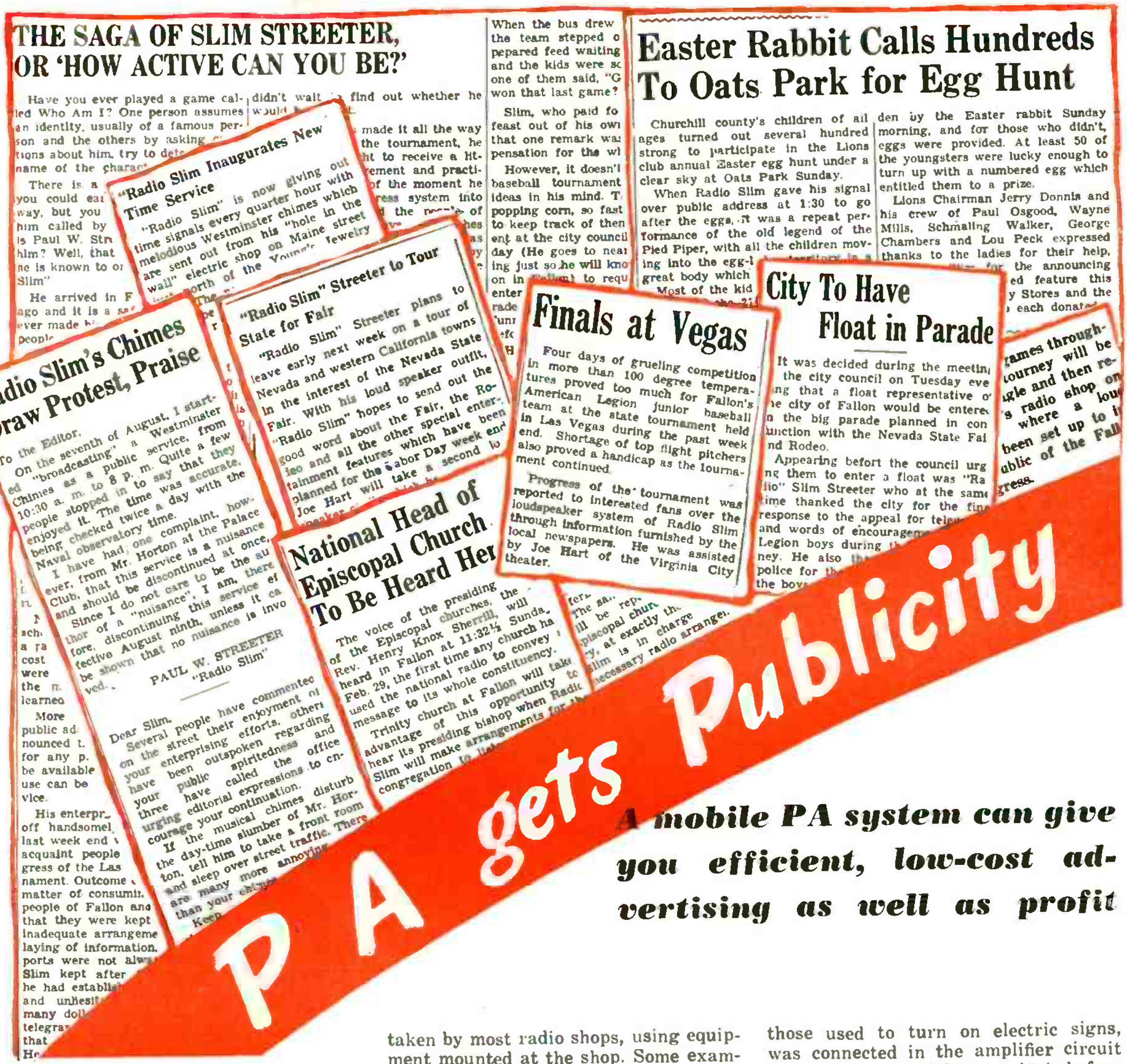


Fig. 3—The lower part of this circuit is like Fig. 2. The relays in the upper part of the figure extend the range of a three-octave keyboard to cover five octaves.



PA gets Publicity

A mobile PA system can give you efficient, low-cost advertising as well as profit

By PAUL W. STREETER

THE postwar boom in radio sales and repairs has definitely declined for many radio shops in smaller towns, and many radio repairmen have turned to increased advertising in various forms tq stimulate sales and repairs. More and more radio shops are using public address systems for advertising, because of their very effective results.

Either direct or indirect advertising is most efficient when the equipment *can be taken to the audience*. For that reason mobile public address equipment installed in a car or truck is unusually effective. Such equipment does not rely on a commercial power source and can be easily moved from place to place as the movements of the audience dictate.

Direct advertising also may be undertaken by most radio shops, using equipment mounted at the shop. Some examples are "broadcasting" ball games; using the equipment with Westminster chimes as a time service; giving chimes or carillon concerts at stated times each day; and playing seasonal music or entertainment such as Christmas carols during the Christmas shopping season. This shop-mounted equipment may also be used with window displays in conjunction with light-cell or capacity-operated relays for unusual, pedestrian-stopping displays.

This writer has used one unique stunt with unusual effect. As a matter of fact, one complete set of PA equipment became permanently immobilized and was not available for any other use, but the results more than justified the expense.

Speakers were placed on the roof of the building, facing in all directions. A Westminster chimes mantel clock was obtained and connected to a 35-watt amplifier with a guitar contact microphone, fastened to the clock case with Scotch tape. A time switch, similar to those used to turn on electric signs, was connected in the amplifier circuit to turn the amplifier on just before 9 am, and off just before 8 pm.

The equipment was placed in a back room, the microphone gain turned up, and comments awaited. They weren't long in coming! They ranged from "ooh's" and "ah's" from old ladies, to nice front page write-ups in both the local papers.

The clock is checked twice a day against standard time broadcasts from WWV, the Bureau of Standards station in Washington, D.C., and is accurate to within 1 second at noon each day. Many clerks in neighboring stores are using the service as a noon whistle!

The Westminster chimes are pleasing, novel, and a source of intense advertising, as everyone within listening distance is reminded four times an hour, all day long, that we are very much in business. Original cost of the equipment is not large, and maintenance is practically nil. Advertising results are tremendous, and we have won a lot of good will.

In addition to the chimes, 15 minutes of recorded carillon music is given each evening just before the motion picture houses open and at 10 o'clock each Sunday morning. These carillon recordings are not expensive and can be obtained in either $33\frac{1}{3}$- or 78-r.p.m. platters. We have about two dozen recordings in stock and have a variety to choose from since only three are played during each evening's concert.

Many shops have made it a practice to have their public address equipment available for community activities at no charge.

One example of this which comes to mind is a parade held recently to publicize a Community Chest campaign being undertaken in the writer's locality. About a month in advance, the parade committee canvassed the merchants (including this writer), asking each to have a float or other entry in the parade. We suggested that we be allowed to "announce" the parade as it passed the judges' stand. Permission was gladly given—those in charge were delighted with the offer, and their whole-hearted cooperation was readily obtained. A letter was secured from them, outlining the permission granted.

We took this letter to one of the local automobile dealers and he agreed to "sponsor" the announcing, and to furnish one of his new demonstrators (with suitable signs, of course), on which we would mount the PA equipment. Other merchants were approached to get information on their entries. This information was for the use of the announcer during the parade.

The chief of police was asked for permission to cruise along the parade route with the sound car before the parade, to entertain the crowd with recorded music, to locate strayed youngsters, to keep the crowd back of the curb line, etc. The event was a great success from every standpoint, and the sponsor wrote out a check for $75 with a big smile the following day. It was well-spent money for him. He reported later that four sales of new cars resulted from the project.

Every event that we handle is followed up in a few days by form letters sent to sponsors and committees in charge of the events, asking for their comments on our performance. Results of these form letters have shown a remarkable similarity—the public address equipment, being mobile, really reaches the public. Sponsors have been shown the value of this kind of advertising, and today we have but to phone a prospect to get him to sponsor an event.

Every effort should be made to communicate with committees in charge of an event as far in advance of the date of the affair as possible. This should always be done by a personal call, never by mail. It must be done to insure that complete arrangements will be made in time to put on a good, intelligent job of announcing.

The chamber of commerce or some leading merchant will want to sponsor programs of Christmas music in the business district during Christmas shopping hours. Re-entrant speakers can be placed on lighting poles along downtown Main Street. Driven by a medium-sized amplifier coupled to an automatic record changer, the installation will require a minimum of attention. The "works" can be placed in the radio shop if it is conveniently located, or in the back of some store on the street. The speakers, with the radio shop's name inside the bell, are sign boards advertising the radio shop all along the street.

Many events of local interest are also the subject of local radio broadcasts. Parades, air shows, rodeos, etc., generally can be used as radio broadcast material. The aggressive public address operator whose equipment is used at any event of this kind will also arrange to carry the broadcast station's announcer on his speakers. Since radio station microphones are sensitive, precautions have to be taken to eliminate audio feedback and echo effects from the PA speakers to the microphone. By placing the equipment in position well ahead of time, these problems can be ironed out easily.

Fairs, races, carnivals, air shows, and other events all have considerable use for public address equipment, announcing, and prior publicity from mobile units. Since most of these events occur during local or national holidays, they can become a source of additional income and will occupy time that will not be put to use otherwise. The announcing of these events can be broken down into three distinct divisions: (a) crowd control before the start of the "doings", (b) announcing the event, and (c) crowd and traffic control afterward. Crowd and traffic control before and after the show is all too often unorganized, with the result that patrons are inconvenienced and traffic hazards ensue.

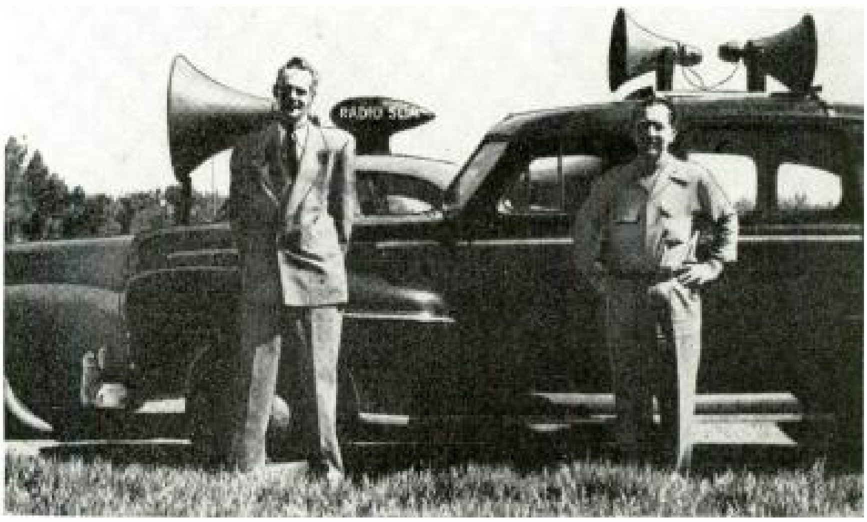
Fire, police and sheriff departments welcome the use of the equipment during emergencies. Every effort should be made to see the local officials to acquaint them with the possibilities of using the equipment in their work. We have been asked to clear streets of parked cars, assist at road blocks, at mounted posse activities, major fires (both in directing firefighters and in traffic control), and to direct traffic at intersections during rush hours.

Many lodges, fraternal organizations, and clubs hold dances periodically that are open to the general public. Committees in charge of the dances invariably had "intended" to get in touch with us. When the chips are down, however, we notice that *we* made the contacts. It is good policy to go after the business—don't wait for it to come to you.

All *good* publicity helps the radio as well as the public address business. It is well to develop a good "mike voice" and personality. Never inject your personal opinions or relate personal experiences over the system. Be factual in announcing events. During a pause in the activities, it is better to turn on a recording rather than try to keep a mike "hot" when there is nothing to talk about. Proper announcing that keeps an audience interested is strenuous work, and a break is welcome.

The most trying problem in PA work is to determine the proper volume level at which to operate the equipment. Too much volume is extremely annoying to the listener. Not enough volume is as bad, since you cannot be understood. For mobile equipment, volume should never be higher than necessary to be heard for one full city block under most conditions, and a lower setting is often desirable. Have someone on the sidewalk check the volume level while the car is in operation.

Always look at it from the listener's angle, and do everything possible to make your announcing a service, not an annoyance. Remember that demands for regulation of public address equipment have only been advanced in communities where no common sense was shown by one or more PA operators. Don't let that happen to you—or your community!



Radio Slim Streeter, left, and assistant with his mobile public address equipment.

PART III

A sample analysis of a well-known circuit—the Williamson amplifier

By GEORGE FLETCHER COOPER

IN THE two previous articles of this series the general principles of design of amplifiers with negative feedback were discussed. The procedure, essentially, is to design the amplifier, test it, not in the solid but on paper, and then modify the design if necessary to obtain the final circuit.

In this article we shall consider a concrete design, and I shall try to emulate the Butcher, who—

. . . wrote with a pen in each hand
And explained all the while in a popular style
Which the Beaver could well understand.
"The method employed I would gladly explain,
While I have it so clear in my head,
If I had but the time and you had but the brain—
But much yet remains to be said."[1]

The Butcher took three as the subject to reason about but I am going to use instead a high-quality amplifier which has received much attention in Europe and which is, I think, fairly well known in the United States. Before going any further I must state that as far as I know this is a jolly good amplifier and any criticism which may appear is only a reflection of the fact that one designer's meat is another designer's *Poissón*.

The circuit is shown in Fig. 1. The output tubes, type KT66, are closely equivalent to the 6L6, although being British they are rather more powerful or are less conservatively rated. If we neglect the feedback for the moment we can consider this circuit as our preliminary design and we can calculate how much feedback is permissible if the amplifier is to remain stable. The original designer has given us all the stage gains, except for the last stage. Here the total load, plate to plate, is 10,000 ohms, so that the peak voltage across the transformer primary must be 173 volts for 15 watts output ($E^2/R = 15$, $R = 10{,}000$, so that E peak $= E\sqrt{2} = \sqrt{30{,}000} = 173$ volts).

Low-frequency response

There are three primary and two secondary factors governing the low-frequency response. The three primary factors are the two resistance-capacitance interstage couplings and the output transformer. At low frequencies the circuit is completely symmetrical, which makes things rather easier. At high frequencies this is not true, because the stray capacitance at the plate of V2 is in parallel with R7 and the impedance of V2, which is high due to the feedback in the cathode resistor R5.

The stray capacitance at the cathode of V2, a different capacitance, is in parallel with the impedance of V2 acting as a cathode follower. This difference could be quite important if the output stage was operating in class B. It is mentioned here merely as an indication of the special difficulties which the high-frequency response presents when compared with the low-frequency response.

Assuming complete symmetry, the primary factors in the low-frequency response are:

1. C3R8 = C4R9 = 0.05 μf × 0.47 meg = 1/43;
2. C6R10 = C7R11 = 0.25 μf × 0.15 meg = 1/27;
3. L/R in the output transformer circuit. Here R is the resistance produced by the load in parallel with the tube impedance. The load, at the primary side, is 10,000 ohms: reference to data sheets shows that the KT66 has an impedance of 1,250 ohms when connected as a triode. The 6L6 is rather higher, 1,700 ohms, but it has a lower transconductance, so that the main effect of replacing the KT66 with the 6L6 is to reduce the gain without feed-

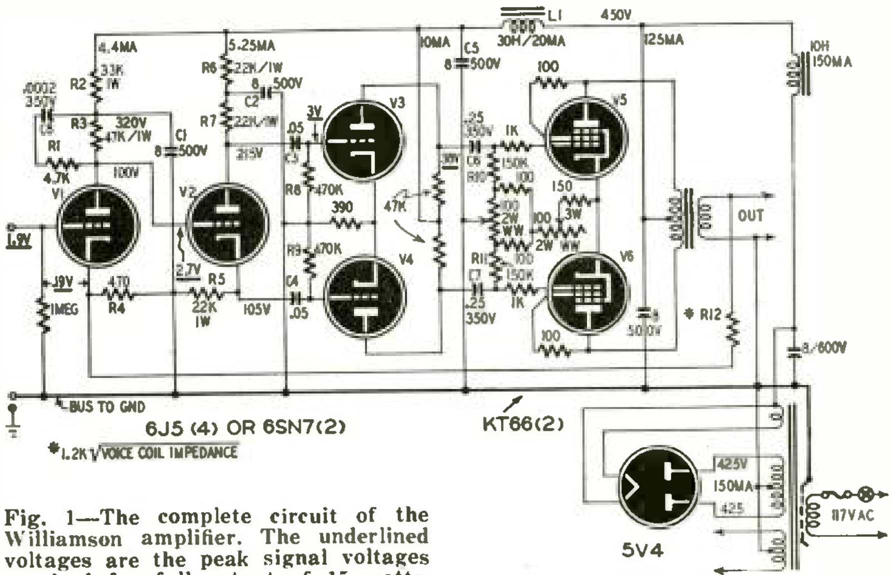
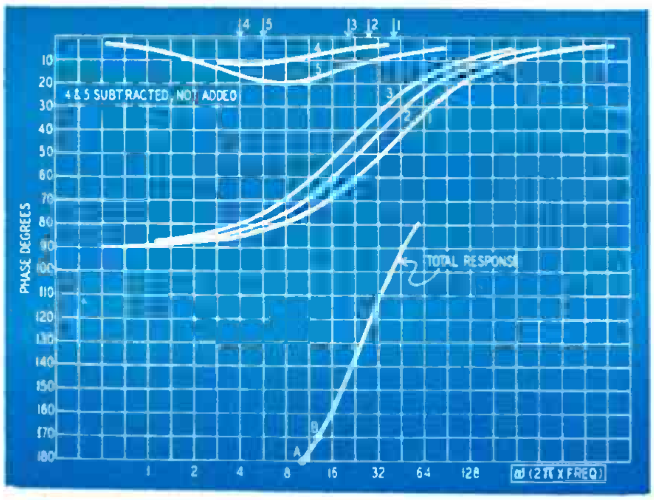


Fig. 1—The complete circuit of the Williamson amplifier. The underlined voltages are the peak signal voltages required for full output of 15 watts.

[1] The Hunting of the Snark, Fit the Fifth, Lewis Carroll



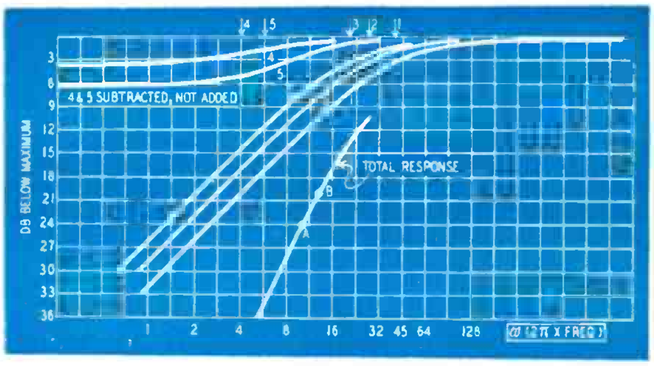


Fig. 2, left—Calculated response curves at the low frequencies of the Williamson amplifier circuit of Fig. 1. Fig. 3, above—The calculated phase characteristic of the amplifier at low frequencies. These curves were plotted by methods described by the author in the second article.

back, and leave the stability about the same as a lower feedback factor.

Two KT66 tubes in series give 2,500 ohms, and this in parallel with 10,000 ohms gives R a value of 2,000 ohms ($1/10{,}000 + 1/2{,}500 = 1/2{,}000$). Using 6L6's, we should have R = 2,500 ohms.

We assume that L = 100 henrics, which gives L/R = 1/20. The choice of 100 h may be because this is the largest inductance obtainable with a reasonable size of transformer, or because we want to keep a very good low-frequency characteristic. In this particular amplifier it was chosen because the designer is doing without an air gap and must allow for the increasing permeability at high flux densities.

The L/R factor must, therefore, be free to increase without equalling either of the R-C factors.

The secondary factors are:

4. C1R2 = 8 μf × 33,000 = ¼; R2/R3 = 33/47 = 0.7;
5. C2R6 = 8 μf × 22,000 = 1/5.7; R6/R7 = 22/22 = 1.0.

These secondary factors cause the response to rise at low frequencies, and thus provide a small amount of phase correction. In the critical region this amounts to 30°, and is, in fact, the feature which keeps the amplifier stable.

The response curves

The individual responses are drawn in Figs. 2 and 3, and the total responses are plotted for the critical region. These responses were plotted by the method described in the previous article, and even drawing them rather carefully to please the editor took only about ten minutes. If the figures are examined, we see that we have a 180° phase shift at $\omega = 10.5$, at which point (A on both curves) the amplitude response has dropped by 24 decibels.

If we wish to have 20 decibels of feedback, we must also consider the phase at the point B, $\omega = 13$. This is 170°. Remembering the definition of margins, we see that the phase margin is 10°, and the amplitude margin is 4 decibels (24–20). The reader will see that these margins are rather narrow.

Two other factors must be taken into account in deciding whether they are safe margins. The first, which may not be very large, is the inner feedback loop produced by the choke L1. At the critical frequencies in the region of $\omega = 10$ (about 2 cycles), C5 is a very high impedance, so that V1 and V2 have a common load in L1. This produces a small amount of negative feedback, which I do not propose to calculate.

The second factor is the increase in inductance produced by any signal in the output transformer. The maximum permeability of the core may be five times the initial permeability, and this will shift curve 3 to the left. The reader can confirm, if he wishes, that this does improve the margins. He can also confirm that improved margins can also be obtained by moving curve 1 to the right, by reducing C3 and C4. In general, stability can always be increased by moving the extreme curve away from the others.

One more factor should be noted. At 10 cycles the response without feedback is only 3 db down. This means that we still have 17 db of feedback at 10 cycles, so that the full distortion-reducing effect of the feedback is in force.

High-frequency response

The calculation of the high-frequency response is never very easy because of the lack of essential data. We shall ignore in the first calculation the circuit C8-R1 connected to the plate of V1. The response is then settled by the shunt capacitances of each stage and by the output transformer. Unfortunately the capacitances depend on the way in which the components are arranged, while the transformer's response may be complicated by resonances between the capacitance of one section and the leakage inductance of another.

