RADIO — ELECTRONICS

LATEST IN
TELEVISION
SERVICING
AUDIO

HUGO GERNSBACK, *Editor*

NOV
1950

30¢
U. S. and CANADA

NEW TOOL FOR NUCLEAR STUDY—SEE ELECTRONICS SECTION

No Need To Worry About Moisture When You Use The MALLORY PLASCAP*

MALLORY FP CAPACITORS

When you select Mallory FP Capacitors, you can be sure of their performance even in circuits where heat is a problem. Every Mallory FP Capacitor will operate continuously at 85° C. In addition, Mallory FP Capacitors are famous for their long shelf-life . . . you can depend on them when you need them. Buy the one line that services both AM and TV sets. They are an outstanding example of Mallory Precision Quality at standard prices.

See your Mallory Distributor right away!

The Mallory Plascap plastic tubular capacitor exceeds R.M.A. requirements for humidity and immersion tests . . . even for metal-cased capacitors. It's the plastic tubular that's years ahead of the rest of the field.

No oil leakage, no unsoldered leads, no messy wax coating, no insulation problems! Check these four exclusive features which make your service jobs surer and easier:

- **TRISEAL CONSTRUCTION.** Sealed three ways . . . with moisture-free Mallotrol, tough outer plastic shell, exclusive Mallocene!
- **FASTITE LEADS.** Permanently fastened . . . sealed with Mallocene . . . unaffected by soldering-iron heat!
- **DISTORTION-FREE WINDING.** No flattened cartridges due to molding pressures . . . no failures due to "shorts"!
- **TRU-CENTER CARTRIDGES.** Cartridges centered every time . . . uniform insulation guaranteed at all points!

You don't have to handle the Mallory Plascap with kid-gloves . . . it is built to "take it"! See your Mallory Distributor, now. Remember, you pay no more for Mallory Precision Quality!

*Trade Mark

P.R. MALLORY & CO. Inc.
MALLORY

CAPACITORS • CONTROLS • VIBRATORS • SWITCHES • RESISTORS • RECTIFIERS • VIBRAPACK* POWER SUPPLIES • FILTERS

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APPROVED PRECISION PRODUCTS

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

I Will Show You How to
LEARN RADIO-TELEVISION SERVICING OR COMMUNICATIONS
by Practicing in Spare Time

YOU PRACTICE RADIO SERVICING

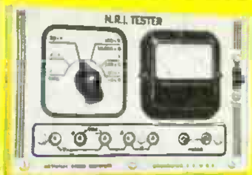
You build the modern Radio shown below as part of my Servicing Course. I send you speaker, tubes, chassis, transformer, loop antenna, everything you see pictured and EVERYTHING you need to build this modern Radio Receiver. Use it to make many tests, get practical experience.

YOU PRACTICE RADIO COMMUNICATIONS

I send you all the parts to build Transmitter shown below as part of my new Communications Course. Conduct actual procedure of Broadcast Operators, practice interesting experiments, learn how to actually put a transmitter on the air.

VETERANS HURRY! To get this valuable training under G. I. Bill. Time is running out.

YOU BUILD THIS TESTER



with parts I send in my Servicing Course. Soon helps you fix neighbors' Radios and EARN EXTRA MONEY in your spare time.

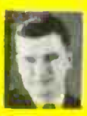
YOU BUILD THIS WAVEMETER

in my Communications Course. Use it to determine frequency of operation, make other tests.

YOU BUILD THIS SIGNAL GENERATOR

in my Servicing Course. It provides amplitude-modulated signals for many interesting tests and experiments.

I TRAINED THESE MEN AT HOME



"While learning, made $5 to $10 a week in spare time. Now have a profitable spare time shop."—L. ARNOLD, Pontiac, Michigan.

"4 years ago, a bookkeeper on a hand-to-mouth salary, am now a Radio Engineer ABC network."—N. H. WARD, Ridgefield Park, N. J.

"Have my own shop. Am authorized serviceman for 5 manufacturers and do servicing for 7 dealers."—P. MILLER, Maumee, Ohio.

"After graduating, worked for servicing shop. Now Chief Engineer of three Police Radio Stations."—S. W. DINWIDDIE, Jacksonville, Ill.

A TESTED WAY TO BETTER PAY...*MAIL COUPON NOW*

I Will Train You at Home with MANY KITS of Radio Parts I Send

Do you want good pay, a bright future, and security? Want your own profitable shop? Get into fast growing, prosperous RADIO-TELEVISION! Radio alone is bigger than ever. 81 million home and auto Radios, 2,700 Broadcasting Stations, expanding Aviation and Police Radio, Micro-Wave Relay, Two-Way Radio 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.

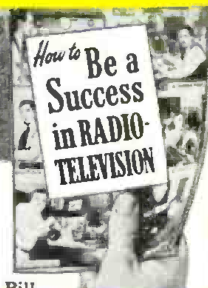
Many Soon Make $10 A Week Extra in Spare Time

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 a week extra 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 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. OMX, National Radio Institute, Washington 9, D. C. OUR 37TH YEAR.

Good for Both-FREE



MR. J. E. SMITH, President, Dept. OMX,
National Radio Institute, Washington 9, D. C.

Mail me FREE Lesson and 64-page book. (No salesman will call. Please write plainly.)

NAME...AGE..............

ADDRESS..

CITY...............................ZONE...........STATE..............

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RADIO — ELECTRONICS

Incorporating
SHORT WAVE CRAFT* TELEVISION NEWS*
RADIO & TELEVISION
*Trademark registered U. S. Patent Office

formerly RADIO-CRAFT

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ON THE COVER: Warren Goodell adjusts the absorber changer used in Columbia's high-speed neutron study. Intercom in the red box communicates with the control position.
Kodachrome by Avery Slack.

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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.

Ever since 1939 when Du Mont introduced the first commercial television set with its 14″ Teletron, Du Mont has pioneered BIG TV TUBES. While others were offering 7″ and 10″ tubes, Du Mont was satisfied with nothing less than 12″. Even as early as 1939, Du Mont made 20″ Teletrons. Since then the public and industry have followed the Du Mont lead, but Du Mont remains in the lead with still larger tubes climaxed by the 30″ Teletron available shortly.

Obviously, in BIG TUBES the BIG NAME is DU MONT.

DUMONT

*Teletrons**

First with the Finest in Television

Literature on request — *Trade-Mark

ALLEN B. DU MONT LABORATORIES, INC.