Let us plunge in boldly, however, and assume a stage capacitance of 20 μμf. We also have the original designer's figure of 30 mh as the maxi-

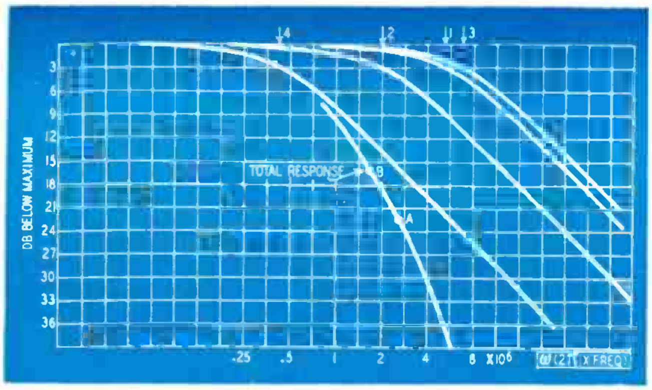
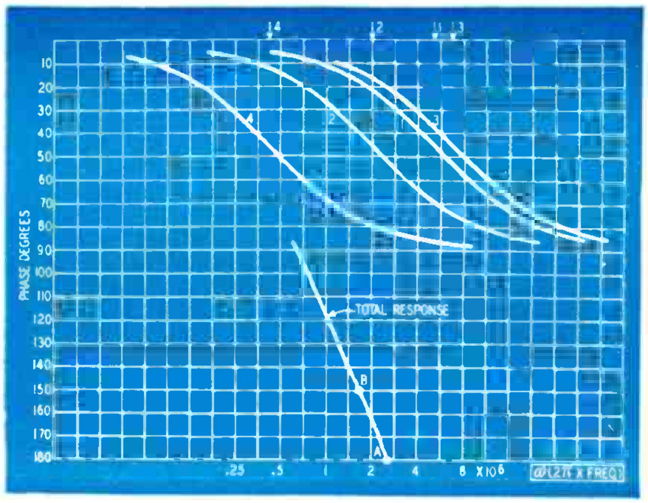
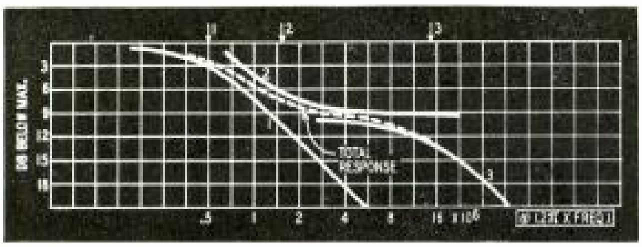


Fig. 4, above—The calculated high-frequency response of the amplifier. At point B the amplitude margin is 6 db. Fig. 5, right—The high-frequency phase characteristic. Maximum feedback for a phase margin of 30° is 16.5 db.





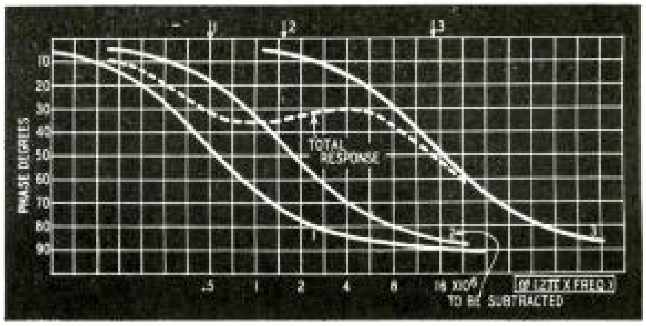


Fig. 6—The high-frequency response of the amplifier including the C8-R1 network. This circuit is added to the amplifier to increase stability at the high frequencies. Fig. 7—High-frequency phase characteristic with C8-R1.

mum leakage inductance, measured at the primary side of the output transformer. The factors controlling the high-frequency response are then, if $C = 20$ μμf is the plate-ground capacitance and R_{v_n} is the impedance of tube V_n, and allowance is made for local cathode circuit feedback:

1. $C \times R_{v1} = 20 \times 10^{-12} \times 10{,}000 = 1/5 \times 10^{-6}$;
2. $C \times R7 = 20 \times 10^{-12} \times 22{,}000 = \frac{1}{2} \times 10^{-6}$;
3. $C \times R_{v3} = 20 \times 10^{-12} \times 7{,}500 = 1/67 \times 10^{-6}$;
4. $L_L/R = 30 \times 10^{-3}/12{,}500 = 1/0.4 \times 10^{-6}$.

These factors give the curves which are shown in Figs. 4 and 5. These were drawn in just the same way as before, using the simple templates, and only the important part of the total response characteristic has been drawn. The phase shift reaches 180° at $\omega = 2.6 \times 10^6$ (f = 300 kc). At this point the amplitude characteristic has fallen by 22.5 db, indicated by the point A in Fig. 4. If we take 150° as the safe limit, we have B, and a maximum feedback is of 16.5 db. The amplitude margin is then 6 db, and the phase margin 30°.

Increasing stability

One way of increasing the stability is to increase the leakage inductance; another is to reduce the stray capacitances, especially that of the first stage. The reader will do well to recalculate these curves for, say, 50-mh leakage inductance and 15-μμf capacitance. In the original version of this amplifier it is clear that the margins were rather small for the use of production transformers, for the circuit C8-R1 has been added. Let us see what this does.

The capacitance C8 is 200 μμf. At a frequency $\omega = 1/C8 \times R_{v1}$, the response of the first stage will start to drop, and it will run down to meet a curve defined by C8 and R1. At still higher frequencies the response will drop owing to the 20-μμf plate capacitance in parallel with R_{v1} and R1. Instead of the curves 1 in Figs. 4 and 5 we will have the curves shown in Figs. 6 and 7. We need the characteristic factors:

$1/\omega_1 = C8 \times R_{v1} = 200 \times 10^{-12} \times 10{,}000 = 1/0.5 \times 10^{-6}$;
$1/\omega_2 = C8$ (R1 and R_{v1} in parallel); $= 200 \times 10^{-12} \times 3{,}000 = 1/1.5 \times 10^{-6}$;
$1/\omega_3 = C$ (R1 and R_{v1} in parallel); $= 20 \times 10^{-12} \times 3{,}000 = 1/15 \times 10^{-6}$.

We could now redraw Figs. 4 and 5, but this would take up too much space for this article, and it is sufficient if we simply compare the curves 1 of Figs. 4 and 5 with the total response curves of Figs. 6 and 7. At $\omega = 2 \times 10^6$, for example, we had a contribution of about 1 db and 20° from the simple circuit, and the addition of C8-R1 has increased the attenuation to 7.5 db and the phase to 32°.

This means that the phase is now just over 180° at this point, and the attenuation is about 26 db. The amplitude margin of 6 db will then allow us to use 20 db of feedback. At $\omega = 1.4 \times 10^6$, the C8-R1 circuit gives us 6 db and 35° instead of 0.5 db and 15°, so that the total response at this point will have a phase shift of 160° and will be 19 db down.

By examining a few more points we can determine the phase margin exactly, but it is a little under 20°. These margins are rather tight; but, as we are making no allowance for the output transformer capacitance and as any assumed capacitance can be in error by ±25% or more, we must not be too critical. In a later article we shall see how to deal with high-frequency instability.

At this point let us look back. We have taken as a design basis the circuit shown in Fig. 1 and have made certain assumptions which have enabled us to draw the amplitude and phase characteristics. These, in turn, showed us that we could apply 20 db of feedback without low-frequency instability, but that we require the stabilizing circuit C8-R1 if the amplifier is not to be unstable at high frequencies. We can also see that, without feedback the response being only 3 db down at 10 cycles, we get the full feedback over this range for the reduction of distortion and intermodulation.

The feedback circuit

One more thing remains to be determined. In the actual design process we must calculate the value of R12 which will give 20-db feedback. Usually, of course, we must just calculate the gain without feedback, but it is assumed that the reader knows how to do this. The designer tells us, or your own calculations will tell you, that the input voltage between grid and cathode for 15 watts output must be 0.19.

We shall ignore the local feedback produced by R4 and assume that with R12 connected we want the gain to drop 20 decibels, making the new input for 15 watts output 1.9. Then we have 1.9 volts from grid to ground, 1.71 volts from cathode to ground, and the necessary 0.19 volt from grid to cathode.

Let us assume that the transformer is designed for a 3.6-ohm secondary load. The 15 watts output then corresponds to $\sqrt{3.6 \times 15}$ volts across the load, or 7.4 volts. My calculations give R12 = 1,570 ohms to produce this required 1.71 volts at the cathode, while the original designer gives 2,200 ohms.

The reason for this discrepancy is the difference in what is meant by 20-db feedback when the main feedback loop also involves a local feedback of 6 db. Two different answers are obtained depending on whether the feedback is removed by disconnecting R12 or by short-circuiting R4 to alternating current with a very large electrolytic capacitor.

In commercial design one more factor needs to be considered. Is the amplifier open-circuit stable? Often we need to have an amplifier switched on, but idle, and, if it operates from a common supply system with other amplifiers, it cannot be allowed to be unstable even when not in use. To test this we must redraw the characteristics for the amplifier with no load on the output transformer. The general question of load impedance will be discussed in a later article.

These calculated response curves are, of course, not the same as the actual measured response curves of the amplifier. We cannot, without a great deal of cumbersome mathematics, account for such things as tolerances of the components, stray wiring capacitance, and a number of other factors. However, most of these items are rather small, and they also tend to average each other out. That is, the tolerances may be either plus or minus.

What we do get from these curves is a very substantial idea of how the amplifier will behave once it is constructed. We immediately see any important flaws in the basic design so that the necessary corrections can be made at no cost of time or parts.

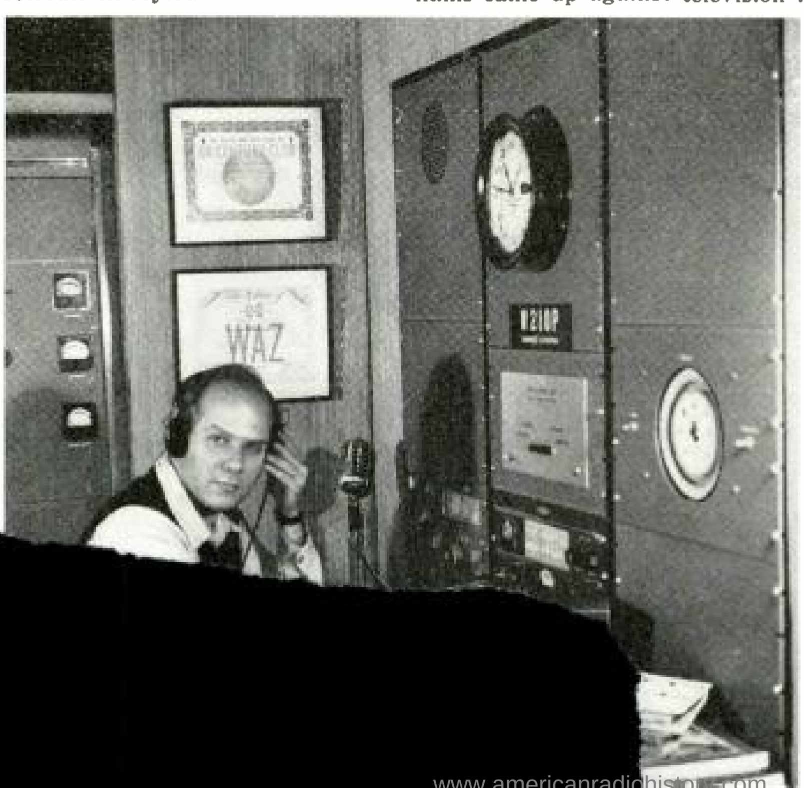
The next article will describe a loudspeaker amplifier designed by the writer. Unlike Mr. Williamson's amplifier, the design is based on a minimum size of transformer, and a comparison of the two designs will show the reader how flexible the design method is in some ways, and how inflexible are some of the restrictions.

Christmas Package for Future Hams

Novice and experienced technician will benefit from two new classes of license proposed by the FCC

By LARRY LE KASHMAN, W2IOP

AMATEUR radio, like the rest of electronics, has come a long way in the past decade. The electronic hobbyist who is not seriously considering getting into the "new" amateur radio may be denying to himself thrills—and opportunities for self-advancement—that few other modern hobbies can offer. The Federal Communications Commission has recognized the importance of radio amateurs to an even greater degree than heretofore and, as a result of this recognition, is wrapping up one of the best Christmas gifts ever presented to the electronic hobbyist.



The era of haywire is gone. The modern radio amateur has taken advantage of the wide availability of good low-priced commercial components, of technical literature never before obtainable, and of over-all advances in the art. The result is that whether the amateur station is low-power or high-power, it usually represents a neat and business-like approach to electronics. But, of course, the hobby has become more complex.

In the postwar period, faced for the first time with a major service harmonically higher in frequency, the hams came up against television interference. TVI was long the scourge of hams operating in television centers, but with their customary doggedness the amateurs are licking TVI and, in doing so, pointing ways of harmonic suppression and interference elimination that are becoming standard.

Along with the rush to get back on the air after the war came a host of new techniques including single-side-band phone, practical microwave communication, and the corollary demand for better and more stable equipment design. To the newcomer without technical training the past and current knowledge added up to an almost insurmountable barrier. It almost seemed that the hobby was degenerating into a plaything for engineers. For the technician anxious to experiment with some of the war-born developments and continue their development as a hobby, much of the paraphernalia required for "standard" operation seemed like unnecessary work. So the technician stood on the sidelines, not making his engineering contributions to one of the best hobbies in the world. The Christmas package is for the bewildered novice and the advanced engineer.

Why amateur radio?

Everyone who has had an opportunity to work in amateur radio, or with amateurs, has benefitted from this experience. as have the military services, the entire electronics industry, and virtually every community in the country at one time or another. The problem facing amateurs and their supporters is how to nurture the continued growth of amateur radio in the face of its new-found complexities. One solution is the proposal creating two entirely new classes of amateur license. These licenses, when they are finally enacted into law, will mark the beginning of a

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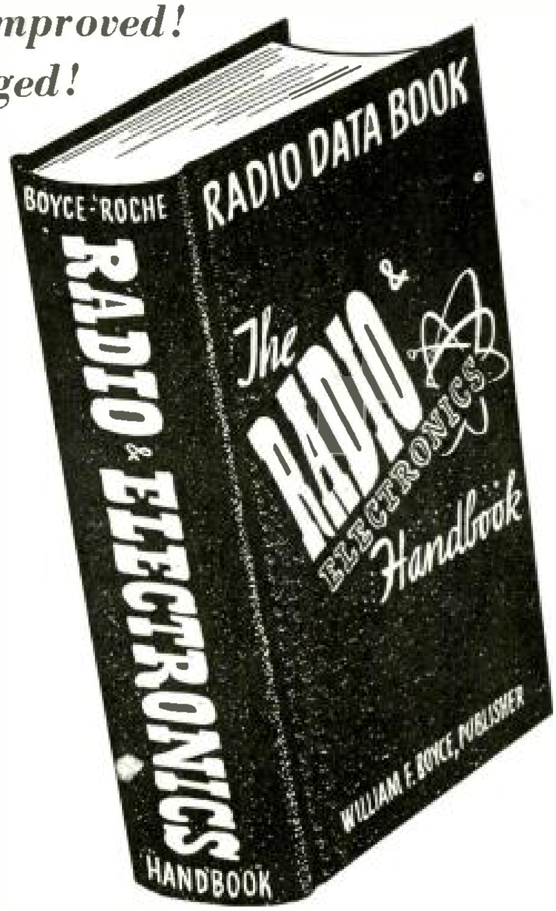

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require only minimum knowledge—knowledge anyone capable of understanding fundamental electricity could easily assimilate.

The novice license will literally lead potential hams by the hand into the fold. It will make possible the practice of code in actual communication on the air, a method greatly superior to ordinary code practice. In a matter of weeks, knowledge and experience can be gained that by any other method might take months. Technical terms which might be meaningless in a book will become very real. The novice license will be of limited duration, but long enough to permit advancement from its simple requirements to the somewhat more complex examination of the standard amateur grade.

Welcome technician

The technician's license on the other hand will be for the "noncommunicating" amateur. It is created primarily to permit the pure experimenter to get on the air without the formality of a code examination. Operation permitted by the technician's license will be limited essentially to the ultra-high frequencies, where much pioneering remains to be done. The new amateur, who will qualify for these technician licenses, promises to bring into the radio hobby much talent and knowledge that will prove useful to all hams, regardless of their particular interest. It opens to many fine technical men the opportunity to participate in amateur radio on the basis most compatable with their personal interests. It brings men into fields which require additional participation.

What about the potential amateur who says to himself that all of the new license requirements are very fine—but, "The hobby is still too complex and too costly for the average pocketbook?" These are the people who apparently have not kept up with the hobby.

Certainly it *is* possible to spend thousands of dollars to get on the air. But the average ham operating has a very modest investment in his equipment. A good communication receiver, for example, can be purchased between $100 and $200. Stack up that against a TV receiver for value. An excellent transmitter—one capable of world-wide communications—can be put on the air for under $100. There are many amateurs on the air with good signals and having a whale of a fine time with a total investment of under $100.

Amateur radio is like any other hobby. You start gradually and build up your equipment as time passes. Furthermore, one of the most important parts of a radio station frequently can be constructed at the least cost. The antenna system is a great "leveler" in ham radio. A properly designed and installed radiating system can give signal gain of many times. Thus, the 100-watt signal can be multiplied in effectiveness to 500, 1,000 watts and even more. It doesn't make much difference whether the original signal came from a modest basement shack feeding a well-designed antenna system or from a millionaire's palatial mansion feeding a piece of bailing wire. All the receiver can do is pick up the two signals. The best one is going to be the loudest. And, while it is true that high-gain antenna systems are desirable, don't be misled into thinking that a simple dipole won't work.

What it all adds up to is that, while electronics has become increasingly complex and while the ham is constantly adding to his store of knowledge, it is still possible to get on the air and enjoy the many advantages of ham radio without being an electronic expert—without investing a tremendous amount of money and without sacrificing any of the enjoyment. The new FCC licenses just make it that much easier for that many more people to get into the swim.

Plus benefits

What are all these "benefits" we talk about? Of course, there is the natural self-interest that motivates every hobbyist. He is looking for some relaxation. Whether you get your relaxation and enjoyment by working with your hands and building a fine new piece of equipment or from operating, there is no hobby that can rival ham radio. But ham radio offers something that few other hobbies do. It offers the individual an opportunity to add to his own knowledge—to improve his education—and, as a direct consequence, to improve his stature in our economy. There are many successful technicians and even engineers whose only formal training has been through amateur radio. There are many individuals whose mark in life was not very bright until sparked by the knowledge gained through amateur radio.

In almost every great national emergency whether it has been a flood, a tornado, or a world holocaust, the hams have served their community with distinction. Few hobbies offer such an opportunity of service. The hobby offers a fraternity among men and women which is virtually unknown in any other group, because hams can talk to one another over great and small distances on what amounts to private communications channels. They meet other hobbyists in a far more intimate manner than, say, the group whose only common meeting place is an official publication or an occasional convention. And, of course, amateur radio, through its very nature, is a leveler of men because bankers and students, doctors and mechanics talk to one another on the ham bands without regard for the usual social barriers.

What it all sums up to is the irrefutable fact that amateur radio can offer more thrills and more opportunities than any other facet of electronics. And now, for the first time, participation in the hobby is being made so simple that anyone with just a little fundamental interest can get started. Amateur radio might be compared to any gift which keeps on giving, because the benefits are truly endless.

40-METER M ANTENNA

By JEROME MASLOWSKI, W8LKM

A ham for 15 years, the author has put up many so-called sky hooks. Most of these have been quarter-wave and half-wave antennas suitable for operating on 40 and 80 meters.

While trying out other antennas, a folded dipole was put up as a receiving antenna in the attic where it would not be too close to the transmitting antenna. One night after trying many calls and just not getting out, this folded dipole was hooked up to the transmitter and the results were surprising.

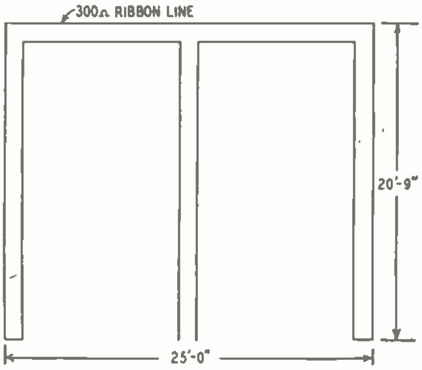

Fig. 1—Dimensions of the M antenna.

The antenna in the attic had to be put up in an M shape because of the lack of space. An antenna may be bent to fit a restricted space if the bend does not exceed ⅛ wavelength at each end.

In this case the bend was more than that. According to the books this reduces the efficiency of the antenna, and having it in the attic doesn't help any. Nevertheless, this antenna outperformed any the author has ever set up.

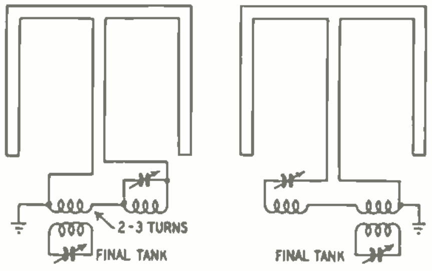

Fig. 2—Two ways to connect the feeder.

Dimensions for the antenna for the 40-meter band are shown in Fig. 1. Made of 300-ohm ribbon line, it may be suspended in any convenient way. The feeder can be any suitable length and should be coupled to the final tank with a tuned and grounded coupling coil. The tuning may be either series or parallel as shown in Fig. 2.

The dimensions given should give good performance on the 40-meter band, and, once tuned, will cover the band.

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Hi-Fi AM Tuner and Amplifier

By D. V. R. DRENNER

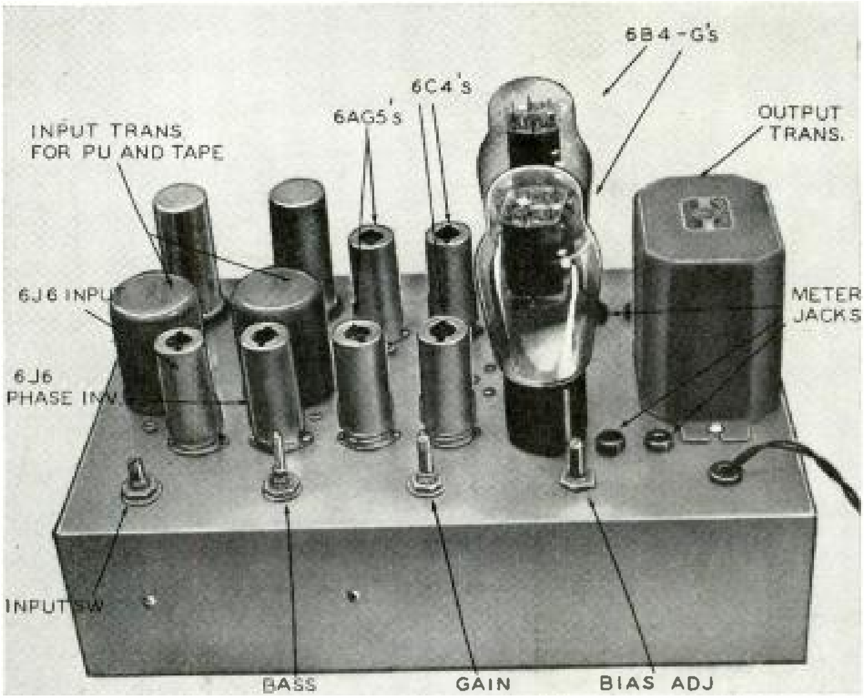


Photo of the amplifier. The two input transformers on the left are for a tape recorder and low-impedance pickup. They do not appear in the schematic diagram.

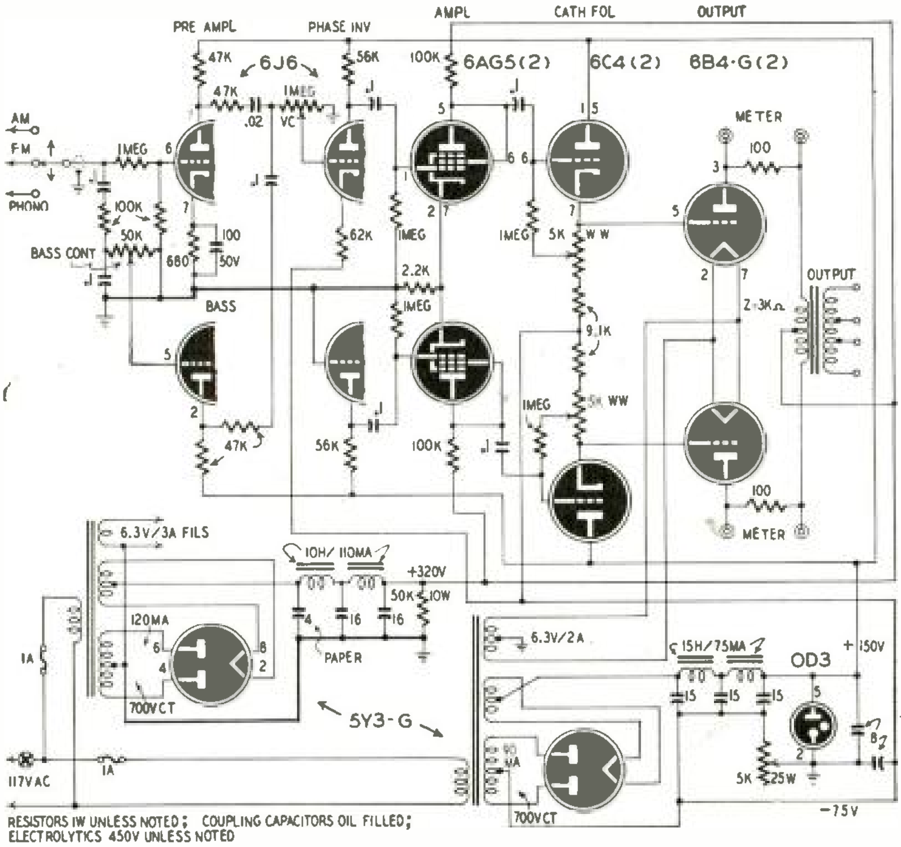


Fig. 1—The schematic of the all-triode amplifier. Although some of its circuits are rather unconventional, it is an excellent amplifier for good audio systems.

PART II

THIS amplifier, a companion for the AM tuner described last month, is a good high-fidelity unit. Although it departs from the conventional in many respects, it has no fancy hard-to-adjust features. A frequency run with a Hewlett-Packard oscillator and a G-E VU panel shows it to be flat within 1½ db, 20 to 20,000 cycles. The output transformer governs the frequency response, and that depends on what the pocketbook will stand. Fig. 1 is the schematic of the amplifier.

Except for the output tubes, all stages use miniatures. The phase inverter stage—a 6J6 duo-triode—is cathode-coupled; so you don't have to juggle resistors. The only transformer in the amplifier is in the output stage. The final tubes are driven by cathode followers for low driving impedance and a good way to adjust the balance of the final stages. The 6AG5's are triode-connected to make the whole amplifier triodes from input to output! That should satisfy even the most rabid "triodes-are-best" boys.

The first 6J6 is a preamplifier to drive the phase inverter and also an electronic bass-boost stage. The mathematics of the bass-boost stage get rather complicated, but the values shown make it perform well.

The second 6J6 dual triode is the cathode-coupled phase inverter. The grid of one section is fed the audio signal, and the other grid is grounded. The cathodes, being tied together, work in unison. Both plates also vary as the input signal varies, but the signal outputs are 180° out of phase. It's a neat scheme that works nicely. Since the 6J6 is a high-mu triode, good stability and low hum level are important. The phase inverter stage must be shielded with a miniature spring-loaded tube shield to minimize microphonics which 6J6's often develop. The a.c. circuits should be carefully laid out to keep hum pickup low. With these precautions the 6J6 performs well. This type of phase inverter shows no aging effects, as is often the case with other inverter circuits.

The next stage uses two 6AG5's, triode-connected, to drive the 6C4 cathode followers. The fixed bias for the final tubes is fed through the cathode loads of 6C4's; and, by varying a portion of this voltage on the 6C4 grids, the bias can be adjusted so the signal in the final output tubes is balanced.

In the final stage either 6B4-G's or 6A5-G's is can be used. When this amplifier was built, the 6A5-G wasn't available, but it is preferable because the cathode-type construction further reduces hum.

Cathode bias can be used, but the fixed bias gives increased output and keeps the bias voltage constant under all plate conditions. This bias voltage is stabilized by an 0D3 regulator tube.

For an output transformer you can take your choice. If you want the ultimate in performance, use one of the best quality transformers, so long as it loads the tubes with 3,000 ohms.

The physical layout of the amplifier can take almost any form, provided the usual wiring precautions are observed. Run the a.c. wiring close to the chassis and so that no ground loops are formed. A common-ground bus is better than the usual chassis ground.

While separate chassis were used for the amplifier and for the two power supplies, both could be on the same chassis if the power transformers are mounted away from the input stages. The input operates at relatively low level and has high gain; stray fields are apt to raise the output—of noise!

With a 15-inch speaker bass reflex cabinet or a woofer-tweeter combination, this amplifier will deliver 15 watts of low-distortion, high-fidelity amplification from a tuner or phono pickup.

The author wishes to acknowledge the assistance of D. W. Gillette in the design of this equipment.

Materials for Amplifier

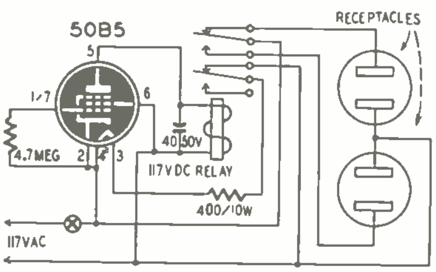
Resistors: 2—100, 1—680, 1—2,200, 2—9,100, 4—47,000, 2—56,000, 1—62,000, 4—100,000 ohm, 5—1 megohm, 1 watt; 2—5,000, 1—50,000 ohm, 1—1 megohm **potentiometers:** 1—5,000 ohm, 25 watt; 1—50,000 ohm, 50 watt.

Capacitors: 2—0.1 µf, 400 volt, paper; 1—.02, 5—0.1 µf oil filled; 1—4 µf, 600 volt, paper; 2—8, 5—16 µf, 450 volt, 1—100 µf, 50 volt, electrolytic.

Miscellaneous: 1—350-0-350 volt, 90 ma, 1—350-0-350 volt, 120-ma power transformers with filament windings; 2—10 h, 110 ma, 2—15 h, 75 ma chokes; 1—output transformer, 3,000 ohm primary; 2—6J6, 2—6AG5, 2—6C4, 2—6B4-G or 6A5-G, 2—5Y3-GT, 1—0D3 tubes with sockets; 2—1-amp fuses and holders; chassis, hookup wire, switches, assorted hardware.

BLINKER CIRCUIT

A blinker circuit was required to control two strings of lights which were to blink on and off at approximately 5-second intervals. Standard bimetallic blinkers could not be used because one string had to light at the instant that the other went off.



Designed around a d.p.d.t. relay and a 50B5 tube, this blinker does the job. The heater is connected across the line in series with a 400-ohm dropping resistor and one of the normally closed contacts of the relay. As soon as the tube heats up, it conducts to open the heater circuit and switch the lights. The relay remains closed until the charge has leaked off the capacitor. The relay then opens to begin a new cycle.—*Albert Szemyak*

HIGH-EFFICIENCY CRYSTAL RECEIVER

By ROBERT E. KELLEY

The crystal detector offers no hope as an amplifier (disregarding such related devices as the transistor). The experimenter must increase the signal input to a maximum for maximum output to the load. The more input to the crystal detector, the more output over the linear range of the crystal.

Many tuned antenna and input coupling systems have been devised to improve the input signal level and, in some cases, the selectivity. The simple input circuit given here illustrates the improvement obtainable with a good load-coupling circuit.

The tuned circuit L2-C1 (Fig. 1) should present an infinite impedance at resonance under ideal conditions. Never obtained of course in practice, it is approached if a high Q coil is used with proper antenna matching and impedance matching. The crystal headphones, on the other hand, offer relatively low impedance to r.f.

To get a good match, simply tap the crystal lead to the coil L2 at the point where maximum current flows in the load circuit. The tap may be adjusted by tuning in a station and adjusting for maximum volume or for maximum indication of a microammeter in the output circuit.

With ordinary headphones (about 2,000 ohms impedance) the author was able to read 18 µa of rectified d.c. with the crystal lead tapped at the top of the coil. By adjusting the crystal lead to about three-quarters of the way toward the bottom of the coil, the reading was increased to 280 µa. Both volume in the phones and selectivity were increased tremendously.

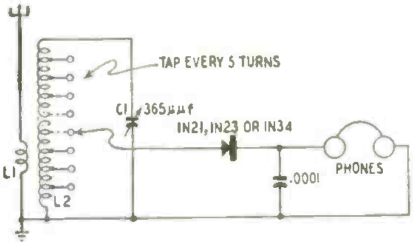


Fig. 1—Hookup of the crystal receiver.

The explanation for this is simply that matching the impedance of the load circuit to the very high impedance of the tuned circuit gives a much higher effective Q and better power transfer to the load.

By using the variable tap, any reasonable load (500 to 20,000 ohms) may be matched to the tuned circuit simply by adjusting the tap for maximum current in the load. High impedance loads will have lower meter readings than low impedances. The meter readings are significant only as comparisons on the same or similar load impedances.

The coil L1 is 16 turns of No. 30 enameled wire on a 1½-inch diameter form. L2 is 95 turns of No. 30 enameled wire on a 1½-inch diameter form and is tapped every five turns.

4 Pages of TEST EQUIPMENT at prices every serviceman can afford!

MONEY BACK?

Every single unit described on this and the following pages is offered on a strict "money-back-if-not-satisfied-basis." No if's—no but's—no maybe's. Simply send your order for any unit or units you select and try them out for 10 days. If not completely satisfied—return for refund in full. No explanation necessary. You are sole judge.

GUARANTEE?

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We have discontinued advertising TEST EQUIPMENT in Kit form. The units offered on these 4 pages are completed instruments, NOT KITS! Every model is factory-wired, calibrated and ready to operate.

TUBE TESTERS

Important Note: The two models described below include slip-on portable hinged covers. This is a very desirable feature in Tube Testers because the multiple switches used on such units indicate properly only when clean. The slip-on covers insure long life because the front panel, including all switches, is fully protected when the instrument is not in actual use.

THE NEW MODEL 247

Check octals, loctals, bantam jr., peanuts, television miniatures, magic eye, hearing aids, thyratrons, the new type H.F. miniatures, etc.

Features:

★ A newly designed element selector switch reduces the possibility of obsolescence to an absolute minimum.

★ When checking Diode, Triode and Pentode sections of multi-purpose tubes, sections can be tested individually. A special isolating circuit allows each section to be tested as if it were in a separate envelope.

★ The Model 247 provides a supersensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals.

★ One of the most important improvements, we believe, is the fact that the 4-position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test.

$29.90 NET

Model 247 comes complete with new speed-read chart. Comes housed in handsome hand-rubbed oak cabinet sloped for bench use. A slip-on portable hinged cover is indicated for outside use. Size: 10¾"x8¾"x5⅛". ONLY

SUPERIOR'S NEW MODEL TV-10

Specifications:

★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, Peanut, Bantam, Hearing-aid, Thyratron, Miniatures, Sub-Miniatures, Novals, etc. Will also test Pilot Lights.

★ Tes s by the well-established emission method for tube quality, directly read on the scale of the meter.

★ Tests for "shorts" and "Leakages" up to 5 Megohms.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TV-10 as any of the pins may be placed in the neutral position when necessary.

★ The Model TV-10 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes.

★ Newly designed Line Voltage Control compensates for variation of any line voltage between 105 Volts and 130 Volts.

The Model TV-10 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

$39.50 NET

TO ORDER—TURN TO PAGE 56 FOR RUSH ORDER FORM

GENERAL ELECTRONIC DISTRIBUTING CO.

DEPT. RC-12, 98 PARK PLACE NEW YORK 7, N. Y.

1

BUY WITH CONFIDENCE!!

WE KNOW THE PRICE IS UNBELIEVABLY LOW,

but that's not all! In addition, this finely engineered instrument provides a degree of accuracy never before attained in a unit selling for even double this price. Furthermore—in designing this unit, we took advantage of every recent improvement in components. For example, by using slug-tuned coils, we are able to efficiently adjust each instrument for perfect accuracy. This feature will also enable you to recalibrate the model 200 periodically without having to return it to the factory. The use of a Noval tube (the 12AU7) with its extremely low inter-electrode capacity enabled us to reach a higher frequency range than was heretofore possible in a unit of this type.

THE NEW MODEL 200 **AM and FM**

SIGNAL GENERATOR

SPECIFICATIONS

★ **R.F. FREQUENCY RANGES:** 100 Kilacycles to 150 Megacycles.

★ **MODULATING FREQUENCY:** 400 Cycles. May be used for modulating the R. F. signal. Also available separately.

★ **ATTENUATION:** The constant impedance attenuator is isolated from the oscillating circuit by the buffer tube. Output impedance of this model is only 100 ohms. This low impedance reduces losses in the output cable.

★ **OSCILLATORY CIRCUIT:** Hartley oscillator with cathode follower buffer tube. Frequency stability is assured by modulating the buffer tube.

★ **ACCURACY:** Use of high-Q permeability tuned coils adjusted against 1/10th of 1% standards assures an accuracy of 1% *on all ranges from 100 Kilocycles to 10 Megacycles* and an accuracy of 2% on the higher frequencies.

★ **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.

The Model 200 operates on 110 Volts A.C. Comes complete with output cable and operating instructions.

$18.85 NET

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2

GENERAL ELECTRONIC DISTRIBUTING CO.

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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!

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

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CUT OUT AND MAIL TODAY!

4

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TOTAL

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Address ....

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3-TUBE RECEIVER FOR WIRED RADIO

By RUFUS P. TURNER

Many hobbyists do not care to obtain amateur radio licenses but wish to enjoy the fun of two-way radio communication over the power lines, wire fences, telephone lines, metal clothes lines, etc. Here is a compact, sensitive wired-radio receiver that the beginner will find easy to build and put into operation. A companion transmitter will appear in an early issue.

To keep within the law, the power output of a carrier current transmitter must be kept low. Its frequency is generally below the broadcast band to prevent radiation and interference with nearby broadcast receivers. For this reason receiver sensitivity must be fairly high. When amateur stations were shut down during the last war, carrier current experimenters tried various types of low-frequency receivers. These tests proved that a hot regenerative receiver is entirely satisfactory for amateur wired radio and in many cases will give a homemade carrier current superhet receiver a run for its money.

This small-sized 3-tube set is complete with a.c. power supply. Its single tuning range is 95 to 400 kc. Loudspeaker operation is provided. The receiver uses parts which are easily obtained, and takes little table space. Its cabinet measures only 11 x 7 x 7¼ inches. It has three controls. One dial takes care of all tuning. The only other adjustable items are the volume control and regeneration control. The setting of the regeneration control has little effect on the dial calibration.

A STANDBY (or TRANSMIT-RECEIVE) switch is provided so the receiver may be shut off during transmitting intervals without turning off the tube heaters. A second ON-OFF switch interrupts the power line to shut off the entire receiver.

Regeneration control is smooth and covers a wide range. Regeneration may be eliminated entirely by turning the regeneration control potentiometer all the way down—the receiver then operates as a simple non-regenerative detector and one-stage power amplifier—or it may be increased to maximum where oscillation begins. Between these two extremes there is a wide range of receiver sensitivity to suit all manner of reception conditions.

Fig. 1 is the schematic of the receiver. A special three-coil coupler L1-L2-L3 provides input coupling and inductive feedback. The grid coil L2 is one coil taken from an old 455 kc i.f. transformer.

The other i.f. coil is removed from the wooden dowel on which the two are mounted. The input coil L1 is 15 turns of No. 26 d.c.c. wire closewound around the dowel and separated from L2 by about ⅛ inch as shown in Fig. 1. The tickler coil L3 is the largest honeycomb pie from a National type R-152 transmitting r.f. choke. This pie is cemented flat to one face of L2. A long *brass* machine screw passed through the center hole of the dowel holds the three-coil coupler to the receiver chassis.

The input coil L1 connects directly to the signal input terminals. If the receiver input is connected to the power line, use the fuse-protected coupler shown in Fig. 2 to prevent burning out L1. This isolating unit is not needed when the conducting line carries no high voltage. A pair of 600-volt paper capacitors will then be sufficient.

The tuning capacitor C1 is a two-section midget broadcast-type unit with 365 μμf per section. The trimmers are removed and the two sections are connected in parallel by a short jumper for a total capacitance of 730 μμf. The vernier tuning dial is a National type AM.

Testing and calibration

After the wiring is completed and inspected, connect the loudspeaker, set the regeneration control to zero, the volume control to maximum, and the standby switch S1 to off. Allow about 3 minutes for the tubes to heat. Close switch S1 and slowly advance the regeneration control. At one point in this adjustment a dull thud or pop should be heard as regeneration begins. As the control is advanced still further, a steady rushing noise should begin and should be followed by a loud whistle that indicates oscillation. If you do not get these effects, reverse the connections of tickler coil L3 and repeat the test. With the receiver oscillating, run the volume control through its range, to check volume control action.

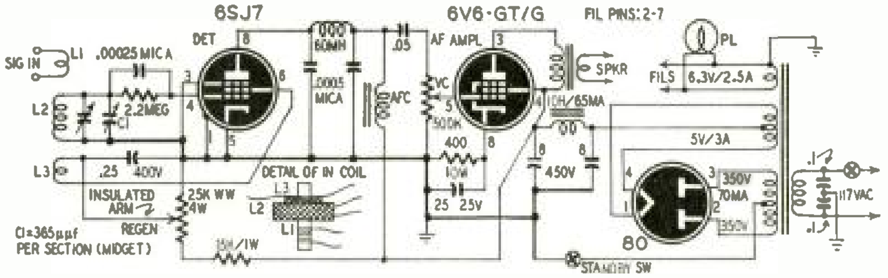
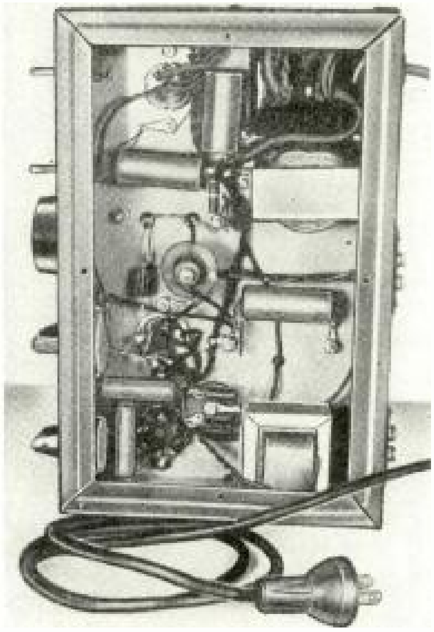


Fig. 1—Circuit of the little 3-tuber. Its tuning range is from 95 to 400 kc.



Underside of the wired-radio receiver.

To calibrate the receiver, connect an amplitude-modulated signal generator or test oscillator to the signal input terminals of the receiver. Set tuning capacitor C1 to maximum capacitance and set the signal generator for 95 kc. Adjust the generator output for a fairly strong modulated signal, advance the volume control to maximum, and advance the regeneration control about one quarter of maximum. If the receiver tunes to 95 kc at considerably less than full capacitance of C1, remove a few turns from grid coil L2. Advance the receiver dial a few divisions at a time, following with the signal generator. The completed calibration will be very nearly identical with the data given in the chart. Always use the minimum regeneration which will sensitize the receiver sufficiently to pick up good signals.

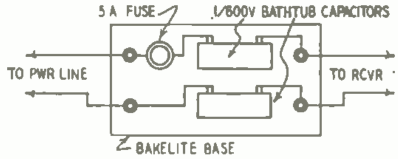


Fig. 2—Fused coupler for the receiver.

CALIBRATION DATA

Dial Setting	Frequency (kc)
0	400
10	360
20	295
30	240
40	205
50	175
60	148
70	130
80	115
90	105
95	100
100	95

Materials for receiver

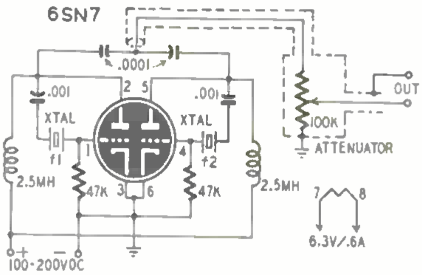
Resistors: 1—2.2 megohm, ½ watt; 1—15,000 ohm, 1 watt; 1—25,000 ohm, 4 watt, wirewound potentiometer with insulated contact arm; 1—500,000 ohm potentiometer; 1—4000 ohm 10 watts.
Capacitors: 1-250 μμf silver mica; 2—500 μμf mica; 1—.05, 2—0.1, 1—0.25 μf, 400 volt, paper; 2—8 μf, 450 volt, electrolytic; 1—25 μf, 25 volt, electrolytic;
Miscellaneous: 1—audio frequency choke, 1080 h; 1—radio frequency choke, 60 mh; 1—universal output 1—2-gang midget variable, 365 μμf per section; 1—transformer to match 6V6-GT/G; 1—power transformer, 350-0-350 v at 70 ma, 5 v at 3 a, 6.3 v at 2½ a; chassis, vernier dial, tubes, sockets, hookup wire, switches, miscellaneous hardware.