TUBE DIVISION · CLIFTON, N. J.

BOOST
your sales with the NEW
ALLIANCE BOOSTER*

Tenna-Scope, like Tenna-Rotor will be backed by national TV advertising that sells! No other booster will have equal acceptance!

For Tenna-Scope is superior in design for ease of operation and performance. One control for all channels! Automatic switch turns booster on with set. Superbly styled plastic control case blends with all furniture. Exceptional high-channel reception and uniformity of picture and sound! Price $29.95.

Actual size—6¼"x3⅞"x5"

2 perfect companions:
* TENNA-SCOPE
TENNA-ROTOR

ctual size
¼"x5⅞"x5"

New Deluxe
Model HIR Tenna-Rotor

New Automatic Tenna-Rotor—Model HIR—just set the pointer—antenna then turns to that point and stops. North—East—South—West. Direction indicator dial shows exact position at all times. May be marked for present or new channels. Guaranteed for one year. Uses special "Zip" feature, 4-conductor cable for fast installation. Advertised in all major TV areas.

Just set it—and forget it!

Alliance Manufacturing Co
Alliance, Ohio
Export Department: 401 Broadway, New York, N. Y., U. S. A.

alliance
TENNA • SCOPE

SCIENTIFIC INFORMATION, which amounts to about a million papers a year, could be filed and coded so completely that any particular piece of information could be located in a matter of minutes. This possibility was described to the American Chemical Society by Calvin N. Mooers, research director of the Zator Company of Boston.

If funds were available, both old and new principles could be used to construct a machine that could do this job. Called the Doken, short for "documentary engine," it would combine microfilm, electronic or magnetic memory devices, and optical copying by television techniques to select all information on a specified subject and print abstracts of it at the rate of ten a second.

The key to successful operation of such a machine is the use of new methods of coding or classifying information. Such a system would be based on the mathematical laws of probability and would allow a multiple number of classification codes on each entry.

FAKE diagnostic machines, supposedly built to fulfill the same objectives outlined in the July editorial of RADIO-ELECTRONICS, often avoid public exposure as frauds because the manufacturers of these machines make no public claims for them. This fact was brought out by the Cleveland, Ohio, Better Business Bureau which has a standing reward of $1,000 for anyone proving that a "radioclast," "diagnometer," or a "soma-ray sonascope" has the slightest curative or diagnostic value.

One such fraud, the "radioclast" was first exposed in 1940 by this magazine, but still seems to be thriving. In a recent investigation by the Cleveland BBB, the manufacturer of this device insisted that his company neither originated nor approved the claims of "miraculous powers" attributed to it by workers in the field. Nevertheless, operators of the machine subscribe in large quantities to the *Radioclast News*, a publication which presents "testimonials" carefully mingled with items about legitimate medical discoveries, often taken out of context in such a way as to seemingly support the radioclast.

Unfortunately many of these machines and similar fakes are still in operation taking money from misguided individuals. Often they are known to the authorities as being frauds, but in many cases the state and local laws do not cover their use.

TELEVISION NETWORK, which eventually will link all the major cities of the country, is ever growing larger. Los Angeles and San Francisco were officially joined on September 15 by microwave link. The Chicago-Omaha microwave leg of the network was in operation October 1. Besides Omaha, Indianapolis, Louisville, Davenport, Rock Island, Ames, Minneapolis, St. Paul, and Kansas City were linked. At the same time, five southeastern cities were joined together in another branch of the network. These cities are Greensboro, Charlotte, Jacksonville, Atlanta, and Birmingham.

PETER C. GOLDMARK, director of the Columbia Broadcasting System laboratories who developed the CBS color television system and the long playing record, has been appointed vice president in charge of Engineering Research and Development. Frank Stanton, president of CBS, stated: "Dr. Goldmark's appointment is not only a recognition of his outstanding contributions in the field of electronics. It also takes cognizance of the fact that color television

has now reached a stage of major significance in the communications field."

Dr. Goldmark joined the CBS staff in 1936 and since then has directed the comparatively small but skilled laboratory staff which has brought the CBS color television to its present state of development. On September 1 the FCC gave tentative approval to the CBS color system.

FATAL TV ACCIDENT occurred recently at Lake Success, N.Y., when a father and his son were killed and a daughter was badly burned while attempting to install a new antenna in the rear of their home. The two men were planting a 29½-foot metal mast into the ground while the girl held one of the guy wires which was to keep the mast in place.

Suddenly the mast tipped and fell against a nearby high-tension line, one of the Long Island Lighting Company's primary distribution lines which carries 13,000 volts. There was a blinding flash as the mast hit the wire and the two men were killed instantly. The girl was saved by the heroic efforts of a policeman who, with the aid of some newspapers, pulled her from the live wire.

TIN has been added to the list of materials known as semiconductors, that lie between the metallic conductors which readily transmit electricity and the insulators which conduct electricity only to a negligible degree.

The semiconducting tin is a rare crystalline form of the element which was first discovered in 1833 in the crumbling organ pipes of a church in Germany. The organ pipes were replaced, but some specimens of the decaying tin were saved. This is very fortunate because scientists find it extremely difficult to produce this form of tin without first seeding the laboratory specimen to be converted with some of the rare crystals.

In 1899 Ernst Cohen, a Dutch physical chemist discovered that the metal of the decayed organ pipes was an allotropic form of tin but little other work was done with it until recently when a report on its electrical properties was read at the International Conference on Semiconductors at Reading, England.

A ROSY FUTURE is predicted for engineering graduates by Dean Thorndike Saville of New York University College of Engineering, but he also stated that it may look dark for national efforts dependent upon engineers. Unless the size of freshman engineering classes can be increased appreciably, a serious shortage of this type of personnel may develop in the next few years, he said.

The Bureau of Labor Statistics last March issued a report which called attention to the large number of engineering students graduating in June and presented a pessimistic outlook as to the immediate availability of sufficient engineering jobs to absorb them. Unfortunately this report came into the hands of many high school advisors and its implications were reported in many national magazines. These reports overlooked the long-term appraisal of the future which, according to the Bureau and to Dean Saville, will provide great numbers of engineering jobs over the next decade.

NEW INDICATOR ION TRAP

Now in all Rauland Tubes

The response to Rauland's new Indicator Ion Trap, after its introduction in the 12LP4-A, has been so enthusiastic that this feature has now been incorporated in all Rauland tubes—as a standard feature of the new Rauland Tilted Offset Gun.