HETERODYNE SIGNAL GENERATOR

There are many uses around the hamshack or service bench for this crystal-controlled heterodyne signal generator. A few standard parts, a dual triode, and the readily available surplus military-type crystals make the device inexpensive.

Each section of the 6SN7 operates as a Pierce oscillator. Their outputs are mixed in the plate circuits, resulting in four possible output frequencies: f_1, f_2, $f_1 - f_2$, and $f_1 + f_2$. It is especially valuable as a substitute for low-frequency crystals in the broadcast and i.f. channels.

By judiciously selecting the crystal frequencies, a number of useful frequencies can be generated. For example, one extra crystal will give five additional frequencies. A total of four crystals will provide 16 different frequencies.



Although the output is shown feeding into an attentuator circuit for signal generator service, any one of the four frequencies has sufficient strength to drive to full output a 6L6 or 6V6 buffer or doubler stage in a transmitter.

This circuit was developed to drive a carrier-current transmitter with 807's in the final at KHSM (St. Mary's College) on 880 kc from available 7-mc crystals of suitable frequencies. The same circuit has since proven its worth as a test oscillator on the bench, being a source of crystal check points throughout the spectrum by using various combinations of crystals.—*Robert D. Oliver, W6SPF*

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) of RADIO-ELECTRONICS, published monthly at Philadelphia, Pa., for October 1, 1950.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Radcraft Publications, Inc., 25 West Broadway, New York 7, N. Y.; Editor, Hugo Gernsback, 25 West Broadway, New York 7, N. Y.; Managing Editor, Fred Shunaman, 25 West Broadway, New York 7, N. Y. Business Manager, none.

2. The owner is: Radcraft Publications, Inc., 25 West Broadway, New York 7, N. Y.; H. Gernsback, 25 West Broadway, New York 7, N. Y.

3. The known b ndholders, mortgagees, and other security holders owning or holding 1 percent or more of total am unt of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and cond'tions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

H. GERNSBACK, Publisher.

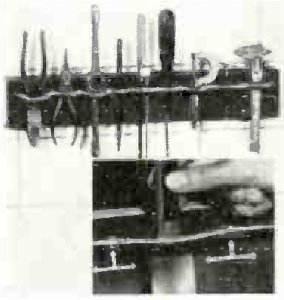
Sworn to and subscribed before me this 28th day of September, 1950. [Seal] Maurice Coyne, Notary Public. (My commission expires March 30, 1952.)

TOOL HOLDER

Hobby Hill
Chicago, Ill.

Called the GRIP-R, this tool hanger consists of a 22-gauge open end metal shell 18 inches long 2¾ inches wide, and ⅝ inch thick. Running along the entire length of the shell is a series of slots for holding sliding ring clips. Directly in front of the line of slots is a 5/16-inch plated coil spring which is held in place by the sliding ring clips, and at each end are screws for wall mounting.

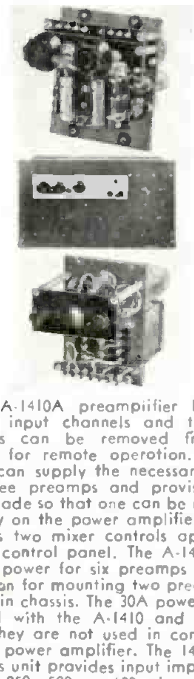
All types of tools, with or without handles, are held on the rack merely by slipping them under the coil spring. The sliding ring clips can be adjusted to the size of the tool. The tension in the coil spring holds the item securely and yet allows easy removal.



AUDIO AMPLIFIERS

Altec Lansing Corp.
Beverly Hills, Cal.

This group of amplifiers, the 1400 series, consists of six units; the 1410A preamplifiers, the 35-watt A-1420 power amplifier, the 75-watt A-1430A power amplifiers, the A-1440A line amplifier, the 1450A apparatus unit and the 30A power supply.



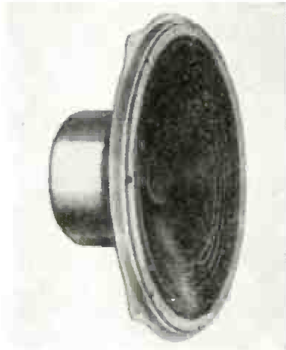
The A-1410A preamplifier has two mixing input channels and the gain controls can be removed from the chassis for remote operation. The A-1420A can supply the necessary power for three preamps and provision has been made so that one can be mounted directly on the power amplifier chassis with its two mixer controls appearing on the control panel. The A-1430A will supply power for six preamps and has provision for mounting two preamps on the main chassis. The 30A power supply is used with the A-1410 and A-1440A when they are not used in conjunction with a power amplifier. The 1450A apparatus unit provides input impedances of 30, 250, 500 or 600 ohms for the power amplifiers when they are not used in conjunction with the preamplifiers. Loudspeaker output impedances are provided for RMA70-volt line.

DUO-CONE SPEAKER

RCA Victor Div.
Camden, N. J.

The new 15-inch Duo-Cone speaker type 515S2 is designed for high-quality reproducing systems at both high and low levels. It has a useful response range from 40 to 12,000 cycles and will handle 25 watts of audio power.

The vibrating system and magnetic structure of this speaker consist of a duo-cone and two voice coils operating in two separate air gaps excited by a single 2-pound Alnico V magnet. The duo-cone has a large woofer and a small tweeter cone each mounted in its own housing so that the large cone



is effectively a continuation of the smaller one. The large cone is driven by a 2-inch voice coil to produce the low frequencies, and the small cone is driven by a ¾-inch voice coil to produce the highs.

The two cones vibrate as a single unit in the crossover range to avoid crossover interference.

TUBE TESTER KIT

Electronic Instrument Co.
Brooklyn, N. Y.

Incorporating the same features as the previous Eico model 625-K tube tester

this new kit, the 625-CK is designed especially for counter display tube testing as an aid in tube merchandising. Individual switches test each tube element. It tests conventional receiving and TV tube types including 4, 5, 6 and both 7-pin, octal, loctal, noval, Hytron VR, electron-ray tubes and pilot bulbs. It has a blank socket for future new tubes, an illuminated gear-driven roller chart, two grid caps, a protective overload bulb, and a full-vision bakelite-cased meter.

This tube tester is also available completely wired.

TV-FM BOOSTER

Sonic Industries, Inc.
New York, N. Y.

The Super Sonic TV-FM Amplifier model IT5 is designed for high gain preselection for any TV or FM receiver with adequate bandwidth and with adequate selectivity to reject unwanted

signals. It has one continuous tuning control without vernier and high-low switching. Six turns of the tuning control tune through channels 6 to 13.

The circuit features pure silver inductances and r.f. circuit contacts, minimum shunt capacitance, short input and output link coupling, high-quality insulating elements, a copper plated chassis, and a well-filtered power supply. Balanced input and output circuits reduce the noise pickup. The booster has both 72 and 300 ohm input and output impedances.

TV BOOSTER

Alliance Manufacturing Co.
Alliance, Ohio

The Tenna-Scope, as this new booster is called, has a single tuning control to cover all channels and an automatic on-off switch controlled by the TV re-

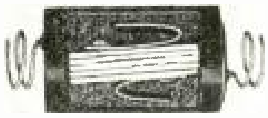
ceiver. The circuit uses a 6J6 dual triode for minimum noise and a selenium rectifier. Separate circuits are used for high and low bands, and the input and output impedances are 72 or 300 ohms.

The booster comes in a walnut plastic cabinet with a gold and maroon dial. Its size is 6¼ x 5⅞ x 5 inches and it weighs 4¼ pounds.

SELENIUM RECTIFIER

Precision Rectifier Co.
Brooklyn, N. Y.

Called Plastisel, these rectifiers look like paper capacitors and are installed the same way—no mounting holes required. The rectifiers are completely sealed and run cool up to full ratings.



LP CARTRIDGE

Astatic Corp.
Conneaut, Ohio

Designed especially for LP records the new CAC-J crystal cartridge is internally equalized to follow the ideal frequency response of the recording characteristic of Columbia records and it also plays the 45 r.p.m. platters. Its output is .6 volts at 1,000 cycles on Columbia No. 103 test record and 1 volt on RCA 12-5-31-V test record.

The cartridge is housed in a lightweight aluminum case with standard mounting holes to fit most tone arms. An adapter plate is furnished to permit mounting in RCA and similar 45 r.p.m. record changers.

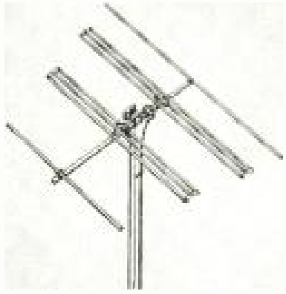
Another model, the CAC-78-J, has a 3-mil needle tip radius for 78 r.p.m. records. Both models use the Astatic type Q sapphire tipped needle.

YAGI ANTENNA

Trio Manufacturing Co.
Griggsville, Ill.

Designed to work on two channels (either channels 4 and 5 on the low band or channels 7 and 9 in the high band), this 4-element Yagi has a gain equal to any two conventional 4-element Yagis on the same channel. The 4 elements have different functions on the two channels. For example, in model 445, the elements on channel 4 act as reflector, dipole, director, director, in that order; while on channel 5 the same elements act as reflector, reflector, dipole, and director.

The gain on the two channels is

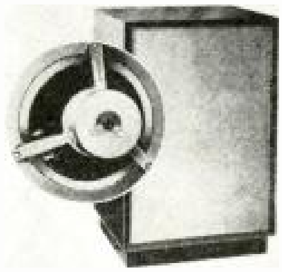


front-to-back ratio is 20 db, 10 db, and the antenna matches a standard 300-ohm line. It is available in single bay, 2-bay stacked array, and in a controlled pattern system using 2 bays offset stacked and tuned with the Trio "phasitron."

LOUDSPEAKER

Sun Radio & Electronics Co.
New York, N. Y.

The new British Wharfedale W10/CSB loudspeaker is being distributed in the United States by the Sun Radio & Electronics Co. Designed for medium



to small rooms, the 10-inch unit handles up to 5 watts and has a response comparable to most 12 to 15-inch speakers without the booming effect caused by the larger speakers when used in small rooms.

A cabinet especially designed for the speaker is available in either blond or mahogany finish.

AUTO ANTENNA

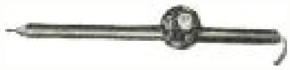
Snyder Manufacturing Corp.
Philadelphia, Pa.

Using army type construction and mounting, the Hot Rod is designed for long-distance and country reception. It has a long 4-section staff of chrome plated brass, a shock absorbing spring mount, red ceramic insulators and a red tenite static ball. It comes complete with 8 feet of u.h.f. polyethylene cable and aircraft type fittings.

HIGH-VOLTAGE PROBE

Industrial Devices, Inc.
Edgewater, N. J.

Using the extinction voltage of a neon lamp in conjunction with a calibrated potentiometer, this test instrument has an accuracy within 5% from 3.2 to 30 kv. The peewee clip is attached to the chassis or similar ground, and the probe tip is applied to the high voltage. When the indicator knob is fully counterclockwise, the neon lamp indicator glows. Clockwise rotation will give an abrupt extinction of the lamp and the pointer indicates the voltage.



Two models are available. Model 500 has a range from 1.6 to 15 kv r.m.s. and draws less than 1 ma at full scale reading, while model 520 covers a range from 3.2 to 30 kv d.c. and draws less than 300 microamps. Model 500 is designed for high-voltage transformers while model 520 is for high-voltage electronic d.c. supplies.

NEW TUBES OF THE MONTH

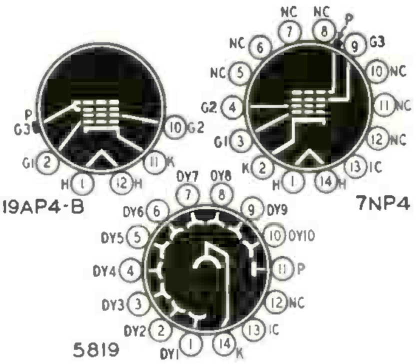
Among the few new tubes that have appeared on the market in recent months are three types by RCA: two kinescopes, and a photomultiplier. G-E has brought out a new transmitting tube and a new kinescope.

RCA's 19AP4-B is a direct-view, metal-cone picture tube for TV receivers. It has a high-efficiency white flourescent screen on a face made of frosted Filterglass for increased contrast and to avoid specular reflection. Except for its frosted face, this tube is identical with the 19AP4-A.

The other RCA kinescope, the 7NP4, is a projection-type tube for theaters which provides a projected image of 15 x 20 feet at a projection throw distance of about 60 feet when used with a suitable optical system. The tube has a metal-backed white fluorescent screen for increased brightness of the projected image.

Using electrostatic focus and magnetic deflection, the 7NP4 operates with a maximum anode voltage of 80 kv and a maximum focusing electrode voltage of 20 kv. High-voltage design features include a bulb with corrugated side-walls with insulated coating for a longer external leakage path; an inner cone-neck section for adequate vacuum insulation; and only one high-voltage envelope connection.

The 7NP4 has a 7-inch diameter bulb that is 19½ inches long. Grid No. 2, which draws only negligible current, is used to make the brightness adjustment independent of the focussing adjustment. Similarly, the focussing electrode, grid No. 3, draws only a few microamperes. The tube uses a plastic-filled, diheptal 14-pin base.



NC=NO CONNECTION; IC=INTERNAL CONNECTION-DO NOT USE

The new 5819 RCA's photomultiplier tube for scintillation counters, has a sensitivity nearly five times better than the original 5819 introduced about a year ago. Other improvements are a greater cathode collection efficiency, higher current amplification, strengthened mount structure, shorter over-all length, and a cathode lead termination in the base pin.

G-E's contribution is the GL-5680, a three-electrode tube for use as a modulator, amplifier, and oscillator. In pulsed r.f. power amplifier service the tube delivers a peak power output of 90 kw at 15 kv under typical conditions. G-E's new kinescope is the 19AP4-C, similar to the 19AP4, but having an aluminized screen. This is the first large metal tube with this feature.

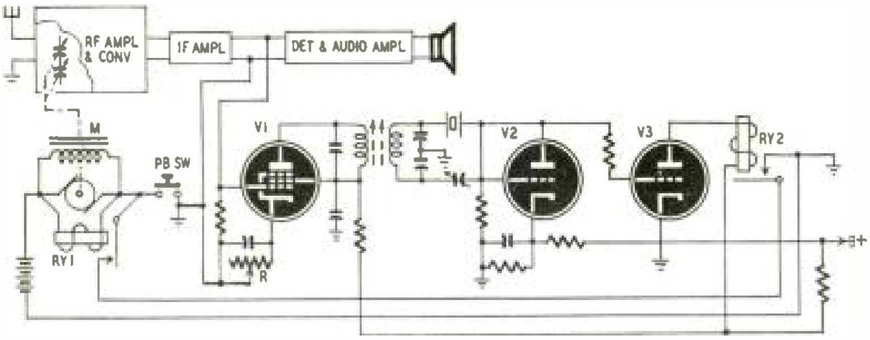
Suggested by Robert W. Gluckstein, Menominee Falls, Wisc.

New Patents

AUTOMATIC MOTOR TUNING FOR RECEIVERS

Patent No. 2,506,869
Roy A. Gull, Kenmore, N. Y.
(assigned to Colonial Radio Corp.)

A motor controls the variable capacitors in this automatically tuned receiver. On depressing a button, the motor is started and tuning continues until a signal is intercepted. Due to inertia, the motor tends to coast for a few milliseconds after it is shut off, leaving the receiver detuned by several hundred cycles. This invention eliminates the error by disconnecting the motor just before a signal is correctly tuned in.



In a typical case the desired band is scanned from the low-frequency end to the upper end. Then the tuning capacitors are snapped back to the l.f. starting point. The broadcast band (535 to 1620 kc) may be scanned in about 5 seconds and the snapback time is about 0.1 second.

Referring to the figure, tuning starts when PB is depressed. This energizes motor M (which rotates the capacitors) and relay RY1 closes its contact. In the absence of signal RY2 is also energized and its contact closed. Therefore M and RY1 continue to operate when switch PB is released.

A portion of the output from the i.f. amplifier is fed to limiter V1, and then to a crystal filter. The crystal is ground for a frequency slightly lower than the i.f. For example, a 454-kc crystal may be used if the i.f. is 455. This permits a signal to pass through the filter a few milliseconds before it is correctly tuned in the receiver, due to the beat frequency on both sides of zero-beat. Output from the filter is rectified by V2, and the d.c. is sufficient to block V3. As RY2 releases, it opens the ground return to M and RY1 so these also release and scanning ceases.

M should be adjusted to coast just long enough to permit accurate tuning. If the crystal frequency is 1 kc below the i.f. and if the tuning rate is 200 kc/second, this would be equal to 5 milliseconds.

HUM ELIMINATOR FOR RESISTANCE PICKUPS

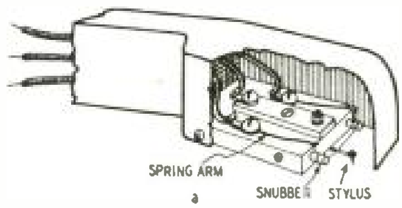
Patent No. 2,511,665
Carroll R. Miner, Stratford, Conn.
(assigned to General Electric Co.)

This circuit is for use with variable-resistance phonograph pickups. The advantage of these pickups is their simple construction, but they require a d.c. supply. If the supply is rectified a.c., the ripple may be objectionable. This invention eliminates this hum without an expensive filter.

The pickup has a metal stylus to which two resistance wires are connected. See part a of the diagram. The wires are wound around snubbing posts and terminate at spring arms. If the stylus is moved slowly, the wires merely wind themselves around the snubbers. When the stylus vibrates rapidly (as its needle follows the record grooves), the wires do not have time to move. Instead, they are alternately compressed and stretched. This changes their resistance and modulates the voltage across the wires.

The a.f. component which appears across transformer T may be amplified as required. This is shown in part b of the diagram.

To balance out hum, a potentiometer R is connected across T. R is adjusted so that equal ripple flows through both halves of the transformer primary. Since this flow is in opposite directions, the hum is cancelled out in the secondary.



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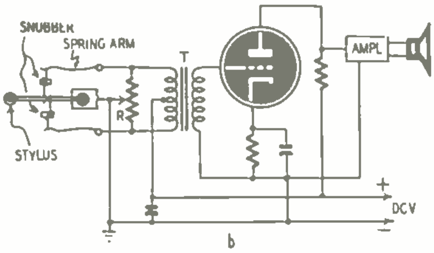


b

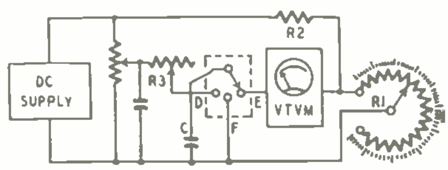
ACCURATE SMALL TIME INTERVAL MEASURING

Patent No. 2,511,868
Earl G. Newsom, Dayton, Ohio
(may be used by the Government of the U. S. without royalty payments)

A simplified circuit diagram is shown here for accurately measuring small intervals of time. For example, it may be used to measure the interval between a radar pulse and its echo.

A three-way switch is arranged to contact either D, E, or F. In the first position a capacitor C is charged through a variable resistor R3. When set to E, the capacitor stops charging and its voltage may be compared with the potential across R1. In position F, the switch discharges C and the cycle may be repeated.

At the first pulse (which begins the timed interval) the switch contacts D and the capacitor charges. The voltage continues to rise until the second pulse arrives. This ends the timed interval. At this instant the switch contacts E. Now R1 may be adjusted until the v.t.v.m. shows zero. Then the capacitor voltage equals that across R1. The dial of R1 may be calibrated in microseconds if desired.



It is convenient to use a linear winding on R1 and to have a linear calibration on its dial. However, the voltage across C rises exponentially with time. To avoid a complicated taper for R1, a resistor R2 is added. Then the voltage across R1 rises *almost* exponentially with respect to its time calibration. For example, if the R1 dial is adjusted from one time value to another twice as large, its resistance is doubled; but current through it decreases so the new voltage drop across R1 is *less* than twice the original value. When R2 has the correct value, this change in voltage is very nearly exponential. A similar increase takes place on the capacitor C. If the time interval is doubled, the potential is *less* than twice as great.

In the actual instrument, the switch is replaced by two thyratrons. The first pulse fires one tube and begins the timed interval. The second pulse fires the second tube and blocks the first one so the capacitor stops charging. A motor controls a switch which discharges C and repeats the cycle.

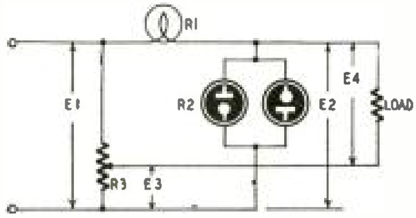
VOLTAGE REGULATOR

Patent No. 2,501,263

Robert H. Cherry, Glenside and Albert J. Williams, Jr., Philadelphia, Pa.
(assigned to Leeds & Northup Co.)

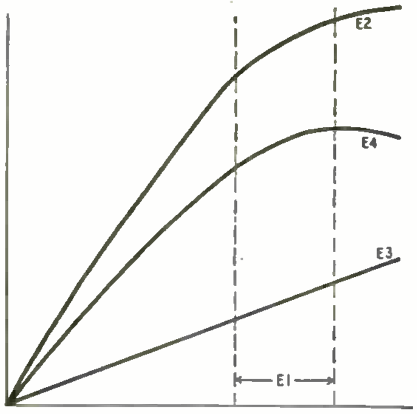
Capable of excellent regulation, this circuit is not difficult to build. The output remains constant despite severe fluctuations of input voltage or output load.

R1 is a conventional tungsten lamp, of the 10-watt, 120-volt type. R2 is made up of VR tubes. A tapped resistor R3 is connected across E1.



The circuit of the voltage regulator.

The three curves illustrate the regulation characteristics. E3 is the voltage across the tapped portion of the resistor. This voltage is proportional to E1 at all times. E2 is the voltage across R2. It shows some regulation but the voltage continues to rise as E1 increases. From the schematic note that E4 (the output) is the difference between E2 and E3, or E4+E3=E2. When E4 is plotted, it is seen to be practically constant over some region of E1. R3 may be adjusted so that the concave portion of E4 is symmetrical over some desired range of input. In this way the output can be made to show less than 1% variation over this range.



Curves showing the regulation action.

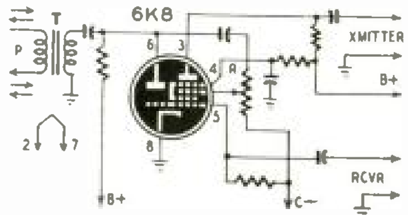
Due to the opposing polarity of the VR tubes, this circuit is equally effective on d.c. or a.c.

TELEPHONE—RADIO COUPLING CIRCUIT

Patent No. 2,511,948

Twen S. Wang, New York City
(assigned to Radio Corp of America)

A telephone circuit may be coupled without complicated apparatus to a radio circuit by means of this invention. A telephone line needs only two wires along which messages pass in both directions. In radio, however, the transmitter and receiver are entirely separate units. If the receiver output is permitted to flow back into the transmitter input, feedback problems may appear. The telephone line must be coupled to both the radio receiver and the transmitter. At the same time the radio receiver and transmitter channels must be isolated from each other.



The figure shows a 6K8 tube. The signal from the radio receiver is applied to both control grids. The triode output is connected to transformer T which couples to the phone line P. A signal which originates in P is passed through the transformer to the screen-grid of the hexode. From here the signal flows into the radio transmitter line. Thus P is coupled both to the receiver and transmitter.

One portion of the signal from the receiver is amplified by the hexode and it appears across the transmitter line. Another portion is amplified by the triode and coupled to the screen grid of the hexode. Since the screen grid signal has passed through a triode stage, it is 180° out of phase with the signal on the control grid. When R is correctly adjusted, these signals produce equal and opposite components of plate current. The result is complete balance, and the receiver is effectively isolated from the transmitter.

U.H.F. TUNING

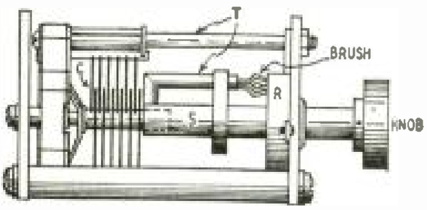
Patent No. 2,511,586

Merle R. Hubbard, Cedar Rapids, Iowa.
(assigned to Collins Radio Co.)

Inductance and capacitance are tuned by this system simultaneously to get a more constant Q over a wide range. The inductor is a transmission line. The capacitor is of the conventional variable type.

In the model illustrated here, C is the variable capacitor. It shunts the transmission line conductors marked T. The shorter line is fixed to an insulated shaft S and is carried around with it. This conductor ends in a brush contact which slides around the metal ring R. Therefore the conductors T are shorted at this end.

As the knob is rotated the capacitor is varied. Simultaneously the spacing between conductors T is varied to change their inductance. Each conductor should be less than one quarter-wave in length and preferably silver-plated.

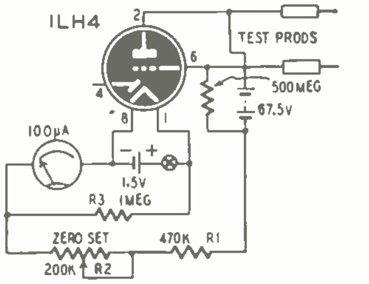


PORTABLE ELECTRONIC INSULATION TESTER

Most portable megohmmeters have a hard-driven high-voltage generator which develops the potential required for the test. Such instruments are bulky and rather impractical in some applications.

An electronic megohmmeter which can be constructed compactly is described in patent No. 2,510,691 issued to R. W. Gilbert. The instrument has a logarithmic scale calibrated from 100,000 ohms to 10,000 megohms. The circuit is shown.

The cathode current of the 1LH4 flows through cathode resistors R1 and R2. The plate voltage is equal to the battery voltage minus the drop across the resistors. Therefore, the plate voltage varies inversely as the cathode current. In a high-mu triode like this one, the grid voltage is low compared to the other elements so the grid-to-plate voltage follows closely the plate-to-cathode voltage. The voltage applied to the resistance under test is inversely proportional to the cathode current. Thus, the applied voltage is zero for zero resistance, half the battery voltage for center-scale resistance, and full

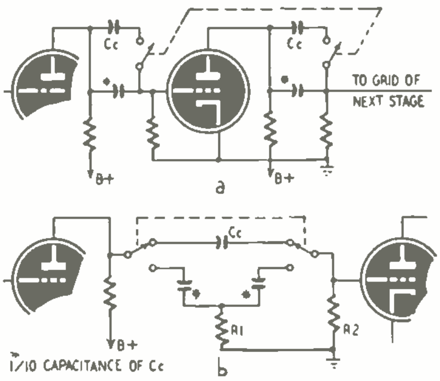


battery voltage for infinite resistance.

Plate current falls because of reduced plate voltage but the cathode current continues to increase logarithmically because the grid current increases as the plate current decreases.

BASS ATTENUATION IMPROVES SPEECH

Radiotelephone engineers and amateurs have long realized that frequencies outside the range of 300 to 2,500 cycles contribute little or nothing to the intelligibility of transmitted speech. When signals are received with the aid of a crystal filter or other circuits which reduce the high-frequency side-



bands, speech is often boomy and difficult to read because of the apparent bass boost.

Circuit modifications which attenuate frequencies below 300 cycles and make speech easier to read through crystal filters and Q5'ers are described by G2TA in *Short Wave Magazine*. The circuit modifications consist of inserting a switch which cuts out the normal coupling capacitors and replaces them with units having one-tenth the capacitance.

The circuit at a in the drawing is for receivers having two R-C coupling networks. Capacitors C_c are the normal coupling units. When there is only one resistance-coupled circuit in the amplifier, use the circuit at b. In this case, a high-pass filter consisting of two small capacitors and a resistor is switched into the circuit. R1 should equal R2, the normal grid resistor.

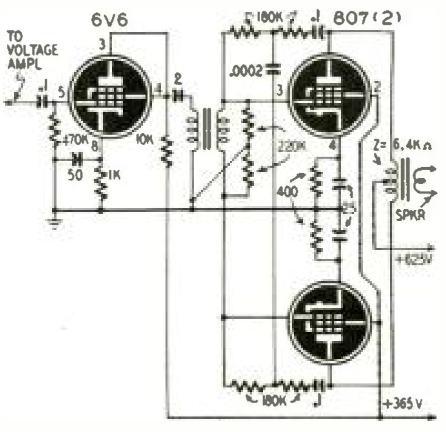
Some amateurs can increase the "talk power" of their phone transmitters by installing these bass-cutting circuits in their speech equipment. Because most of the modulating power of a wide-range a.f. system is in the low frequencies, these determine the maximum or 100% modulation point. When frequencies below 300 cycles are removed, the modulation level is determined by the intelligence-bearing frequencies.

UNUSUAL FEEDBACK CIRCUIT IN 50-WATT AMPLIFIER

In most circuits where inverse feedback is applied to a single transformer-coupled stage, the driver transformer has balanced secondary windings to insure proper operation.

In this circuit used in the Omega 50-watt amplifier described in *Toute La Radio* (Paris, France), the transformer does not require balanced secondaries or even a center tap on the single secondary. Instead, two 220,000-ohm resistors are connected across the secondary and grounded at their junction. Feedback voltage is fed from plates to grids through R-C networks.

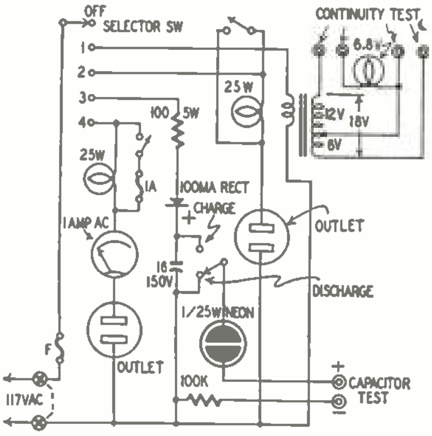
Core saturation in the driver transformer is eliminated by employing resistance-capacitance coupling between the plate of the 6V6 and the primary.



UTILITY TESTER

Designed for high- and low-voltage continuity testing, measuring a.c. power consumption, and checking capacitors, this instrument is a useful addition to a radio service test bench.

When the selector switch is in position 1, 117 volts a.c. is fed to the primary of an 18-volt filament transformer having a 12-volt tap—you can probably find one at your favorite surplus outlet. Six, 12, or 18 volts can be taken directly from the transformer.



A 6–8-volt pilot lamp is in series with one side of the 12- and 6-volt windings for low-voltage continuity tests and for checking 6-volt heaters, pilot lamps, and filaments.

Throwing the selector to position 2 applies voltage to a 117-volt receptacle which has a 25-watt lamp and bypass switch in series for short testing.

Position 3 is for testing capacitors by the familiar charge-and-discharge method. The 100-ma selenium rectifier supplies d.c. for the capacitor test, and an s.p.d.t. switch is used to charge and discharge the capacitor. The neon lamp serves as indicator.

Position 4 places a 25-watt lamp, fused bypass switch, and 1-ampere a.c. meter in series with a second 117-volt outlet for measuring power drain. The initial test is made with the bypass switch closed so the lamp will limit the current in the event that the device being tested is shorted.—*Wm. R. Blaylock*

HI-FI AMPLIFIER FOR RECORDING AND PLAYBACK

? *I have a disc recorder and playback unit manufactured by General Industries Co. Please show a diagram of an amplifier using push-pull 6V6's which I may use with this unit. Also show how the speaker level can be reduced for monitoring the recordings.*

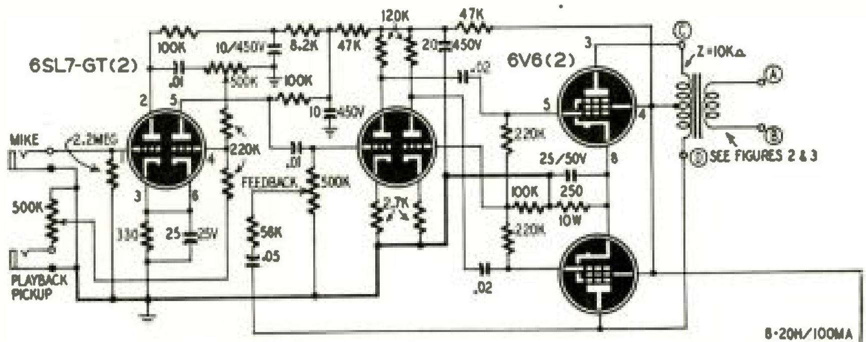


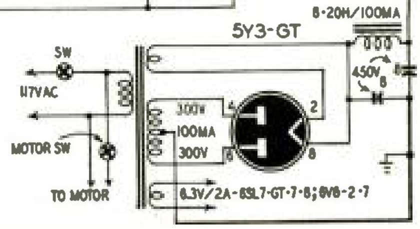
Fig. 1—A 10-watt recording amplifier.

Is a volume-level indicator necessary? If so, what type shall I use?—M. V., Chicago, Ill.

A. The amplifier circuit is shown in Fig. 1. Inverse feedback has been included to improve the performance of the push-pull pentodes. Adjust the 500,000-ohm feedback control to the point which gives the minimum acceptable output level when the microphone and phono volume controls are at maximum.

Not knowing which type of cutter you have, connections for magnetic and crystal types are shown in Figs. 2 and 3, respectively. Table I shows the values for shunting resistors for different values of Z1 and Z2 when using 10-ohm magnetic cutters as in Fig. 2.

Shunt the 47,000-ohm resistor in series with the crystal cutter in Fig. 3 with a .001-to .01-μf capacitor to boost highs. Vary its value up to 250,000 ohms to boost lows. Table II shows the values of R1 and R2 for fixed values of attenuation in the speaker circuit for three common values of output and voice-coil impedances when using a crystal cutter. Values given in the speaker-level columns of the tables are in decibels below the recording level. Values given in the tables were supplied by General Industries Co.



A volume-level indicator is recommended in the interest of good recordings. The level indicator for a magnetic cutter may be a 1-ma d.c. meter having a resistor and 1N34 or meter rectifier connected in series with it across the cutter terminals. The value of the resistor should be selected so the meter reads 2 or 2.5 volts full scale.

A 1,000-ohm-per-volt or better, 150-volt a.c. meter can be used with the crystal cutter. The average level will probably run to approximately 100 volts; however, the best value can be determined by making a few trial recordings.

TABLE I

Z1 and Z2 (ohms)	R1 (ohms)	R2 (ohms)	Speaker level (decibels)
3.2	10	0.4	17.0
4.0	10	0.5	16.5
6.0	10	1.0	13.0
8.0	16	2.25	10.0
10.0	16	5.50	5.0

TABLE II

Z1 and Z2 (ohms)	R1 (ohms)	R2 (ohms)	Speaker level (decibels)
3.2	5.5	6.5	8.5
3.2	10	4.5	12.0
6.0	10	10	8.5
6.0	15	8.0	11.0
8.0	11	14	7.5
8.0	20	11	11.0

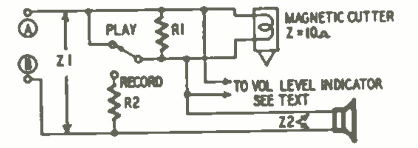


Fig. 2—Input circuit for low-Z cutter.

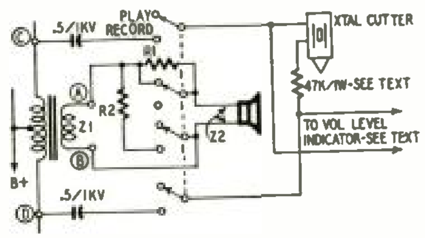


Fig. 3—Crystal cutter input connections.

XTAL SET COIL DATA

? *The push-pull crystal receiver in the November, 1949, issue works so well that I want to give it a try on the shortwave bands. Please print winding data for coils covering from 550 kc to approximately 15 mc. I plan to use five-prong, 1¼-inch, plug-in forms.—S. S., Peru, Ill.*

A. The table gives the number of turns and the approximate tuning range of each coil. Experiment with the number of turns on L1 to obtain maximum volume.

Tuning range (megacycles)	L1	L2—L3	Wire size
0.55-1.6	40	110	32
1.5-4.5	16	35	24
4.0-15	5	11	18

FM SET CONVERSION

? *I have a standard FM receiver which I wish to convert for reception in the 152–162-mc band. Please supply coil winding data.—B. J. H., Birmingham, Ala.*

A. Tuning components for these frequencies are so critical that it is almost impossible to supply winding data which will prove useful in any one circuit. It is possible to make your own coils if you have a good grid-dip meter or a high-frequency v.t.v.m. and a signal generator which covers the required range. You may be able to make the conversion merely by removing turns from the coils in the set.

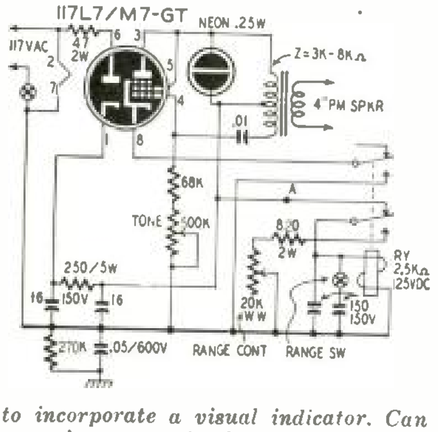
With the grid-dip oscillator, prune the oscillator coil until its range is 162.7 to 172.7 mc when connected across the oscillator section of the tuning capacitor. The antenna and r.f. coils are adjusted to tune from 152 to 162 mc.

If you use the v.t.v.m. and signal generator method, connect the generator and a 270,000-ohm resistor in series across the coil and tuning capacitor in parallel. Connect the v.t.v.m. across the combination. Close the tuning capacitor and tune the signal generator for maximum voltage on the meter. Note the frequency, then make the same test with the tuning capacitor open. The two frequencies are the high- and low-frequency limits of the coil and capacitor combination. Vary the number of turns, the diameter, and spacing between turns until you have the desired tuning range.

If you want to try winding your own coils, the antenna and r.f. coils may consist of three turns of No. 12 tinned wire wound to an inside diameter of ⅜ inch and spaced ½ inch long. As a start, the oscillator coil may consist of two turns of No. 12 wire having an inside diameter of ½ inch and a winding length of ¼ inch. If you use National XR-50 or Millen 69040 series coil forms, it will be easier to adjust the inductance of the coils to fit the tuning capacitors.

ELECTRONIC METRONOME

? *I want to construct an electronic metronome but haven't found a circuit I like. One was described in your January, 1947, issue but it emits clicks. I want a tone or beep. I would also like*



to incorporate a visual indicator. Can you give me a simple circuit?—W. S., Waukesha, Wis.

A. This circuit is the metronome described in the January, 1947, issue combined with a vacuum-tube oscillator. Large capacitors are connected across the relay coil. As soon as these charge, the relay armature pulls down and stays down until the capacitors discharge through the 820-ohm resistor and the range control. Auxiliary contacts on the relay close the cathode circuit of the oscillator. If the beeps are too long, insert a 500,000-ohm variable resistor at A, then adjust it for the desired effect.

The neon lamp across one side of the primary of the output transformer is the visual indicator. It may be necessary to place it across the entire winding.

SHORTWAVE CONVERSION

? *I am interested in using the simplified shortwave conversion described on page 124 of the January, 1950, issue, but I cannot work out values for the shortwave coil and the frequency to which the receiver must be tuned for reception of a 2490-kc signal. My receiver has a 262-kc i.f.—L. W. S., Buena Park, Calif.*

A. Your receiver should be tuned to 852 kc as found by the formula

$$\frac{F1 - F2}{2} - F2,$$

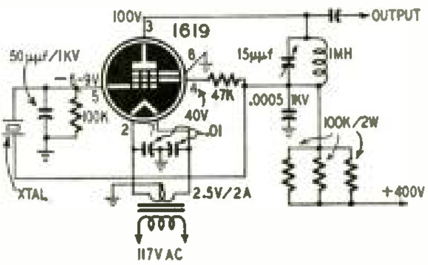
where F1 is the frequency of the shortwave station and F2 is the i.f. of the receiver.

You may use an antenna coil consisting of 25 turns of No. 28 wire closewound on a ¾-inch form. This winding may be shunted with a single-section 365-μμf capacitor or a small trimmer of the same value. The primary of the antenna coil may have approximately 18 turns of No. 28 or smaller wire wound over the grid winding. Because of the short antenna used on auto radios, it may be necessary to experiment with the number of turns on the primary to get optimum performance. You may get good results by tapping the grid coil at a few turns above the grounded end and connecting the antenna to the tap through a 100-μμf blocking capacitor.

SURPLUS CRYSTALS

? *I purchased a flock of surplus crystals which were marked with channel numbers between 0 and 79 and frequencies ranging from 20 to 27.9 mc. I want to use some of these in a 10-meter transmitter but can't get any of them to take off in any of the usual oscillator circuits. I've tried them in oscillators having circuits tuning as low as 2 mc without any luck. A friend tells me that these rocks are from the BC-604 but I can't get any dope on it.—E. K. W., Bronx, N.Y.*

A. If the crystals are from the BC-604, they will probably be in FT-241 holders marked Western Electric on the bottom. To get the fundamental



frequency, divide the frequency marked on the crystal—the output frequency—by 54. The fundamentals of these units range from 370.370 kc for channel 0 to 516.667 kc for channel 79.

The basic circuit of the oscillator in the BC-604 is shown in the diagram. We'll bet that this one will put your rocks to work. They may even work in the average Pierce oscillator circuit if you replace the usual 2.5-mh plate choke with a choke of 6 or 10 mh.

You GET THE BEST IN Heathkits

Heathkits are the Quality Line of TEST INSTRUMENT KITS

Famous HEATHKIT PARTS

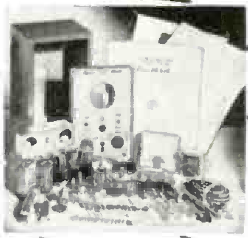
- MALLORY FILTER CONDENSERS
- WILKOR PRECISION RESISTORS
- GRIGSBY ALLISON SWITCHES
- ALLEN-BRADLEY RESISTORS
- GENERAL ELECTRIC TUBES
- CHICAGO TRANSFORMER
- CENTRALAB CONTROLS
- SIMPSON METERS
- CINCH SOCKETS

Modern STYLING KITS THAT MATCH

Heathkits are styled in the most modern manner by leading industrial stylists. They add beauty and utility to any laboratory or service bench. There is a complete line of Heathkit instruments allowing a uniformity of appearance.

An attractive service shop builds a feeling of confidence. Many organizations have standardized on Heathkits providing uniform service departments.

There is no waste space or false effort to appear large in Heathkits — space on service benches is limited and the size of Heathkit instruments is kept as small as is consistent with good engineering practice.



Complete KITS WITH PARTS THAT FIT . . .

When you receive your Heathkit, you are assured of every necessary part for the proper operation of the instrument.

Beautiful cabinets, handles, two-color panels, all tubes, test leads where they are a necessary part of the instrument, quality rubber line cords and plugs, rubber feet for each instrument, all scales and dials ready printed and calibrated. Every Heathkit is 110 V 60 Cy. power tranformer operated by a husky transformer especially designed for the job. Heathkit chassis are precision punched for ease of assembly. Special engineering for simplicity of assembly is carefully considered.

Accuracy ASSURED BY PRECISION PARTS

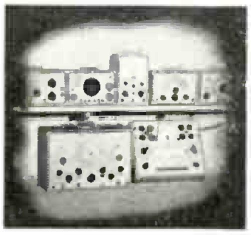
Wherever required, the finest quality 1% ceramic resistors are supplied. These require no aging and do not shift. No matching of common resistors is required. You find in Heathkit the same quality voltage divider resistors as in the most expensive equipment.

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.