In the field or on the assembly line, this new Indicator Ion Trap reduces Ion Trap Magnet adjustment time to a matter of seconds, eliminates mirrors and guesswork, and assures accuracy of magnet adjustment. It can increase profits for every service man and service dealer—and at the same time assure better customer satisfaction.

A bright green glow on the anode of the picture tube signals when adjustment is incorrect. Correct adjustment is made instantly, by moving the magnet until the glow is extinguished or reduced to minimum.

Only Rauland offers this advanced feature—one of a half-dozen important post-war developments from Rauland.

RAULAND

The first to introduce commercially these popular features:

Tilted Offset Gun

Indicator Ion Trap

Luxide (Black) Screen

Reflection-Proof Screen

Aluminized Tube

•

THE RAULAND CORPORATION

Perfection Through Research

4245 N. KNOX AVENUE • CHICAGO 41, ILLINOIS

NEW STANDARDS for electrical units were given formal acceptance when the 81st Congress enacted Public Law 617. Proposed by the Bureau of Standards, the legislation makes small changes (none greater than .0005%) in magnitude of the units, but the new values are on a clear and unambiguous basis that permits the closest practicable agreement between electrical and mechanical units.

The previous law, enacted in 1894, included double definitions of the units. The ampere was defined by the rate of deposition of silver in a coulometer, the ohm was the resistance of a specified column of mercury, and the volt was a certain fraction of the electromotive force of a standard cell.

These standards did not produce the values for the units which were intended. With the development of science and technology it became increasingly necessary to have electrical units consistent with those of mechanics. Furthermore, the old system of reproducible electrical standards is no longer needed as most countries have national standards laboratories which maintain the basic standards of measurements.

The new act is similar to the old act in defining the fundamental practical units as multiples of the centimeter-gram-second electromagnetic system of units. Actually, they are also component parts of the meter-kilogram-second system which is now being widely used in engineering practice and in textbooks.

MEXICAN TV was unveiled on September 1 when station XHTV, channel 4, telecast the President's annual message to the opening of Congress. To guarantee an audience for its first official showing, XHTV had 2,000 receivers flown in and set up in public places.

LISTENER STATISTICS of the European broadcast area show that little Monaco leads the rest of Europe with a receiver density, based on total population, of 40%. Next in line are Iceland with 30%, Denmark with 28% and Great Britain and Northern Ireland with 24%. Norway and Switzerland each have 23% and France and Western Germany have 15%. Monaco is the only one of these countries which has no annual tax on radio receivers.

At the bottom of the list are Turkey with 1.3%, Rumania and Spain with 1.4%, and Greece and Yugoslavia with 1.6%. Russia, as far east as 40° E. longitude and including the Baltic States, has a receiver density of 7.3%.

A CAMPAIGN to increase the membership to over 5,000 got under way this fall by the Federation of Radio Service Men's Associations of Pennsylvania. One new group, the Blair County Association of Radio Service Engineers, became affiliated with the state organization, and plans are being made to organize chapters in Lancaster, Hazleton, and Sunbury. Present membership of the state organization is between 3,500 and 4,000.

New Plants and Expansions

General Electric Company's expansion plans include $3,000,000 for adding 134,000 square feet and new tube-making equipment to its receiving tube plants at Owensboro, Ky., and Tell City, Ind. The company also announces the outright purchase of the Illinois Cabinet Co. in Rockford, Ill. G-E has been part-owner of the cabinet company since 1947.

The G-E Research Laboratory celebrated its fiftieth anniversary with the dedication of its new home near Schenectady, N. Y., where most of G-E's research will be carried on.

International Resistance Co. announced that it would boost production sharply in October and again in February when 60,000 square feet being added to the company's Terminal Commerce Building quarters in Philadelphia will be in use.

Superior Electric Co. of Bristol, Conn., opened a new office in Cleveland to handle its line of transformers, automatic voltage regulators, a. c. and d. c. power supplies, and other equipment. Harold W. Lorenson heads the new office.

Acme Electric Co. has begun construction on a new 25,000-square-foot building at Allegany, N. Y. The new $100,000 building will substantially increase the company's output of transformer components.

Sarkes-Tarzian, Inc., Bloomington, Ind., TV tuner manufacturer, expects that moving the company's Philadelphia plant to new and larger quarters will increase production of its tuner units by 500%.

Westinghouse Electric Corp. announced plans for a new television plant at Metuchen, N. J., which will nearly triple the firm's TV set production capacity. Plans call for a 400,000-square-foot building to be erected on a 50-acre site. When completed in April, it will become the headquarters of the Westinghouse Television-Radio Division.

Radio-Matic of America, Inc., has acquired plant facilties for the manufacture of radio and TV cabinets in Hillside, N. J.

Sightmaster Corp. has moved its New York office and salesroom to its new plant in New Rochelle, N. Y., where it manufactures TV sets.

The Universal Microphone Co. has been reactivated and has started a factory in Pasadena. Cal., for manufacturing microphones.

Merchandising and Promotion

National Union Radio Corp. has announced the release of a three-piece dealer sales promotion package available through distributors. It includes a large banner, a metal flange sign, and a door decal with the dealer's street number.

JFD Manufacturing Co. issued a three-color counter display to promote sales of the JFD television lightning arresters. The laminated, lithographed display is available to dealers and distributors with the purchase of 12 JFD arresters.

Capehart-Farnsworth Corp. has produced two sound movies to aid Capehart distributors stimulate TV sales and improve service practices.

Financial Reports

(First six months reports)

	1950	1949
Aerovox Corporation		
Earnings	$1,220,745	$233,167
Cornell-Dubilier Electric Corp. (Nine months ending June 30)		
Earnings	$970,148	$450,785
International Resistance Co.		
Earnings	$417,447	$169,465
Oak Manufacturing Co. (Year to May 31)		
Earnings	$1,179,334	$776,437
Philco Corporation		
Earnings	$6,672,000	$1,998,000
Sales	$147,012,000	$67,525,000
Sangamo Electric Co.		
Earnings	$916,691	$719,102
Standard Coil Products		
Earnings	$3,135,393	Not given
Stewart-Warner Corp.		
Earnings	$1,884,833	$796,564
Sales	$33,649,039	$27,875,957
Weston Electrical Instrument Corp.		
Earnings	$184,418	$227,053

Dividends

Aerovox directors declared a 20¢ dividend on common stock and a 100% stock dividend subject to stockholders' approval.

Cornell-Dubilier Electric Corp. issued a 20¢ dividend on common stock and a payment of $1.31¼ on preferred.

Allen B. Du Mont Laboratories, Inc., gave a 25¢ interim dividend on common stock and a regular quarterly dividend of 25¢ on outstanding preferred stock.

Globe-Union, Inc., parent company of the Centralab Div. announced a quarterly dividend of 25¢ and an extra of 25¢.

RCA declared an 87½¢ dividend on preferred stock.

Sprague Electric Co. paid a quarterly dividend of 30¢ on common stock.

Stewart-Warner Corp. gave a 25¢ dividend on common stock.

Financial Notes

RCA has sold $40,000,000 of its notes to mature May 1, 1974 at 3%. Proceeds will be used for working capital for expanded business requirements.

Allen B. Du Mont Laboratories' 10¢ par value class-A common stock was admitted to listing and dealings on the New York Curb Exchange.

John Meck Industries, Inc., registered 150,000 shares of common stock for public sale. The funds will be used to provide additional working capital.

Raytheon Manufacturing Co. offered 289,459 shares of common stock to stockholders. Of these, 282,433 shares were immediately subscribed, leaving only 7,026 to be taken up by underwriters.

Wilcox-Gay stockholders approved a merger with the **Majestic Radio & Television, Inc.**, and its subsidiary, **Garod Radio Corp.** For the exchange of stock, a controlling interest in Wilcox-Gay was voted to Leonard Ashbach, head of Majestic and Garod.

Industry Notes

The **Radio-Television Manufacturers Association** estimated that 2,612,000 TV receivers were shipped to dealers during the first six months of 1950. In this period 3,114,000 sets were manufactured. The 503,000 difference represents inventories and sets in transit. Shipments during the month of June were 289,000 as against 369,000 in May.

Slumping summer TV set sales were brought to an abrupt halt in July by developments in Korea, according to a report by Hugh M. Beville Jr., NBC director of plans and research. According to his figures, 431,500 new receivers were installed in July bringing the total to 6,942,000. The previous month's sales were 296,400.

The RTMA further reported the sale of 191,503,938 radio receiving tubes in the first seven months of 1950 as against 198,753,295 during the entire year of 1949. A breakdown of the 21,128,017 units sold in July showed 14,600,533 tubes were sold to manufacturers for new sets; 6,015,511 for replacement; 417,586 for export and 94,387 for government agencies.

RCA tube department spokesman, H. F. Bersche, predicted a sharp upsurge of the market served by the electronics parts distributor. Speaking before the NEDA convention in Cleveland, Bersche predicted that by 1955 the home and auto renewal market would increase from 600 million tube sockets in 1950 to 800 million. About 38 million TV receivers in 1955 would provide 700 million tube sockets and a replacement market for 350,000 kinescopes. Bersche also estimated that by 1955 there would be 130,000 technicians and 150,000 amateurs up from the 65,000 technicians and 84,000 amateurs today.

Color Comments

General Electric Co. announced its own new color television system, which will be demonstrated this fall at Syracuse. It is known as "frequency interlace" and, according to G-E, it has both technical and economic advantages over any system yet shown.

Remington Rand, Inc., and the **Columbia Broadcasting System** have entered a cooperative agreement to produce color TV for industrial, hospital, governmental, military, and similar use. The process called "Vericolor," was demonstrated at the New York Business Show during the week of October 23.

Color Television, Inc. (C.T.I.), San Francisco, announced a new method which it calls "Uniplex." This is the second color development of the company and was completed only recently. The company stated that the new system makes color reception possible in present black and white sets with only the addition of a single small unit and a new tube.

Here are some of the many reasons why there are more Simpson 260 high sensitivity volt-ohm-milliammeters in use today than all others combined. The Simpson 260 has earned world-wide acceptance because it was the first tester of its kind with all these "Firsts":

Simpson 260 SET TESTER

WORLD FAMOUS FOR ALL THESE "FIRSTS"

- First high sensitivity instrument to use a metal armature frame.
- First to use fully enclosed dust proof rotary switch with all contacts molded in place accurately and firmly.
- First to do away with harness wiring.
- First to provide separate molded recesses for resistors, batteries, etc.
- First to cover all resistors to prevent shorts and accidental damage and to protect against dust and dirt.
- First with a sturdy movement adapted to the rugged requirements of a wide range of service work or laboratory testing.
- First to provide easy means of replacing batteries.
- First to use all bakelite case and panels in volt-ohm-milliammeters.
- First volt-ohm-milliammeter at 20,000 ohms per volt with large $4\frac{1}{2}''$ meter supplied in compact case (size $5\frac{1}{4}'' \times 7'' \times 3\frac{1}{8}''$).
- First and only one available with Simpson patented Roll Top Case.
- First to provide convenient compartment for test leads (Roll Top case).
- First to offer choice of colors.

RANGES

20,000 Ohms per Volt DC, 1,000 Ohms per Volt AC
VOLTS: AC & DC—2.5, 10, 50, 250, 1,000, 5,000
OUTPUT: 2.5, 10, 50, 250, 1000
MILLIAMPERES, DC: 10, 100, 500
MICROAMPERES, DC: 100
AMPERES, DC: 10
DECIBELS: (5 ranges)—12 to +55 DB
OHMS: 0-2,000 (12 ohms center), 0-200,000 (1200 ohms center), 0-20 megohms (120,000 ohms center).