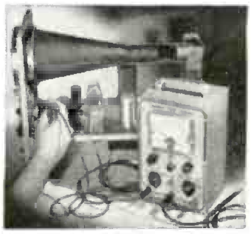
Complete INSTRUCTION MANUALS

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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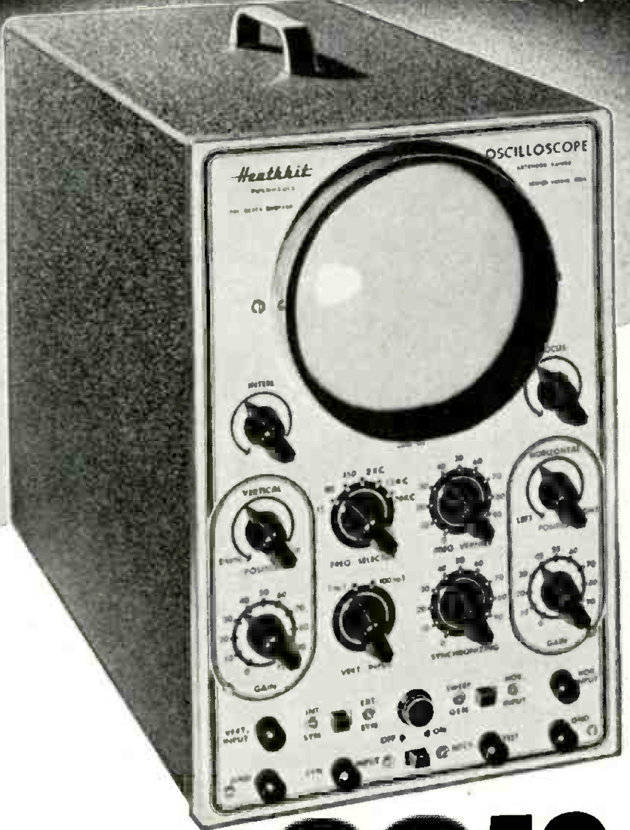
12 *Improvements* IN NEW 1951

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.

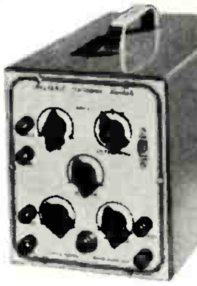
A new synchronization circuit allows the trace to be synchronized with either the positive or negative pulse, an important feature in observing the complex pulses encountered in television servicing.

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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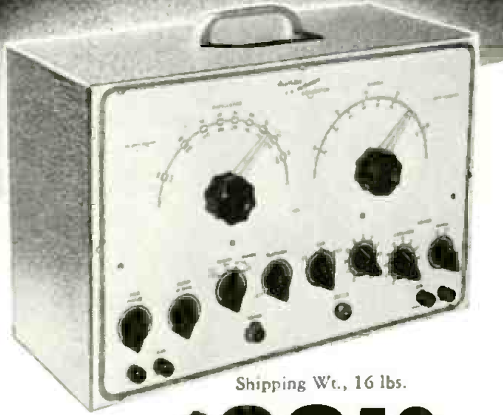
NEW *Heathkit* T. V. ALIGNMENT GENERATOR KIT



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.

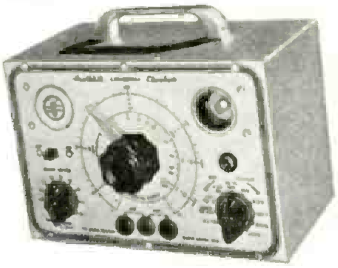
A standby position is provided making the instrument always instantly available.

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



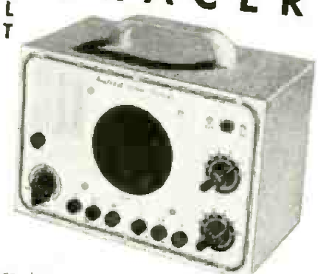
Features

- 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.

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NEW 1951 *Heathkit* **SIGNAL GENERATOR KIT**

Features

- Sine wave audio modulation.
- Extended range 160 Kc. to 50 megacycles fundamentals.
- New step attenuator output.
- New miniature HF tubes.
- Transformer operated for safety.
- Calibrated harmonics to 150 megacycles.
- New external modulation switch.
- 5 to 1 vernier tuning for accurate settings.

A completely new Heathkit Signal Generator Kit. Dozens of improvements. The range on fundamentals has been extended to over 50 megacycles; makes this Heathkit ideal as a marker oscillator for T.V. New step attenuator gives controlled outputs from very low values to high output. A continuously variable control is used with each step. New miniature HF tubes are required for the high frequencies covered.

Uses 6C4 master oscillator and 6C4 sine wave audio oscillator. The set is transformer operated and a husky selenium rectifier is used in the power supply. The coils are precision wound and checked for calibration making only one adjustment necessary for all bands.

New sine wave audio oscillator provides internal modulation and is also available for external audio testing. Switch provided allows the oscillator to be modulated by an external audio oscillator for fidelity testing of receivers.

A best buy — think of all the features for less than $20.00. The entire coil and tuning assembly are assembled on a separate turret for quick assembly — comes complete — all tubes — cabinet — test leads — every part. The instruction manual has step-by-step instructions and pictorials. It's easy and fun to build a Heathkit Model SG-6 Signal Generator. Shipping Wt., 7 lbs.

$19.50

Heathkit SINE AND SQUARE WAVE **AUDIO GENERATOR KIT**

Either sine or square wave.
Stable RC bridge circuit.
Covers 20 to 20,000 cycles.
Less than 1% distortion.

Hundreds of Heathkit Audio Generators are used by speaker manufacturers—definite proof of their quality and dependability. The added feature of square wave opens up an entirely new field of amplifier testing. Uses the best of parts, 4 gang condenser, 1% calibrating resistors, metal cased filter condensers, 5 tubes, completely calibrated panel and detailed instruction manual. One of our best and most useful kits. Model G-2. Shipping Wt., 12 lbs.

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THE NEW *Heathkit* **HANDITESTER KIT**

- Beautiful streamline Bakelite case.
- AC and DC ranges to 5,000 Volts.
- 1% Precision ceramic resistors.
- Convenient thumb type adjust control.
- 400 Microampere meter movement.
- Quality Bradley AC rectifier.
- Multiplying type ohms ranges.
- All the convenient ranges 10-30-300-1,000-5,000 Volts.
- Large quality 3" built-in meter.

$13.50

A precision portable volt-ohm-milliammeter. An ideal instrument for students, radio service, experimenters, hobbyists, electricians, mechanics, etc. Rugged 400 ua meter movement. Twelve complete ranges, precision dividers for accuracy. Easily assembled from complete instructions and pictorial diagrams. An hour of assembly saves one-half the cost. Order today. Model M-1. Shipping Wt., 2 lbs.

NEW *Heathkit* **BATTERY ELIMINATOR KIT**

Features

- Provides variable DC voltage for all checks.
- Locates sticky vibrators-intermittents.
- Voltmeter for accurate check.
- Has 4000 MFD Mallory filter for ripple-free voltage.

Even the smallest shop can afford the Heathkit Battery Eliminator Kit. A few auto radio repair jobs will pay for it. It's fast for service, the voltage can be lowered to find sticky vibrators or raised to ferret out intermittents. Provides variable DC voltage 5 to 7½ Volts at 10 Amperes continuous or 15 Amperes intermittent. Also serves as storage battery charger. Ideal for all auto radio testing and demonstrating.

$22.50

A well filtered rugged power supply uses heavy duty selenium rectifier, choke input filter with 4,000 MFD of electrolytic filter for clean DC. 0-15 V. voltmeter indicates output which is variable in eight steps. Easily constructed in a few hours from our instructions and diagrams — better be equipped for all types of service — it means more income. Model BE-2. Shipping Wt., 19 lbs.

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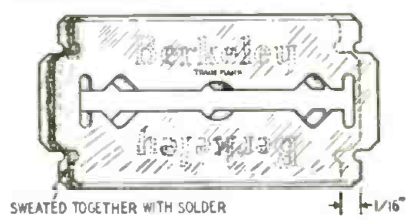
OUTPUT INDICATOR

A sensitive output indicator for use when aligning receivers can be constructed with a minimum of time and parts. As shown in the diagram, it consists of a small PM speaker and output transformer mounted on a small base which can be placed close to the speaker in the set being aligned.

Connect a low-range v.t.v.m. to the terminals and use it as the output indicator. With the meter set to the 0.25-volt a.c. range, the signal from the test oscillator can be turned low enough to prevent the set's a.v.c. from operating and broadening the output peaks.—*W. M. Finley, Jr.*

HANDY SERVICING TOOL

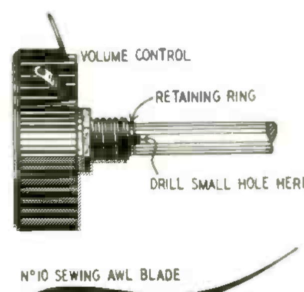
One of the biggest headaches in radio servicing is the job of realigning scraping plates in a variable capacitor. In trying to straighten a bent plate by usual methods, adjacent plates may be bent and the technician finds himself in a vicious circle.



An old-timer gave me a simple jig which does the job miraculously. Two double-edged razor blades are soldered together at one end with a 1/16-inch overhang as shown. When the blades straddle the suspected plate, they make a tight width gauge on either side without undue pressure on adjacent plates. The jig can be held in the hand, needle-nose pliers, or fastened to the end of a small rod.—*William R. Brown, Jr.*

REPAIRING VOLUME CONTROLS

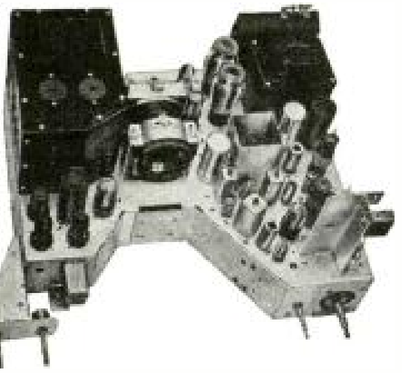
Here is a simple method of removing the C-rings or retaining collars, used in rotary switches and potentiometers, without gouging a hunk out of your thumb.



Drill a small hole in the shaft close to the retaining ring as shown in the drawing. Slide a prying tool under the ring and lift it out. A shoemaker's No. 10 sewing awl blade is an ideal tool for the job. Its shape and sharp point make it a handy tool for cleaning up soldering lugs and socket pins.—*Frederick Box*

#630 Chassis Still the Best in TV

NOW . . . More Outstanding than Ever!



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Engineered in strict adherence to the genuine RCA #630 plus ADDED FEATURES . . . LARGE POWER TRANSFORMER . . . VOLTAGE DOUBLER . . . PULSE KEYED AGC . . . UNIVERSAL MOUNTING BRACKET . . . 70° DEFLECTION YOKE.

A NEW 31-TUBE SUPER DELUXE EDITION

DESIGNED FOR THE NEW LATEST TYPE **20″** RECTANGULAR PICTURE TUBE

Delivered (as pictured) complete ready to play with all tubes, hardware, knobs and large 8″ PM speaker (less CRT)	$187.97
SAME 20″—31-TUBE SUPER DELUXE KIT Major parts mounted and aligned complete (less CRT)	166.49
16″—31-TUBE DELUXE CHASSIS, READY to plug in and play, complete (less CRT)	169.74
10″ or 12½″ 30-TUBE STANDARD KIT Unassembled, incl. instructions, complete (less CRT)	139.62

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16DP4A — (Round Glass Black)	39.63
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LUCITE SUB-CHASSIS, formed & drilled	2.49
3 - 20K H.V. FILTER CONDENSERS, set	2.22
RESISTORS, set of 7	.98
TUBULAR & MICA CONDENSERS, set of 3	.46
TERMINAL & WIRE STRIPS & CLIPS	.48

(Add the doubler system to the standard 630 circuit with these parts plus the 16″ bracket kit, the plastic sleeve and ring a 1B3 and 211T5. Easy to follow instructions included)

FREE—WITH ORDERS OF $10 OR OVER

- 630TV Circuit Diagram with Modifications
- Hints for Better Performance on your 630TV
- Illustrated Television Conversion Manual
- Pulse Keyed Type AGC Circuit Diagram
- RMA Handy Resistor and Mica Code Charts

#630 TV PARTS . . . TOP QUALITY . . . LOW PRICES

FOR KIT BUILDERS, REPLACEMENTS AND EXPERIMENTERS

The following television parts list comprises all the components needed to build the famous #630 television chassis plus added features. PRICES UNLESS MARKED PER SET ARE PER ITEM. Parentheses indicate amounts of parts needed in lots of two or over. THE PRICES SPEAK FOR THEMSELVES.

RCA FRONT END TUNER, compl. w/tubes		$22.49
STANDARD TURRET TUNER, com. w/tubes		22.49
ESCUTCHEON PLATE, for either tuner		.69
COMPLETE SET OF KNOBS, incl. decals		.98
COMPLETE SET OF KNOBS, (Gold) "		2.49
POWER TRANSFORMER, 295ma.	201T6	9.97
VERTICAL OUTPUT TRANS.	204T2	2.69
VERTICAL BLOCKING TRANS.	208T2	1.32
HORIZONTAL OUTPUT TRANS.	211T1	2.47
HORIZONTAL OUTPUT TRANS.	211T3	2.98
HORIZONTAL OUTPUT TRANS.	211T5	3.98
FOCUS COIL, 247 ohms,	202D1	2.29
FOCUS COIL, 470 ohms,	202D2	3.42
DEFLECTION YOKE, 60°	201D1	2.97
DEFLECTION YOKE, 70°	206D1	3.98
SOUND DISCRIMINATOR TRANS.	203K1	1.12
1st PIX I.F. TRANSFORMER,	202K2	1.08
2nd PIX I.F. TRANSFORMER,	202K3	1.08
1st & 2nd SOUND I.F. TRANS. (2)	201K1 ea.	1.02
HORIZONTAL DISCRIM. TRANS.	208T8	1.49
FILTER CHOKE, 62 ohms		1.47
CATHODE TRAP COIL,	202K4	1.08
WIDTH CONTROL COIL,	201R1	.44
WIDTH CONTROL COIL,	201R4	.48
WIDTH CONTROL COIL,	keyed AGC	.79
HORIZONTAL LINEARITY COIL,	201R3	.39
HORIZONTAL LINEARITY COIL,	201R5	.49
3rd & 4th PIX COILS, (2)	202L1 ea.	.39
FILAMENT CHOKES, (5)	204L1 ea.	.09
VIDEO PEAKING COIL,	203L1	.18
VIDEO PEAKING COIL,	203L2	.18
VIDEO PEAKING COILS, (2)	203L3 ea.	.18
VIDEO PEAKING COILS, (2)	203L4 ea.	.18
ION TRAP BEAM BENDER, (single)	203D1	.79
ION TRAP BEAM BENDER, (double)	203D3	.98
AUDIO OUTPUT TRANSFORMER (6K6)		.69
HV RECTIFIER, SOCKET ASSEMBLY, single		.79
HV RECTIFIER, SOCKET ASSEMBLY, double		1.37
HV KINESCOPE LEAD, with clip		.39
TV 6′ LINE CORD, with both plugs		.29
INTERLOCK SAFETY CONNECTOR (input)		.17

PUNCHED CHASSIS PAN, cadmium plated	$4.87
630-KIT, screws, nuts, rivets, washers	1.69
HI VOLTAGE CAGE ASSEMBLY, complete	3.73
VOLTAGE DIVIDER SHIELD & COVER, "	1.79
ELECTROLYTIC COND. SUB-CHASSIS	.94
SOUND DISCRIMINATOR SHIELD	.19
TUBE CRADLE BRACKET	.57
DEFLECTION YOKE BRACKET	.29
DEFLECTION YOKE MOUNTING HOOD	.59
FOCUS COIL BRACKETS per set	.49
CATHODE TRAP COIL SHIELD	.39
CHASSIS MOUNTING BRACKETS set of 4	.44
BRIGHTNESS & HOLD CONTROL BRACKET	.59
WIDTH CONTROL BRACKET	.16
TUNER SHAFT BRACKET	.17
TERMINAL STRIPS, 4-LUG set of 11	.48
TERMINAL STRIPS, 3-LUG set of 2	.08
TERMINAL STRIPS, 2-LUG set of 2	.06
TERMINAL STRIP, 1-LUG	.02
ANTENNA TERMINAL STRIP	.19
3-SCREW TERMINAL STRIP	.19
CORONA TERMINALS set of 2	.08
CORONA RING	.09
TUBE SHIELD & CLIP 2 sets	.22
MINIATURE WAFER SOCKET (10) ea.	.07
MINIATURE MOLDED SOCKETS (2) ea.	.12
OCTAL WAFER SOCKETS (13) ea.	.07
CATHODE RAY TUBE SOCKET, 18″ leads	.39
AMPHENOL CONNECTOR PLUGS, set	.48
OVAL PM SPEAKER, 5″x7″	2.49
8″ PM SPEAKER, heavy alnico #5 magnet.	3.97
12″ PM SPEAKER, heavy alnico #5 magnet	5.63
SPEAKER CONNECTOR PLUGS set of 2	.18
12½″—CRT MOUNTING BRACKET SET	1.96
16″—CRT MOUNTING BRACKET SET	2.98
UNIVERSAL MOUNTING BRACKET SET	6.97
PLASTIC SLEEVE, for insulating 16AP4	1.88
PLASTIC SLEEVE, for insulating 16GP4	1.88
PLASTIC RING, for insulating rim 16″ CRT.	1.97
PLASTIC SLEEVE, for insulating 19″ CRT	1.96
PLASTIC RING, for insulating rim 19″ CRT.	2.08

VARIABLE CONTROLS

PICTURE & SOUND, 10K ohms 1 meg. & switch	1.14
VERTICAL & HORIZ, 50K ohms 1 meg.	1.04
BRIGHTNESS CONTROL, 50K ohms	.44
HORIZ. CENTERING, wirewound, 20 ohms	.57
HEIGHT CONTROL, 2.5 megohm	.48
VERTICAL LINEARITY, 5000 ohms	.44
VERTICAL CENTERING, wirewound, 20 ohms	.96
FOCUS CONTROL, wirewound, 1500 ohms	.98
HORIZONTAL DRIVE, 20K ohms	.44

H.V. FILTER CONDENSERS (Cartwheels)

10KV —— 500 MMFD	.48
15KV —— 500 MMFD	.67
20KV —— 500 MMFD	.79

WIREWOUND RESISTORS

5000 ohms, 5 watts	.22
VOLTAGE DIVIDER, 1360/250 ohms	.74
VOLTAGE DIVIDER, 5300/2-500 ohms	.89
VOLTAGE DIVIDER, 6750/12/93 ohms	.72

CARBON RESISTORS

½ WATT, 5% TOLERANCE, 10, 150(5) 3900 4700, 5600, 10K(2), 18K 680K(2), 820K OHMS, 1.2 & 1.5 MEG	ea. .09
½ WATT, 10% TOL., 3.3, 39(3), 330, 560(3) 680, 1800, 2700(2), 3300, 4700, 6800(4), 8200(4), 10K(3), 22K, 27K(2), 47K, 56K, 100K(3), 150K, 270K, 470K(3) OHMS, 1(2), 2.2(2) 4.7, 6.8 MEG	ea. .07
½ WATT, 20% TOL., 100(2), 1000(9), 3300, 22K(3), 100K, 150K, 220K(2), 330K, 470K(3) OHMS, 1(3), 10 MEG	ea. .05
1 WATT, 5% TOL., 2.2, 39K, 47K OHMS	ea. .14
1 WATT, 10% TOL., 1800, 3300, 4700(2) 10K (2), 18K, 22K, 27K, 39K OHMS, 1 MEG	ea. .12
1 WATT, 20% TOL., 10K OHMS	ea. .10
2 WATT 10% TOL., 100, 270 OHMS	ea. .18
2 WATT, 20% TOL., 2200(2) OHMS	ea. .14

MICA CONDENSERS—85°C Operation

270 MMFD — 500 W.V. (7) ea.	.12
390 MMFD — 500 W.V.	.12
470 MMFD — 500 W.V.	.12
680 MMFD — 500 W.V.	.16
4700 MMFD — 500 W.V.	.29

ELECTROLYTIC CONDENSERS—85°C

40/10/80MFD — 450/450/150 VOLTS	1.37
40/40/10MFD — 450/450/450 VOLTS	1.49
80/50MFD — 450/50 VOLTS	1.49
40/10/10MFD — 450/450/350 VOLTS	1.37
20/80MFD — 450/350 VOLTS	1.49
250/1000MFD — 10/6 VOLTS	.98

TUBULAR CONDENSERS—85°C

.002 – 600V		.09	.005 – 400V	(3) ea.	.07
.0025 – 600V	(2) ea.	.09	.01 – 400V	(5) ea.	.09
.004 – 600V		.11	.015 – 400V	(2) ea.	.11
.005 – 600V		.11	.05 – 400V	(5) ea.	.12
.01 – 600V	(2) ea.	.12	.1 – 400V	(2) ea.	.14
.05 – 600V	(6) ea.	.15	.001 – 1000V		.14
.1 – 600V		.17	.004 – 1000V	(2) ea.	.14
.25 – 400V	(2) ea.	.21	.035 – 1000V		.18

.05 – 1000V .... .18

CERAMIC CONDENSERS

10 MMFD, 10% Tolerance	.12
51 MMFD, 10% Tolerance	.12
56 MMFD, 10% Tolerance	.12
82 MMFD, 10% Tolerance (2) ea.	.12
1200 MMFD, not less than rated capacity	.14
1500 MMFD, not less than rated capacity (21) ea.	.14
6800 MMFD, not less than rated capacity	.19

#630 TV TUBES—STANDARD MAKES

6J6	R.F. Amplifier	1.97
6J6	R.F. Oscillator	1.97
6J6	Converter	1.97
6BA6 (2)	1st and 2nd Sound I.F. ea.	1.08
6AU6	3rd Sound I.F.	1.69
6AL5	Sound Discriminator	1.69
6AT6	1st A.F. Amplifier	1.08
6K6GT	Audio Output	1.08
6AG5 (4)	1st, 2nd, 3rd, 4th Pix I.F. ea.	1.74
6AL5	Pix. Det. & DC restorer	1.69
6AU6	1st Video Amplifier	1.69
6K6GT	2nd Video Amplifier	1.08
6SK7	1st Sync. Amplifier	.98
6SH7	Sync. Separator	1.69
6SN7	2nd Sync. Amp & Hor. Dis	1.62
6J5	Vert. sweep osc. dis.	.87
6K6GT	Vertical sweep output	1.08
6AL5	Hor. Sync. Discriminator	1.69
6K6GT	Hor. Sweep Oscillator	1.08
6AC7	Hor. Sweep Osc. Control	2.29
6BG6G	Horizontal Sweep Output	2.89
5V4G	Reaction scanning	1.87
1B3/8016	High Voltage Rectifier	1.94
5U4G (2)	Power Supply Rectifier ea.	1.08

BROOKS RADIO & TELEVISION CORP., 84 Vesey St., Dept. A, New York 7, N.Y.