Prices: *$38.95 dealers net; Roll Top $45.95 dealers net.*

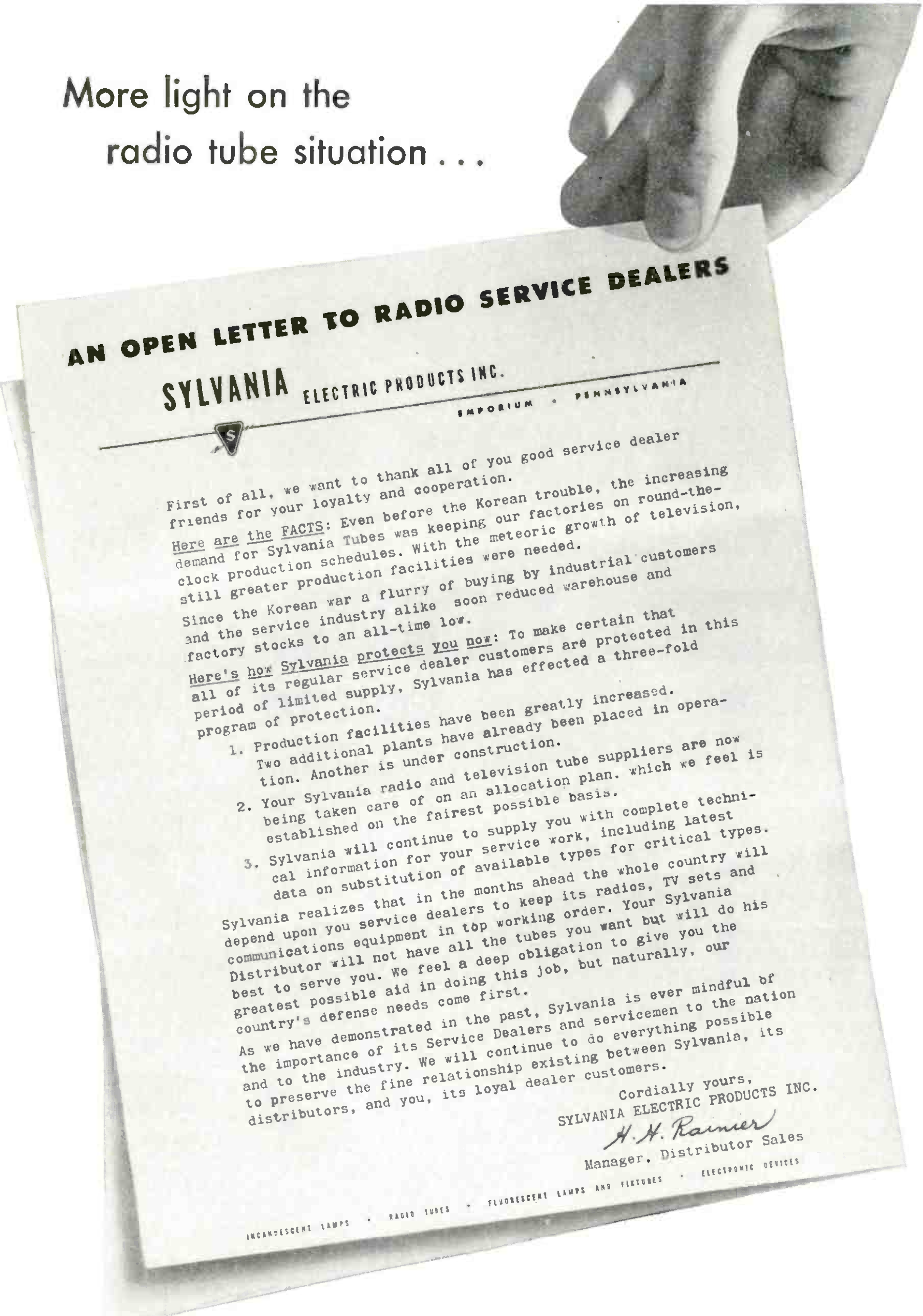
Simpson
INSTRUMENTS THAT STAY ACCURATE

The Model 260 also is available in the famous patented Roll Top safety case with built-in lead compartment. This sturdy, molded, bakelite case with Roll Top provides maximum protection for your 260 when used for servicing in the field or shop.

25,000 volt DC Probe for television servicing, complete, for use with 260, $12.85

SIMPSON ELECTRIC COMPANY • 5200-18 W. Kinzie St., Chicago 44, Ill. • *In Canada: Bach-Simpson, Ltd., London, Ont.*

More light on the radio tube situation . . .



AN OPEN LETTER TO RADIO SERVICE DEALERS

SYLVANIA ELECTRIC PRODUCTS INC.
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First of all, we want to thank all of you good service dealer friends for your loyalty and cooperation.

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S/Sgt. Ben H. Davis, 317 North Roosevelt, Lebanon, Ill.	1st Phone	28
Albert Schoell, 110 West 11th St., Escondido, Cal.	2nd Phone	23

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To the Technical G. I.

. . . Technical men in the armed forces benefit by radio-electronics . . .

By HUGO GERNSBACK

NO one today will contradict the fact that World War II could not possibly have been won without the powerful weapon, radio-electronics. Radar, the proximity fuse, sonar, radio communication, and a score of other radio-electronic instrumentalities were some of the outstanding weapons of the Allies in World War II.

Immersed as we are in the pursuit of radio-electronics we often forget th.s fact—a fact which should remain uppermost in our minds.

Once more we are assembling a huge armed force in which several hundred thousand technical men will be needed to make our men invincible. Thousands already in the service and countless thousands others who will join our armed forces have an unsurpassed opportunity in this country's security, defense, and eventual victory through the medium of radio-electronics.

Often the young G.I. radio technician does not fully realize that frequently the lives of many of his fellow combatants depend upon a single radio technician. There are indeed few men in the service who are more important than the radio technician—if he knows his job and knows it expertly. This means he must know radio and electronics from the ground up. He must know how to put defective equipment into workable shape again. He must know how to diagnose trouble quickly and replace defective parts. He must also know how to improvise and do "stunts" with the instrument in emergencies. If he knows his job thoroughly the chance for advancement is made greater.

It is, therefore, evident that long before he sees action, he must have made himself letter-perfect in the radio art if he wants to serve his country well and if he wants to advance himself. *Nowhere can it be done more readily than in radio-electronics for the simple reason that expert radiomen are always at a premium in the armed forces.*

You who read this—if you are now in the armed forces or will soon be—should make it a point to spend most of your spare time in learning all there is to know in the radio art by reading all available textbooks and radio magazines. Supplement this with practical knowledge in operating and repairing the various radio instruments.

In addition, make it your business to try and obtain maintenance manuals on the various equipment you work with.

If you are not inducted already, enroll in a resident or correspondence radio school which can train you in communications, electronics, radar, or whatever branch you feel most competent to study. The school will teach you basic theory and service techniques—all important knowledge which will be invaluable once you are inducted. It will help you to get assigned to the proper job where your radio knowledge will give the armed forces and yourself maximum benefit.

If it should not be possible for you to enroll in a school it is still possible to secure practical knowledge through book study and by acquiring surplus instruments such as were used in World War II by our armed forces. Many such surplus instruments can be bought at a very low cost and if you have sufficient radio knowledge it should not be difficult to learn the intricacies of a variety of equipment which has been used in the past by our armed forces. It is true that such items may be out-dated today. Nevertheless, radio fundamentals and principles have not changed. If you understand how to service, for instance, an aviation transmitter of vintage 1945, you will not have much trouble in servicing a 1950 model.