BATTERY-DRAIN REBUTTAL

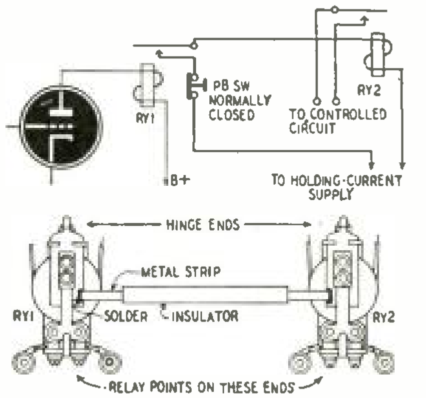
In the "Try This One" column of the July, 1950 issue, Mr. Cohn suggested replacing 300-ma tubes with their 150-ma equivalents to reduce drain on automobile batteries. I have found that 150-ma tubes do not last long in vehicular service because their heaters are too fragile to take the pounding and vibration. On the other hand, 150-ma tubes are fine for a.c.-operated equipment.

If you must save heater current in a battery set, do not replace a 6X5 or similar rectifier with an 0Z4. Use smaller pilot lamps and economize elsewhere. These tubes generate a hash which defies description. It starts shortly after a new tube is placed in service.

If an auto radio comes in with a complaint of odd-sounding whistles, hisses, or hash; check to see if it uses an 0Z4. If so, a new one will provide temporary relief. For a more effective cure, try shunting each of the filter capacitors with a 500-μμf, 1,000-volt capacitor and connect a hash filter—a parasitic choke and 500-μμf capacitor in parallel—in series with each plate of the 0Z4. The choke may be made by winding No. 18 enameled wire over a 10,000-ohm, 2-watt resistor.—*James Charles Soukup*

SELF-LOCKING RELAY

If you need a special locking relay with electrical release, you can make one from two surplus relays. Mount the relays side by side and connect their armatures together with a mechanical linkage. If the armatures do not carry current, they can be linked by a metal strip soldered to each. If either carries current, then you can use a plastic rod drilled for short lengths of bus bar or metal strips which are soldered to the armatures.



The drawings show the construction of the relay and a typical circuit. RY1 may be a s.p.s.t. sensitive relay in the output of a capacitance relay, photocell, etc. When a pulse is applied to the coil of RY1, it pulls in and closes the holding circuit to the coil of RY2. The contacts of both relays will stay closed until the circuit is opened with the normally closed push-button switch.

The coil of RY2 may match any convenient source of current for the holding current. It should have enough contacts to handle the controlled circuits. Use this system as a push-to-start, push-to-stop control for your transmitter.—*O. C. Vidden*

PHASING LOUDSPEAKERS

Having enjoyed reading the article "Connecting Loudspeakers" in the June, 1950, issue, I would like to add a few words on the subject.

When a number of speakers are mounted on a common baffle or close to each other, it is necessary that they be phased or connected so that they work as one unit. Before connecting each speaker, momentarily connect a 1.5-volt dry cell across the voice coil. Note the polarity of the battery and the direction the cone moves.

If matching transformers are used with the speakers, connect a high-resistance voltmeter across the secondary. Touch the leads of a 22.5-volt battery to the primary and note which direction the meter reads. In either case, connect the speakers so the cone movements or meter deflections are in the same direction.—*C. J. Laughlin*

MORE USE FOR WELLER IRON

Weller-type soldering irons are useful in determining which parts of a radio or amplifier are sensitive to 60-cycle hum. Hold the tip of the iron close to transformers, chokes, and any other components suspected of picking up hum. (The radio and iron must be on for this test.) Not only will the strong magnetic field around the tip show which parts are sensitive to hum, it will also show which side of the component is most sensitive. Thus it is simple to orient transformers and other components for minimum pickup.

We worked on a phono amplifier which had a low-level a.c. hum which resisted all the standard hum-elimination practices. By using the method outlined above, we traced the hum to a small iron-cored choke in the scratch-filter assembly. A grounded metal shield around the assembly cleared up the trouble.—*O. C. Vidden*

HELP FREDDIE WALK FUND

It is most pleasing to state this month that the Freddie Fund has reached almost $3500.00 in contributions to Freddie, the Arkansas radio technician's two-year-old son born without arms or legs.

Freddie returned South last month after a stay of several months in West Orange, N. J. where he was fitted with his artificial legs. This, as previously reported, is the first stage in rehabilitating the child so he can become a useful citizen and, we hope, an excellent radioman in due time.

Freddie is now learning how to stand.

The artificial legs so far have enabled him only to balance himself, which for a person born without legs is a task in itself. It should always be remembered that Freddie is only two years old. His father reports that Freddie is doing fine at this particular point and he believes that with just a little more practice he will be able to take a step. This he will be able to do by twisting the lower part of his body. It will take a lot of patience on the part of his parents and others, but his doctors believe that it won't be long before he will learn how to walk. It will be several years before any attempt will be made to fit Freddie with artificial arms as he must first learn how to use his legs which will be quite a task to master.

In the meanwhile we hope that our readers will do their utmost with contributions which are badly needed to rehabilitate the boy so that he will be able to take care of himself.

The Editor was particularly pleased to receive a letter from a young college student who is organizing a Help-Freddie-Walk Fund through his college. We hope to report more on this particular effort in the near future.

Keep up the good work by sending your contributions—even the smallest one will be highly welcome.

Make all checks, money orders, etc., payable to Herschel Thomason. Please address all letters to:

Help-Freddie-Walk Fund
c/o RADIO-ELECTRONICS
25 West Broadway
New York 7, N. Y.

Balance as of September 22	$3134.21
Wilbur M. Abel—Lawpoint, Ill.	$ 25.00
Ack Radio Supply Co.—Birmingham, Ala.	10.00
E. H. Allen—Belmont, Mass.	1.00
Anonymous—Escondido, Calif.	2.00
Anonymous—Los Angeles, Calif.	2.00
Anonymous—Redwood City, Calif.	10.00
Anonymous—Washington, D. C.	10.00
Anonymous—Bellewood, Ill.	1.00
Anonymous—Rantoul, Ill.	2.00
Anonymous—Rutherford, N. J.	5.00
Anonymous—Brooklyn, N. Y.	10.00
Anonymous—Brooklyn, N. Y.	1.00
Anonymous—Buffalo, N. Y.	2.00
Anonymous—New York, N. Y.	1.00
Anonymous—Philadelphia, Pa.	1.00
Anonymous—Roscoe, Pa.	5.00
Anonymous—Memphis Tenn.	2.00
Anonymous—Houston, Texas	1.00
Anonymous—Seattle, Wash.	1.00
Barbara and Ernie Baker—Wellesley, Mass.	1.00
R. P. Battle—Bayside, N. Y.	3.00
Virgil E. Beck—Omaha, Nebr.	3.00
Patty Boxx—Downey, Calif.	1.00
Ernest E. Case KL7WK—Vacaville, Calif.	5.00
Charles Cerami—Newark, N. J.	1.00
Peter Cerasoli—South Plainfield, N. J.	1.00
L. D. Clemmons—Thomasville, N. C.	2.00
Communications Equipment Co.—New York, N. Y.	20.00
P. M. Conroy, Conroy Radio & Television—Detroit, Mich.	10.00
R. W. D.—Short Hills, N. J.	5.00
J. C. W. Dick—Detroit, Mich	2.00
Lila and Ronnie Driver—Pikeville, Ky.	2.00
Leiland M. Duke—Vicksburg, Miss.	1.00
Eddie Etienne—Brussels, Belgium	1.00
Laurence M. Eugene—Chicago, Ill.	1.00
Friends from Yonkers—Yonkers, N. Y.	5.35
Dr. William H. Grace—Bronxville, N. Y.	15.00
N. X. Herman, W6ZSA—San Diego, Calif.	5.00
Louis H. Hippe, W6APQ—No. Hollywood, Calif.	10.00
Roy Johnston—Detroit, Mich.	5.00
Stanley C. Kukla—Honolulu, T. H.	5.00
Jim Lawson—Lebanon, Mo.	1.00
W. W. Ledli—Bartlesville, Okla.	1.00
D. B. Lones—Los Angeles, Calif.	1.00
Mr. & Mrs. Robert E. McCullough, Grove City, Pa.	2.00
H. McK.—Longmont, Colo.	10.00
Mrs. June Madden—Detroit, Mich.	2.00
Johnny and Billy Martin—Jeffersonville, Pa.	2.00
William G. Martin—Cincinnati, Ohio	5.00
Mid-West Associated—Rockford, Ill.	10.00
Alice Sally Miller—Rochester, N. Y.	1.00
W. Moehring—Charlotte, Mich.	2.00
D. Nestor—Detroit, Mich.	1.00
John J. Pacosky—Pittsburgh, Pa.	10.00
J. F. Pepi—Framingham, Mass.	2.00
J. C. Pope—Philadelphia, Pa.	1.00
Psalm 100—New York, N. Y.	15.00
John Rabuse—Brooklyn, N. Y.	1.00
C. S. Rasmussen—Evansville, Ind.	3.00
Roessler Radio Service—Ridgewood, N. Y.	2.00
Rosicrucian Sunshine Circle—Dayton, Ohio	5.00
Jerome Salinger—Easton, Pa.	5.00
San Francisco Radio & Supply Co.—San Francisco, Calif.	10.00
Henry A. Savard—Queens Village, N. Y.	1.00
E. Schoenike—Cedar Rapids, Ia.	3.00
Serva-Tek Products Co., Inc.—Paterson, N. J.	10.00
Caryl, Marvin and Douglas Sholes—Pleasantville, N. J.	2.00
Swift All-Steel Body Company, Inc.—Saginaw, Mich.	25.00
Elbert L. Taylor W2EWD—Monsey, N. Y.	5.00
George M. Todd—Philadelphia, Pa.	2.00
F. Tomasek—Bronx, N. Y.	5.00
J. C. Varga—Cleveland, Ohio	4.00
WØSD—Fergus Falls, Minn.	1.00
Burton O. Williams—Seattle, Wash.	5.00
Paul Wing—Detroit, Mich.	5.00
Mrs. J. J. Workheiser—Rock Island, Ill.	1.00
Total Contributions received up to October 23, 1950	$3491.56

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.

DECEMBER, 1916, ELECTRICAL EXPERIMENTER

Eyes and Ears for the Sub-Sea Fighters, by Thomas W. Benson
Transmitting Your Photo Over a Wire, by Jacques Boyer
Western Radio Amateurs Offer Their Stations to Army
The Arlington Radio Station (NAA), by Capt. W. H. G. Bullard, U.S.N.
The Revolving Mirror for Determining Spark Characteristics, by Samuel Cohen
Anent the Audion, by Dr. Lee deForest
Efficient and Economical Method of Utilizing the Armstrong Regenerative Audion System for Damped and Undamped Waves, by Samuel Curtiss, Jr.
Electrolytic Rectifiers and How They Work
An Adjustable Fixed Condenser, by Raymond Sutcliffe
A Sounding Board Microphone, by Len K. Wright
Standard Radio Terms Defined

TECHNICIAN'S EXHIBIT

Philadelphia radio technicians held their second annual show and exhibit in that city's Broadwood Hotel September 25-27. Technical sessions were held throughout the second two days, and a number of excellent technical papers were read.

Attendance was disappointing, due apparently to last-minute publicity difficulties, though some blamed the rush of sets being repaired for important sport events for keeping technicians away. In any case, not more than 3,000 of the expected 8,000 technicians registered for the affair, and a number of important papers were read to small audiences.

A number of interesting exhibits were entered by manufacturers, representatives and publications. Most impressive was the very complete demonstration of the use of electronics in defense by the Armed Forces.

The technical lectures were on a higher plane than most of those previously presented at service technicians' meetings. Highlight of the convention was possibly the paper on color television systems by Charles J. Hirsch of the Hazeltine Research Corp. Illustrated with color slides which showed exactly how the "mixed highs" principle is applied, and with tables comparing the more common color systems as to efficiency, spectrum use, and detail, it was the most educational lecture that has been delivered to radio technicians for some time. Second only to it was John Rider's discussion "Radio or TV" in which he proved that AM and FM radio will be with us for a considerable number of years to come. A film which drove home the correct methods of television installation by showing how *not* to install a receiver also obtained the convention's unqualified approval.

NEW GUILD FORMED

A new organization, the Electronic Technicians' Guild of Pennsylvania, has been formed in Philadelphia. The organization is the first of its type, in that it takes in all phases of the servicing industry. The Guild comprises four groups: employees, employers, "neutral members" and student members. All individuals and organizations that are members of the Guild are classified as to the membership group to which they belong.

The purpose of the Electronic Technicians' Guild may be best summed up in the words of its constitution:

"The Guild exists for the purpose of aiding its members in improving and uplifting their social, professional and economic status in life through cooperation, registration and informative advertisements; the adoption of an enlightened educational program; the classification of employees according to their skills, talents and qualifications; the establishment of a recommended wage schedule consistent with the skills involved; the encouragement of the adoption of fair trade pricing policies;

the elimination of sweat shops and unfair and cut-throat competition, securing the compliance with statutory, federal, state and local laws and regulations as they pertain to labor, business and health and fire underwriter policies; the amicable settlement of disputes between Guild members and the public or between Guild members and outside organizations; legal aid services and such other benefits, programs or policies the membership of the Guild may adopt for the purpose of securing the individual and collective interests of the membership."

The Philadelphia Section of the Guild has already begun to function. The present officers are: Paul Lau, president; Karl Vogelsang, vice-president; John Zagury, corresponding secretary; Stan Myers, secretary treasurer; and Frank Gerhard, recording secretary.

SHORTAGES DISCUSSED

Labor and parts shortages were discussed at the October meeting of the Television Contractors Association in Philadelphia. Two methods to help ease these problems were approved.

A central employment bureau will be established to make it easier to get labor, particularly qualified television service technicians. The facilities of this bureau will be open to potential employees without charge and it will operate for the benefit of TCA membership.

The failure of manufacturers to set aside sufficient parts and tubes to meet service needs was severely criticized. To reduce the problem in Philadelphia, the association will establish a cooperative buying agency. In the beginning, association members will band together to buy large offerings of much needed items that could not be handled by individual contractors. If this meets with success, the cooperative buying plan will be expanded. The association hopes that this scheme will reduce the cost of servicing and help the contractor to stay in business.

N. Y. TECHNICIANS MEET

The Empire State Federation of Electronic Technicians Associations held their fall meeting at Kingston, N. Y., September 24. Twenty-four delegates, representing ten local associations, were present, as well as 30 guests.

Discussion centered around the fall educational program, in connection with which the following resolution was adopted:

"Any local association so requesting, shall have the educational lectures made available to their membership, even if they have only a small membership and can get only a small attendance."

The secretary reported that no answer had been received to letters sent the industry concerning distributor and jobber malpractices. These letters are being followed up with the idea of obtaining some satisfaction.

The next meeting of ESFETA is scheduled for Binghamton, January 14, 1951.

Howard E. Anthony, president of HEATH MANUFACTURING Co., was awarded an honorary degree of Doctor of Science in Electronics by the University of Hollywood.

The degree was conferred upon Mr. Anthony at Benton Harbor, Mich., in recognition of his contributions to the field of industrial electronics.

Charles Odorizzi, former vice president in charge of service for the RCA VICTOR division, was elected operating vice president. Mr. Odorizzi joined RCA in 1949 as administrative head of service

activities. RCA also announced the election of Edward M. Tuft as vice president and director of the personnel department. Mr. Tuft has been with RCA since 1930.

Peter L. Jensen, president of JENSEN INDUSTRIES, INC., received the Order of Knight of the Flag from King Frederick of Denmark on his recent trip to Denmark. Mr. Jensen was knighted for his contributions to the field of radio.

Sketch by Otto C.

Curtis A. Haines, former general manager of the photoflash division of SYLVANIA ELECTRIC PRODUCTS, was appointed general manager of operations for the radio and television picture tube divisions. Sylvania also announced the appointment of L. R. Wanner to the post of plant manager in charge of plastics operations for the parts division.

Dr. Vladimir K. Zworykin, director of electronic research and vice president of RCA Laboratories, will be awarded the 1951 Medal of Honor, the highest award of the Institute of Radio Engineers, at the IRE convention in March, 1951. Dr. Zworykin will be given the medal for his outstanding contributions to the development of television.

The Radio-Television Manufacturers Association named several important committees. The committees and their membership are:

JOINT ELECTRONICS INDUSTRY COMMITTEE: F. R. Lack, WESTERN ELECTRIC, chairman; Benjamin Abrams, EMERSON; C. F. Adams, RAYTHEON; W. R. G. Baker, GENERAL ELECTRIC; Max F. Balcom, SYLVANIA; William Balderston, PHILCO; W. J. Barkey, COLLINS RADIO CO.; Harold Buttner, I. T. & T.; John W. Craig, CROSLEY; Allen B. Du Mont, DU MONT; Harry A. Ehle, INTERNATIONAL RESISTANCE CO.; Walter Evans, WESTINGHOUSE; Malcolm P. Ferguson BENDIX; Frank Folsom, RCA; Paul V. Galvin, MOTOROLA; R. E. Gilmour, SPERRY; W. J. Halligan, HALLICRAFTERS; H. L. Hoffman,

OPPORTUNITY AD-LETS

Advertisements in this section cost 25c a word for each insertion. Name, address and initials must be included at the above rate. Cash should accompany all classified advertisements 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 January, 1951, issue, must reach us not later than November 24, 1950.**
Radio-Electronics, 25 W. Broadway, New York 7, N.Y.

HOFFMAN RADIO; J. J. Kahn, STANDARD TRANSFORMER; Arie Liberman, TALK-A-PHONE; W. A. MacDonald, HAZELTINE; E. F. McDonald, Jr., ZENITH; A. D. Plamondon, Jr., INDIANA STEEL PRODUCTS; Ross Siragusa, ADMIRAL.

"TOWN MEETINGS" COMMITTEE: Harry A. Ehle, INTERNATIONAL RESISTANCE CO., Chairman; Benjamin Abrams, EMERSON; A. T. Alexander, MOTOROLA; H. C. Bonfig, ZENITH; A. A. Brandt, GENERAL ELECTRIC; Leonard F Cramer, DU MONT; J. B. Elliott, RCA; G. M. Gardner, WELLS-GARDNER; H. L. Hoffman, HOFFMAN RADIO; J. J. Kahn, STANDARD TRANSFORMER; Stanley H. Manson, STROMBERG-CARLSON; Leslie F. Muter, MUTER CO.; Henry T. Paiste, PHILCO; A. D. Plamondon, Jr., INDIANA STEEL PRODUCTS; Edward C. Tudor, INDUSTRIAL DEVELOPMENT ENGINEERING ASSOCIATES.

SALES MANAGERS COMMITTEE: Clifford J. Hunt, STROMBERG-CARLSON, Chairman; Stanley M. Abrams, EMERSON; A. A. Brandt, GENERAL ELECTRIC; William Dunn, BELMONT RADIO; V. C. Havens, CROSLEY; William H. Kelley, MOTOROLA; E. G. May, SENTINEL RADIO; Allan Mills, RCA; John M. Otter, PHILCO; Stewart Roberts, MAGNAVOX; R. J. Sherwood, HALLICRAFTERS; Raymond P. Spellman, ARVIN; Walter L. Stickle, DU MONT; E. L. Taylor, STEWART-WARNER; L. C. Truesdell, ZENITH; J. F. Walsh, WESTINGHOUSE.

R. G. Zender, LENZ ELECTRIC MFG. CO., Chairman of the RTMA parts division named heads of the various Parts Division Section. These are ANTENNA: G. O. Benson, PREMAX PRODUCTS.
CERAMIC CAPACITOR: K. E. Rollefson, MUTER CO.
COIL: Edwin I. Guthman, EDWIN I. GUTHMAN CO.
FIXED CAPACITOR: W. Myron Owen, AEROVOX.
FIXED RESISTOR: D. S. W. Kelly, ALLEN-BRADLEY.
INSTRUMENT & TEST EQUIPMENT: R. L. Triplett, TRIPLETT ELECTRICAL INSTRUMENT CO.
METAL STAMPINGS & SPECIALTIES: Jay H. Johnson, JOHNSON & HOFFMAN, INC.
PHONOGRAPH CARTRIDGES: S. N. Shure, SHURE BROS.
RECORD CHANGERS: H. E. Moon, GENERAL INDUSTRIES.
SOCKETS: Lester W. Tarr, CINCH MFG. CO.
SPEAKERS: Matt Little, QUAM-NICHOLS.
SPEAKER PARTS: Wm. H. Welsh, WM. H. WELSH CO.
SPECIAL PRODUCTS: W. R. MacLeod, KING LABS.
SWITCHES: W. S. Parsons, CENTRALAB DIV. Globe-Union.
TRANSFORMERS: L. S. Racine, CHICAGO TRANSFORMER DIV. Essex Wire Corp.
TUBE PARTS: S. L. Gabel, SUPERIOR TUBE.
VARIABLE CAPACITORS: Russell E. Cramer, Jr., RADIO CONDENSER CO.
VARIABLE RESISTORS: Victor Mucher, CLAROSTAT.
WIRE: John S. Miller, CORNISH WIRE.
WIREWOUND RESISTORS: Roy S. Laird, OHMITE.
BUDGET: Charles A. Hansen, chairman; Samuel J. Spector; Herbert C. Clough, BELDEN MFG. CO.; Lew Hatry, HATRY & YOUNG and Lew Howard.

Jerome J. Kahn, president, STANDARD TRANSFORMER CORP., was elected for a second term as president of the Radio Parts and Electronic Equipment Shows board of directors. Samuel J. Spector, INSULINE, was elected vice president; Lew Howard, TRIAD TRANSFORMER, secretary; and Charles A. Hansen, JENSEN MFG. CO., treasurer. Mr. Kahn appointed the following committees:

PUBLICITY: John H. Cashman, RADIO CRAFTSMEN, INC., chairman; Tom Jenkins, RADIO SUPPLY CO.; Jerry Kirshbaum, PRECISION APPARATUS CO.
HOUSING: Samuel J. Spector, chairman; John H. Cashman; Lew Howard and Tom Jenkins.
ARRANGEMENTS: Entire board of directors and Charles Golenpaul, AEROVOX; Walter W. Jablon, ESPEY MFG. CO.; Harry Kalker, SPRAGUE ELECTRIC; and William O. Schoning, LUKKO SALES.
ENTERTAINMENT: Jerry Kirshbaum, Lew Howard, and Charles Hansen.
CREDENTIALS: Lew Hatry, Charles Hansen, Jerry Kirshbaum, and Tom Jenkins.
EDUCATIONAL: Jack Berman, SHURE BROS.; Herbert C. Clough, John Cashman; John F. Rider, JOHN F. RIDER, Publisher; and Howard W. Sams, HOWARD W. SAMS & CO.
MANUFACTURER-DISTRIBUTOR ADVISORY COMMITTEE: Herbert C. Clough, chairman; William O. Schoning; W. D. Jenkins, RADIO SUPPLY CO., Richmond, Va.; L. W. Hatry; W. A. Wilson, HUGHES-PETERS; George Barbey, GEORGE D. BARBEY CO.; Lew Bonn, LEW BONN CO.; H. L. Dalis, H. L. DALIS, CO.; Sam Poncher, NEWARK ELECTRIC; Charles Golenpaul, AEROVOX; Milton Deutschmann, RADIO SHACK; Walter W. Jablon, ESPEY COMPANY; John Stern, RADIO ELECTRIC SERVICE CO.; Les Thayer, BELDEN MFG. CO.; Robert Sprague, SPRAGUE ELECTRIC.