Radio tube knowledge is particularly important. We never have too many radio tube experts or even technicians who are tube wise and understand what types can be substituted for other types.

Generally speaking, what the technical command is looking for today is expert radio knowledge in its various radio branches.

Specialization here is of vast importance—whether you are expert in radio receiver servicing or in radar instrumentation or if you are expert in radio mathematics or in any other radio branch, you will be welcomed with open arms.

Admittedly all of this is not easy. It means hard work, long hours of study, a knowledge of how to improvise, and native resourcefulness. If you have these qualities and know how to apply them it should not take you long to rise. You will also be rendering your country a patriotic service.

Familiar Circuits Aid Human Hearing

A modern medical audiometer with its associated equipment. Various types of headphones are shown in the foreground.

By EUGENE J. THOMPSON

Audiometers, which measure aural response, and hearing aids use common audio circuits

Photo of a screening audiometer. Compact units like this are used by nurses to check the hearing of schoolchildren.

AN AUDIOMETER is an instrument that measures the ear's ability to hear sounds of different pitch and loudness. When molecules of the air vibrate they produce sound—there can be no sound in a vacuum. The number of vibrations per second is called the pitch or frequency of a sound, and the force of the vibrations is its intensity or loudness.

The range of human hearing is said to extend from 16 to 20,000 c.p.s., although many adults cannot hear frequencies above 8,000 or 10,000 c.p.s. Speech is contained within the range from 250 to 4,000 c.p.s. and, if an individual has no hearing loss between these limits he is not socially handicapped.

The sharpness of human hearing is usually measured at various frequency octaves. An octave of any pitch has a frequency twice (or one-half) the pitch itself. Thus, 250 c.p.s. is one octave higher than 125 c.p.s., and 500 c.p.s. is two octaves higher. Similarly, 500 c.p.s. is one octave lower than 1,000 c.p.s.

The ear has a logarithmic and not a linear response to the loudness of a sound. That is, a sound which is 100 times as loud as another (in units of sound energy) appears to the ear to be only about twice as loud. The decibel system was developed to compare sound intensities in units that are very much like the way the ear hears them. The formula for comparing two sounds in decibels (db) is:

$$db = 10 \log P_2/P_1$$

P_1 is the intensity of the first or reference sound, and P_2 is the intensity of the sound to be compared with it. In practice it is usually easier to dispense with this formula and use a table like Table I or a more complete one if needed.

One db is about the smallest change in sound intensity that the human ear can detect. However, this varies with the frequency because the ear is less sensitive to loudness at the very high and the very low frequencies than in the middle range of frequencies. A sound intensity of about 120 db above the least perceptible sound will cause pain to most people.

Modern audiometers have been de-

Table I—Comparison of db with sound energy level

Db	Increase of Sound Energy
1	1.26
3	2
10	10
20	100
30	1,000
60	1 million
100	10 billion

veloped to meet the need for more accurate, uniform, and convenient means of measuring hearing than were provided by older methods. The limitations of those methods are now generally recognized. Watch-tick, voice, or whisper tests, for example, are good only as a rough check. A voice test is inaccurate because even a well-trained speaker cannot maintain a uniform voice level. A recorded voice can be made uniform, but it requires additional expensive equipment. Room reflections often introduce a large error. Reflections also influence the accuracy of watch-tick tests, and in addition reflections from the head of the listener may confuse the results. Furthermore, watch-tick frequencies are confined to the region around 2,000 c.p.s., and therefore give only a limited picture of the hearing in the speech range.

Tuning forks have long been used to test hearing. With a series of calibrated forks an experienced operator can make fairly accurate tests, but the procedure is tedious to both patient and tester, and this is a source of error.

Nevertheless, the tuning fork is an ancestor of the modern audiometer, which essentially is a vacuum-tube oscillator for generating pure tones that can be controlled more conveniently and accurately than can tuning forks. The tone of the audiometer can be sustained indefinitely, and can be increased or decreased accurately in intensity. Its frequency can be varied at will. Early audiometers, in fact, continued to use the fixed frequencies of tuning forks and were usually calibrated at octaves of 128, 256, 512, etc., cycles.

With an audiometer, the ear specialist can measure the ear's ability to hear sounds throughout the entire spectrum of human hearing. In the original audiometers that had only a selection of tuning fork frequencies, the frequency of the oscillator circuit was determined by combinations of inductance and capacitance and a rotary switch selected various inductances or capacitances (depending on the particular design) while the other circuit constants remained fixed.

But the ear specialists found it better to cover the frequencies in a continuous range rather than to have only a few frequencies at octave or half-octave intervals. This requires continuously variable elements (capacitance or inductance, but for the frequencies in the audio range, the inductors and capacitors have to be so large that it is impractible to make them continuously variable.

One way to get around this difficulty is to use an R-C oscillator whose fre-

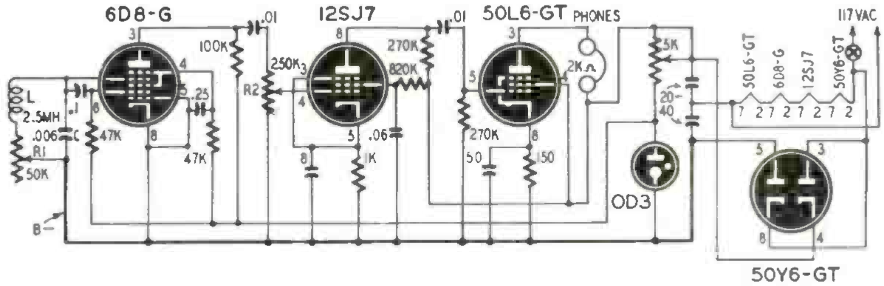


Fig. 1—Schematic of the essentials of an audiometer. Most instruments have a complex switching circuit for various tests, but basically they are the same.