TRUETONE RECEIVERS

When aligning these receivers, don't pass up the r.f. or antenna trimmers if you can't peak them. Most of these sets are designed to have a definite peak with r.f., oscillator, and antenna trimmers. Replace the converter (and r.f. tube, if necessary) even when they check O.K. on a tester. An aged tube might change its input capacitance so much that the tuned circuits can't be peaked.—*David Gnessin*

PHILCO MOPAR SETS

Lack of volume and distortion often show up after Mopar custom-built sets have been operating for about an hour. These troubles are almost invariably caused by the tiny 47,000-ohm resistors in the plate and cathode circuits of the phase-inverter tube. These resistors are under strain and sometimes open intermittently. Replace them with standard ½-watt units.—*T. M. Ferreira*

LICKING AN INTERMITTENT

If you are still stuck with an intermittent receiver after trying all the tricks in the book, subject the set to several cycles of heating and cooling. In winter, leave the set near a radiator or furnace for one day, then put it outside for another. Do this several times. In summer, use a sunny spot and a refrigerator. A few cycles of heating and cooling will almost invariably show up the faulty part.—*Leonard Pfeiffer*

AUTOMOBILE RADIOS

Many automobile radios, particularly the 1947 Chevrolet models, have dynamic speakers with the hot 6-volt lead connected to an insulated eyelet which is used as a tie-point. These eyelets invariably twist around and short to the speaker frame, making the fuses blow. This won't happen again if you drill out the eyelet and replace it with a small, one-lug, insulated terminal strip.—*Bob Williams*

BLINKING PILOT LAMPS

Pilot lamps which blink intermittently in a.c.-d.c. sets can be caused by an intermittent heater in one of the tubes. Locate the faulty tube by connecting a fast-acting a.c. voltmeter across each heater until you come to one which causes the meter to rise above normal when the pilot is off. Replace this tube.—*DeLoss Tanner*

TRAV-LER 5028-A

If this set comes in with an open filament in the 3V4 power amplifier tube, check the filament dropping resistor which is located above the chassis, behind the speaker. Its bottom lug sometimes cuts through the insulation and shorts the red lead going to the top of the resistor. Reinsulate the lead and turn the lug away from it.—*Hurley D. Robinson*

FORD RADIO MODEL 6MF780

If this set will not play or will not receive stations except at one spot on the dial, the trouble may be traced to the shunt coil in the oscillator circuit. This coil has been found open due to improper soldering and waxing. The connections of the oscillator coil are shown.

To locate the trouble measure the resistance across the 6.2-ohm section of the coil with a low-range ohmmeter. Since the 3-ohm shunt coil parallels this section of the coil, the meter will read approximately 2 ohms if the coil is good. A 6-ohm reading indicates that the shunt coil is open.

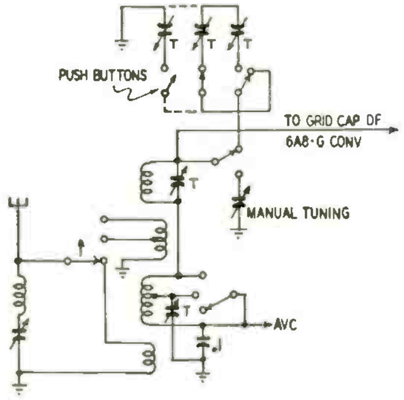
Cleaning and resoldering the connections usually clear up the trouble.—*Adams Radio Service*

KILLING BIRDIES AND OSCILLATION

To determine the source of oscillation in a receiver, tune the set for a good beat note or birdie. Use a metal tool such as a screwdriver to probe around the grid and plate leads of the r.f., mixer, and i.f. stages until there is an abrupt change in the audio note. Verify your findings by detuning the suspected circuit. This will also change the frequency of the beat. Check the alignment, shielding, lead dress, bypass capacitors, and decoupling networks for causes of oscillation. Do not overlook possible coupling between a loop antenna and the mixer or i.f. stages.—*Charles Buscombe*

GE MODEL G61

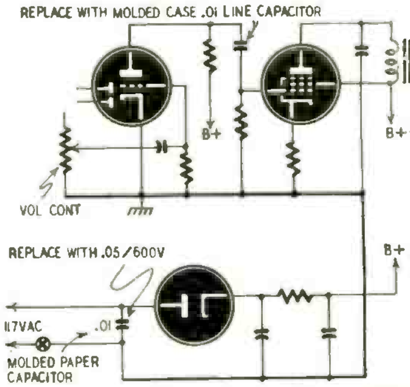
This set came in with the complaint that it would play when push-button tuning was used but could not be tuned manually on the broadcast or shortwave bands. Checking the oscillator circuit with a dynamic analyzer, we found it to be operating properly on



manual and push-button tuning. After setting the receiver for touch tuning, we connected an ohmmeter across the antenna tuning capacitor and found it shorted. The short was cleared by separating the plates, which were touching. The diagram shows the antenna circuit when the set is adjusted for push-button tuning.—*Manuel E. Silva*

RCA 26X1

Intermittent noises and squealing are frequent complaints on this and similar models. Trouble-free perform-



ance can sometimes be had by replacing the 600-volt capacitor between B-minus and the chassis.—*Peter Bedrosian*

CROSLEY 10-401 AND OTHERS

The horizontal oscillator in the models 10-401, -404, -412, -414, -416, and 10-418 has a tendency to drift, thus causing the receiver to lose horizontal sync after it has warmed up. If the horizontal sync adjustment is made after the set has warmed up, the picture will not fall in sync when the receiver is cold.

This trouble is caused by a molded capacitor C160 (type 487) which may change capacitance with temperature. The capacitance change is sufficient to cause the receiver to lose horizontal sync.

Correct the trouble by replacing it with a .01-μf, 600-volt paper capacitor (part No. 39001-13).—*Crosley Service Department*

EXPERIMENTAL ARTICLES

Dear Editor:

Regarding your query in the January issue "Shall we abandon experimental articles?" I feel that it would be a great loss to those readers interested in all phases of electronics. The growth of science is based largely on experiment and without it knowledge and industrial growth would stagnate. Anything that will stimulate thinking is worthwhile.

Here is a short list of some problems that need further working on. None of them are new, but they all are in need of development.

Simplified full-color three-dimensional television; more efficient loudspeakers; improved transistors; uses for electrets; biological electronics—diagnosis and cure of disease; electronic weather forecasting; high power-to-weight ratio storage batteries; power from the sun's energy; radio transmission of power; electronic rain-making; electronic insect extermination; efficient hearing aid battery.

VANCE PHILLIPS
Santa Barbara, Cal.

SIG GEN TABULATION

Dear Editor:

I have made good use of the tabulation of multitesters you printed in May, 1949, comparing the testers shown before buying one. Now I need a standard signal generator and have been hoping you would print a similar table of their characteristics. The advertisements are some help, of course, but they almost never give the detailed, factual information that one of your tabulations affords. Are you likely to run such an item soon?

JOHN J. LA BRIER
Barstow, Calif.

(We published a tabulation of sweep generators in the February issue. Other readers interested in a survey of standard generators should let us know. If the demand is real, we'll run one.—*Editor*)

ELECTRONICS AND MUSIC

Dear Editor:

Apparently the subject of electronic music has a good number of highly interested adherents, judging from the mail I have received as a result of my electronic music series in RADIO-ELECTRONICS I have been answering each letter and want to suggest that readers let me know whenever they think I have left out material.

A common query is for information on books dealing with the subject. I think readers will be interested to know of the two books I have uncovered so far, one with the help of an enthusiastic correspondent in West Wales, Great Britain, Mr. Stanley Lewis. The first is *Electronic Musical Instruments*, by S. K. Lewer, available at 3 shillings sixpence from Electronic Engineering, 28 Essex Street, London W.C.2. The second is *The Electronic Musical Instrument Manual*, by Alan Douglas, priced at 18 shillings and available from Sir Isaac Pitman & Sons, Ltd., Pitman House, Parker Street, Kingsway, London W.C.2. Both books are small and consist principally of some theory and description of existing commercial instruments, but any electronic music enthusiast should find them interesting.

RICHARD H. DORF
New York, N. Y.

WANTS PORTABLE PURR

Dear Editor:

I like cats: I have a cat. But my cat has a very quiet purr. I like to hear cats purr.

I have thought of putting a throat mike on my cat and hooking it up to an amplifier. But I don't think my cat would like a throat mike or would purr at all.

Would you please print a circuit for a low-variable-frequency oscillator that would sound like a cat's purr? To be really good, it should have a random "long breath" effect.

The best would be a pocket-size portable so that I can carry it around and turn on when I feel like hearing a cat purr. It needn't lap milk.

PHILIP WALKER
Washington, Conn.

(We have an old solution, more than 100 years old, but regret there is no diagram available. We suggest you read "The *Purrloined* Letter" by Edgar Allan Poe.—*Editor*)

NEW.. EICO Instruments and KITS

Over 50,000 SERVICEMEN must be right!

give you Laboratory Precision *at Lowest Cost!*

NEW 5" PUSH-PULL OSCILLOSCOPE

All-new laboratory-precision scope with all the extra sensitivity and response for precise servicing of TV, FM & AM sets. Push-pull undistorted vertical and horizontal amplifiers. Boosted sensitivity, .05 to .1 rms volts/inch. Useful to 2.5 MC. TV-type multivibrator sweep circuits, 15 cps—75 KC. Z-axis intensity modulation feature. Dual positioning controls move trace anywhere on screen. Complete with 2-6J5, 3-6SN7, 2-5Y3, 5BP1 CRT. 3-color etched rubproof panel; steel case. 115 v., 60 cycle AC. 8½ x 17 x 13".

Model 425-K, KIT, only $39.95

Model 425, factory wired, $69.95

NEW VACUUM TUBE VOLTMETER

Laboratory-precision VTVM for trigger-fast operation and lifetime service. 15 different ranges. Large 4½" meter, can't-burn-out circuit. New zero center for TV & FM discriminator alignment. Electronic AC & DC ranges: 0-5, 10, 100, 500, 1000 v. (30,000 volts & 200 MC with HVP-1 & P-75 probes). Ohmmeter ranges, .2 ohms to 1000 megs. DB scale. New stable double-triode balanced bridge circuit—extreme accuracy. 26 megs DC input impedance. 3-color etched rubproof panel; steel case. 115 v., 60 cycle AC. 9-7/16 x 6 x 5".

Model 221-K, KIT, only $23.95

Model 221, factory wired, $49.95

NEW TUBE TESTER

Brand new professional tube tester and merchandiser EICO Service-Engineered for unbeatable value! Large 4½" full-vision meter. Tests *conventional and TV tubes* including 9 pin miniatures. New lever-action switches—tests every tube element. Illuminated "Speed Roll-Chart." 2 grid caps. Short and open-element tests. Spare socket for new tubes. Protective overload bulb. Electronic rectifier. 3-color etched panel; rugged steel case. 115 v., 60 cycle AC. 12½ x 9½ x 4¼".

Model 625-K, KIT, only $29.95

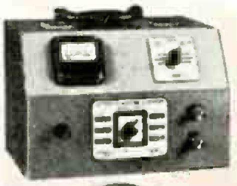
Model 625, factory wired, $44.95

NEW SIGNAL GENERATOR

For FM-AM precision alignment and TV marker frequencies. Vernier Tuning Condenser. Highly stable RF oscillator, range: 150 KC—102 MC with fundamentals to 34 MC. Separate audio oscillator supplies 400-cycle pure sine wave voltage. Pure RF, modulated RF or pure AF for external testing. Attractive three-color etched rub-proof panel; rugged hammertone steel case. 115 v., 60 cycle AC. 10 x 8 x 4¾".

Model 320-K, KIT, only $19.95

Model 320, factory wired, $29.95



NEW BATTERY ELIMINATOR, CHARGER & BOOSTER

For all auto radio testing. Latest-type full-wave bridge circuit. 4-stack manganese copper-oxide rectifiers. Specially designed transformer, variable from 0 to 15 volts. Continuous: 5-8 v., 10 amps. Intermittent: 20 amps. 10,000 mfd filter condenser. Meter measures current and voltage output. Fused primary; automatic reset overload device for secondary. Hammertone steel case. 115 v., 60 cycle AC. 10½ x 7⅝ x 8⅜".

Model 1040-K, KIT, only $22.95

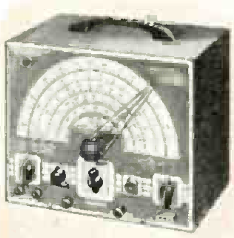
Model 1040, factory wired, $29.95

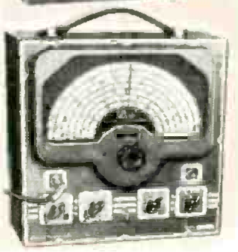
NEW SWEEP GENERATOR

Covers all TV-FM alignment frequencies. 500 KC—228 MC. Vernier-driven dial: center of each of 13 TV channels marked on front panel. Sweepwidth variable 0-30 MC with mechanical inductive sweep—permits gain comparison of adjacent RF TV channels. Crystal marker oscillator, variable amplitude. Provides for injection of external marker. Phasing control. Complete with HF tubes: 6X5GT, 12AU7 (dual-triode), 2-6C4. Less crystal. 10 x 8 x 6¾". 5 MC Crystal, ea. $3.95.

Model 360-K, KIT, only $29.95

Model 360, factory wired, $49.95





NEW DELUXE SIGNAL GENERATOR

A laboratory-precision generator EICO Service-Engineered with 1% accuracy. Extremely stable, frequency 75 KC—150 MC in 7 calibrated ranges. Illuminated hairline vernier tuning. VR stabilized line supply. 400-cycle pure sine wave with less than 5% distortion. Tube complement: 6X5, 7F7, 6C4, VR-150. 3-color etched panel; rugged steel case. 115 v., 60 cycle AC. 12 x 13 x 7".

Model 315-K, KIT, only $39.95

Model 315, factory wired, $59.95

VOLT-OHM-MILLIAMMETER

Pocket-size VOM cram-packed with value! 22 different ranges. 3" D'Arsonval movement. Ring-type shunts. Germanium crystal rectifier. Ranges—DC: 0-5, 50, 250, 500, 2500 v. AC & Output: 0-10, 100, 500, 1000 v. DC Ma: 0-1, 10, 100. DC Amp: 0-1, 10. Ohm: 0-500, 100,000; 0-1 Meg. DB: −8 to +55. 3-color etched panel; rugged hardwood case. 8 x 4½ x 3".

Model 511-K, KIT, only $14.95

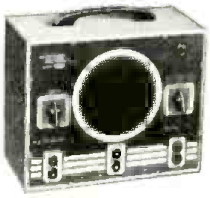
Model 511, factory wired, $17.95

MULTI-SIGNAL TRACER

Highest gain and flexibility in low-cost field. Audibly traces all IF, RF, Video and Audio from ANT to SPKR or CRT without switching. Response well over 200 MC. Integral test speaker. Provision for visual tracing with VTVM. Complete with 6SJ7, 6K6, 6X5. Germanium crystal diode. 3-color etched panel; rugged steel case. 115 v., 60 cycle AC. 10 x 8 x 4¾".

Model 145-K, KIT, only $18.95

Model 145, factory wired, $28.95



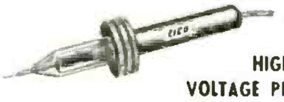
R F PROBE

Sensitive Germanium crystal probe for signal tracing and measurements to over 200 MC. Extends range of VTVMs and scopes.

P-75K KIT, for VTVM;

P-76K for Scope; ea. $3.75

P-75 or P-76, factory wired, ea. $7.50



HIGH VOLTAGE PROBE

New professional EICO-engineered HV probe carefully designed and insulated for extra safety and versatility. Extends range of VTVMs and voltmeters up to 30,000 v. Lucite head. Large flash-guards. Multi-layer processed handle. Complete with interchangeable ceramic Multiplier to match your instrument.

HVP-1 (wired) only $6.95

Due to unsettled conditions, prices are subject to change without notice.

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Easy-to-follow step-by-step EICO pictorial and schematic instructions—most explicit and comprehensive in electronics!—supplied with each Kit. *Anyone* can build the EICO Kits!

ELECTRONIC INSTRUMENT CO., Inc.

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Each EICO Kit and Instrument is doubly guaranteed, by EICO and your jobber, to contain only selected quality components. EICO guarantees to replace any component which might become defective in normal use if returned to the factory transportation charges pre-paid within 90 days of purchase. EICO guarantees all Kits assembled according to EICO's simplified instructions will operate as specified therein. EICO guarantees service and calibration of every EICO Kit and Instrument at the nominal charge as stated in the instructions.

Be sure to 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.

Prices 5% higher on West Coast

RADIO SCHOOL DIRECTORY

ELEMENTS OF SINGLE AND DUAL TRACK MAGNETIC TAPE RECORDING AND 1001 APPLICATIONS (Second Edition), by A. C. Shaney. Published by Amplifier Corp. of America, New York. 5½ x 8½ inches, 128 pages plus 16-page supplement. Price $1.00.

The first edition of this book was published in 1947 under the title *Elements of Magnetic Recording—and 999 Applications*. With this edition, the title was changed and its scope enlarged to cover dual-track recording.

Starting with the history of magnetic recording, the author traces the development of the art from early single-track recorders to the most modern dual-track instruments. Among the 21 chapters are those devoted to recording, playback, and erasing processes, magnetic tape nomenclature, performance specifications, tape-handling mechanisms.—*RFS*

TELEVISION SERVICING, by Walter H. Buchsbaum. Published by Prentice-Hall, Inc., New York, N. Y. 6½ x 9½ inches, 340 pages. Price $5.35.

Too few of the television books aimed at the student or service technician are written from the servicing viewpoint. In this one, the service technician's viewpoint crops up even in the part devoted to theory, where such practical points as voltage and current values appear regularly, in happy contradistinction to the generalization loved by so many theorists.

The section on theory is Part I of three; the other two are "Alignment, Installation" and "Troubleshooting." These two strictly service sections occupy 152 pages of the book. This does not mean that Part I is unimportant to the television technician; indeed, the technician reading chapter 19 on r.f. alignment finds that chapter 11 on television tuners complements it to give as complete a picture of television front ends as he has been able to find in the literature. The same close twinning of theory and practice is observable in other chapters.

Readers of the "Television Clinic" in RADIO-ELECTRONICS, conducted by Mr. Buchsbaum, are familiar with his style and approach. The same clear-cut, down-to-earth language is used in this book, especially in Parts II and III.

TRAVELING-WAVE TUBES, by J. R. Pierce. Published by D. Van Nostrand Co., New York, N. Y. 6¼ x 9¼ inches, 260 pages. Price $4.50.

A thoroughly mathematical and tech-

ADVERTISING INDEX

RADIO SCHOOL DIRECTORY

nical treatment of new traveling-wave tubes, with a chapter each on double-stream and magnetron amplifiers. Of interest to advanced students or tube engineers who wish to understand the new tube, or to design engineers who may wish to apply it in their work.

PRIMARY BATTERIES, by George Wood Vinal. Published by John Wiley & Sons, Inc., New York, N. Y. 6 x 8½ inches, 336 pages. Price $5.00.

Written by the author of the standard text on storage batteries just before his retirement as a physicist with the National Bureau of Standards, this work may become as authoritative as the earlier *Storage Batteries*.

The whole field is covered, from the voltaic pile to the mercury and vanadium cells. Other new types discussed are silver and lead primary cells, each of which receives a chapter.

A historical introduction opens the book, followed by a chapter on the elementary theory of electric cells. Materials and production of dry cells, their operating characteristics, and effects of temperature are discussed in separate chapters. Standard cells, air-cells and other batteries with special polarizers, and copper oxide cells also receive a chapter each.

Characteristics of various types of primary batteries are given in 87 tables scattered throughout the book, and there is an extensive index.

SERVICING TV RECEIVERS, compiled and published by Sylvania Electric Products Inc. New York, N. Y. 5 x 7 inches, 119 pages plus a few end pages and large fold-in schematic. Price $2.00.

A handy little work of the ring binding, open-flat type. The characteristic page has a photograph of an abnormal test pattern, with a statement of the probable causes and the remedies.

The list of illustrations can be used as a handy trouble-shooting chart. Altogether the screen patterns number 53. There are also seven schematic drawings, including the large fold-in.

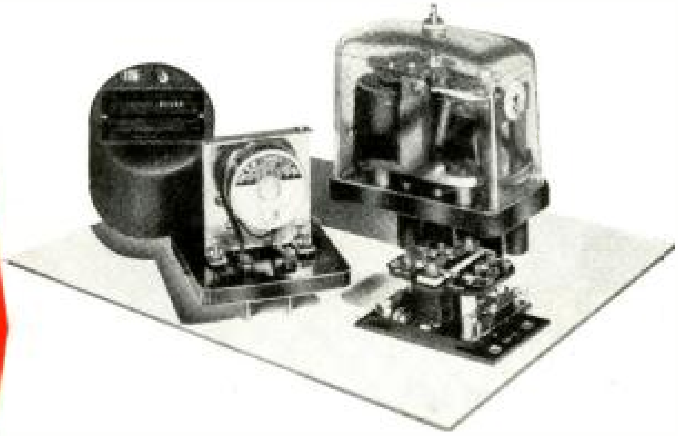
TELEVISION SIMPLIFIED, third edition, by Milton S. Kiver. Published by D. Van Nostrand Company, Inc., N. Y. 6 x 8½ inches, 608 pages. Price $6.50.

Nearly twice the size of the first edition, this new edition closely follows the pattern of the previous two. A new chapter discusses the principles of intercarrier television and the chapter on color television includes the latest material on the CBS, RCA, and CTI systems.—*MW*

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	227668 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 Switcn 2927B100-C2	.95
R-669	75 VAC.	400 CYC.	1B, 1A	Clare 400	.95
R-660	6 VDC.		," Stroke	Cannon Plunger Relay •13672	.95
R-651	24 VDC.	100	Solenoid Valve	...	2.50
R-295	12 VDC.	275	Annunciator 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

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