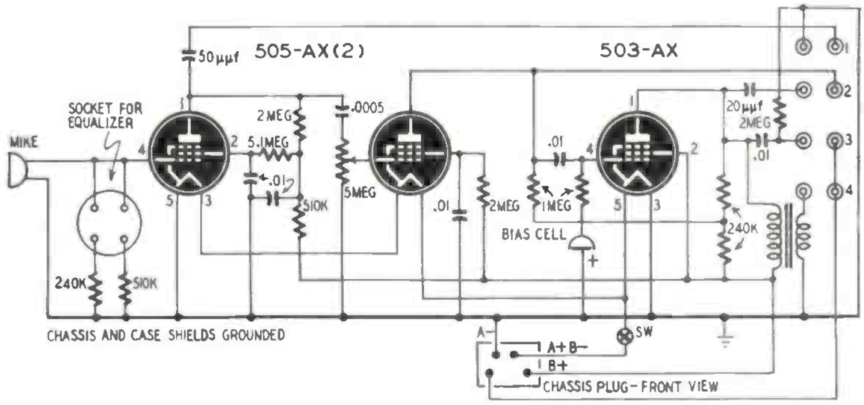


Fig. 2—A typical hearing aid circuit. This one is the Maico Precisioneer "K".

Table II—Troubleshooting chart for hearing aids

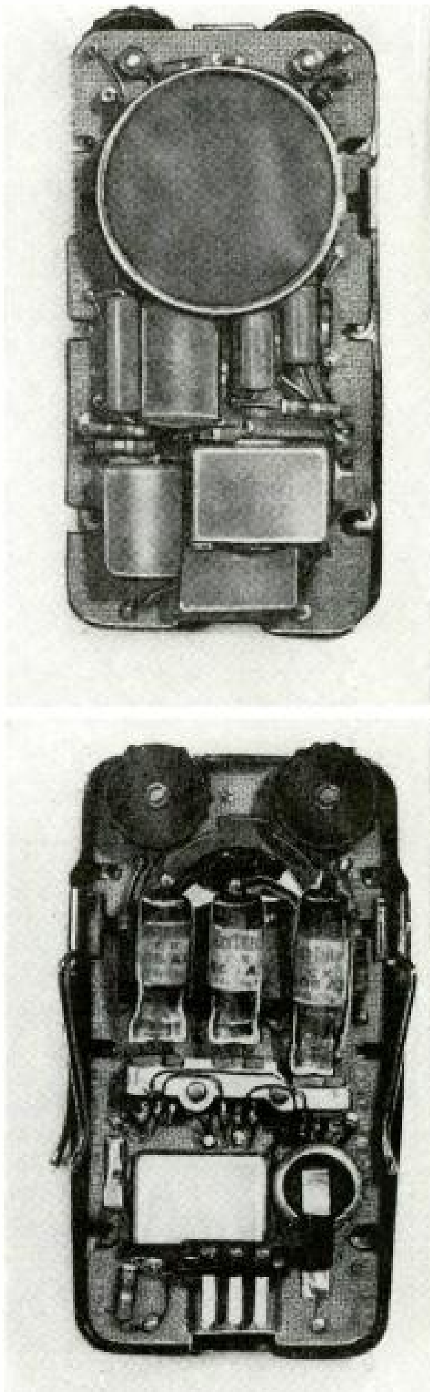
SYMPTOM → DIAGNOSIS ↓	HEARING AID DEAD	WORKING, BUT WEAK	WORKS INTERMITTENTLY	WHISTLES	NOISY, SHRILL OR RASPY	HOLLOW OR MUSHY	TEST	REMEDY
Dead or run-down batteries	√	√				√	Check with voltmeter or try new batteries	Replace with new batteries
Wrong battery or polarity reversed	√	√				√	Examine connections	Correct battery polarity
Poor contact at plugs—dirty	√	√	√		√		Wiggle contacts and withdraw and reinsert	Clean contacts with cleaning fluid
Open or nearly open circuit	√	√	√		√		Wiggle cords, check continuity	Replace defective part
Plugs not fully inserted in sockets	√	√	√		√		Examine contacts	Insert plugs firmly
Eartip not properly seated in ear		√		√			Press receiver firmly into ear	Insert eartip properly
Eartip plugged with wax or water		√				√	Examine eartip, see that passage is open	Clean eartip with soap and water
Insufficient pressure of bone receiver on head		√		√	√		Press bone receiver against side of head	Bend receiver head-band for greater pressure
Batteries oozing liquid	√	√	√		√		Examine batteries	Replace batteries. Clean with damp cloth
Receiver near wall or other reflector				√	√		Check receiver location	Avoid positions causing feedback
Microphone too close to receiver				√	√		Separate microphone and receiver	Avoid having microphone too close to receiver
Defective tube or other component	√	√	√	√	√	√	Test tubes and parts	Replace defective part

quency is determined by the R-C time constant of the resistance-capacitance pair. Then either a variable resistance or variable capacitance can be used. Many such circuits have been developed, and they are familiar to most technicians.

A typical instrument is shown in Fig. 1. Here, an L-C combination is used, together with a pentagrid converter, in a transitron negative-resistance oscillator hook-up. The maximum frequency of the oscillator tank circuit is determined by the combination of L and C. However, the variable resistance R1 between L and ground varies the frequency of the signal, decreasing it as the resistance in the circuit is increased. The oscillator output is then fed through a conventional resistance-capacitance-coupled amplifier with a beam-power output stage. The power supply has a voltage-doubler arrangement and is electronically regulated to insure oscillator frequency stability. The amplitude of the output signal is controlled by the potentiometer R2 in the first audio stage. This dial is calibrated in db loss of hearing. That is, the volume level at which the normal ear can just hear a signal is marked 0 db. As the volume has to be increased for a hard-of-hearing person to hear the tone in the bone or air conduction headset, the reading on the dial also increases. Thus, if the volume level must be turned up to 40, the person has a hearing loss of 40 db. (Sounds have to be 40 db louder than normal for him to hear them.)

A hearing aid is nothing more than a compact miniature audio amplifier built with sub-miniature tubes, midget volume controls and sometimes printed circuits. The circuits may vary in minor details but they are all resistance-coupled amplifiers, with small earphones and microphones. Fig. 2 is a circuit of a typical hearing aid and the troubleshooting chart, Table II, should be a help in servicing.

Audiometers and hearing aids therefore are simply audio oscillators and audio amplifiers, and any radio technician who has standard audio servicing equipment, such as an audio oscillator, oscilloscope and multitester will have no trouble servicing them.



Front and back view of the insides of a hearing aid. It is a three-stage audio amplifier reduced to minimum size.

SOME NEW USES FOR CRYSTALS

By A. V. J. MARTIN

By using two bars of crystal cemented together it is possible to get vibrations at frequencies as low as 30 cycles per second. One such composite crystal vibrates at 50 cycles and has been used to control an electric clock. The dimensions of the crystal are $80 \times 10 \times 0.3$ mm.

The same crystal, when clamped at the two nodal points as shown in Photo A will vibrate at 150 c.p.s. The nodal points are at 22.4% of the total length from the ends.

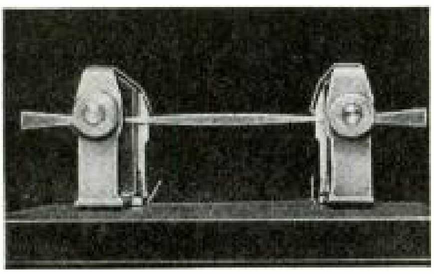


Photo A—This composite crystal is vibrating at 150 c.p.s. The crystal is made up of two thin sheets of quartz.

In the other direction, ring-shaped crystals have been used for high-frequency work. The advantage of these is that a suitable ratio of inner to outer diameter gives the crystal a very low temperature coefficient over a fairly wide range of temperature. The spectrum of these crystals is very pure—they are free of parasitic frequencies. This is very important if the crystal is to be used as an r.f. filter.

The drawback of most crystal filters is that the crystals do not have a single resonant frequency but a spectrum of frequencies. The parasitic frequencies are often as close as 4 kc to the fundamental and sometimes have an amplitude that is 50% of the fundamental. This is no problem with oscillators because the crystal will always oscillate at the frequency which requires the least energy, which is the fundamental. But when the crystal is used as a filter, it will allow oscillations of these parasitic frequencies to pass., and if these parasitics should lie within the bandwidth of, say, an i.f. amplifier, they can cause much interference.

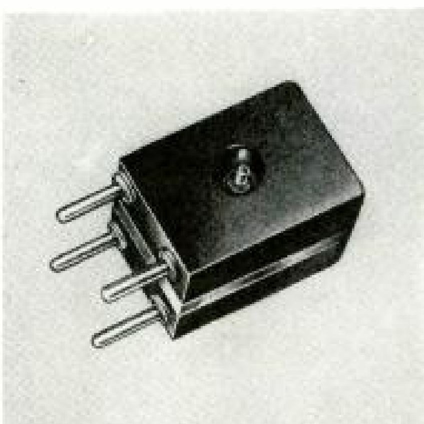


Photo B—This twin crystal has a very narrow bandpass and a pure spectrum.

A twin crystal is used to eliminate this problem. This device, shown in Photo B, consists of two silver-faced crystals having the same resonant frequency and clamped one on top of the other. A screw varies the pressure between the two crystals. Because they are held together tightly, the two crystal blocks have what is equivalent to a mutual inductance between them. The selectivity is varied by varying the pressure with the screw. This changes the mutual inductance and also changes the effective resistance of each crystal. When these two effects add, the bandwidth varies from about 500 c.p.s. to 5 c.p.s. or less.

Audio Feedback Design — PART II

Presenting a simple way to draw the calculated amplifier response curve

By GEORGE FLETCHER COOPER

IN THE first article of this series we examined the basic principles of negative-feedback amplifier design and saw that the quantity of key importance is the feedback factor 20 log (1 + Kβ). This we can write as 20 log (Kβ) if Kβ is fairly large. This, of course, is equal to

20 log K + 20 log β,

so that most of our attention can be centered on the gain of the amplifier without feedback, which is K (20 log K db).

The first thing to do is decide what you want. This may sound platitudinous, but even professional designers sometimes try to produce amplifiers which are not possible. Some of the basic design problems were indicated in the previous article. For example, if a 6AQ5 beam power output tube is to give 4.5 watts, the distortion without feedback will be, according to the maker's list, 8%. To get only 1%, it is necessary to use about 20 db of feedback. The mutual conductance is 4100 μmhos, the optimum load 5000 ohms; therefore the gain will be about 20 or 26 db. The input stages of the amplifier must therefore provide most of the total gain we need.

If we want, say, 50 db all together, the gain without feedback must be 70 db. Since the 6AQ5 will supply 26 db, the earlier stages must have 44-db gain. This is an awkward example because 44 db is just about on the limit for a single high-gain pentode. We should have to look closely to decide whether to use two stages before the 6AQ5 and have the advantage of the extra feedback or risk the distortion rising to perhaps 2% at full output.

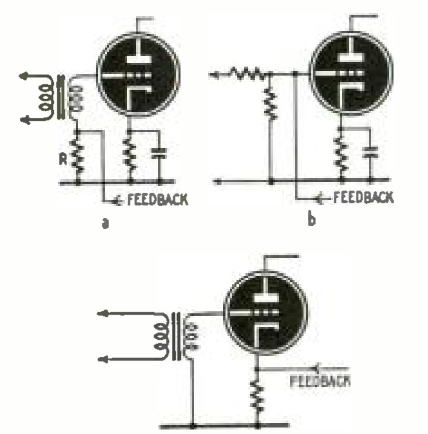


Fig. 1—Three common ways of applying voltage feedback to an amplifier input.

Where to apply feedback

In this preliminary design, we must decide where the negative feedback is to be applied. Voltage feedback can be applied either to the grid or the cathode of the input stage in the ways shown in Fig. 1. The second way (Fig. 1-b) is useful only for feedback around a single stage because the resistances in the feedback connection must be very high and stray capacitances then become important. Method 1-a has the disadvantage that the secondary of the transformer is not grounded; but as the resistance R is usually only about 100 ohms, this is not serious. This method allows the cathode to be bypassed, thus increasing K and therefore βK, the feedback factor. The cathode R-C circuit is sometimes useful for increasing the stability margin. Method 1-c is simple if the loss of gain due to the unbypassed cathode can be allowed.

If the feedback voltage cannot be taken from a transformer, there is no way to reverse its polarity. In that case 1-a or 1-b must be used with an odd number of tubes and 1-c with an even number. Otherwise the feedback will be positive. This assumes that the output is taken from the plate and not from a cathode load. When the feedback is taken from the output side of an output transformer, circuit 1-a is the best because there is no d.c. in the feedback circuit and no capacitors are needed. If 1-c is used, a blocking capacitor must be used to keep the cathode voltage off the output line. This capacitor usually must be very large because of the low impedances normally used in this type of circuit. Some output transformers have separate windings for feedback.

Safety margins

An amplifier will be unstable if the phase shift through it reaches 180° while at the same time the value of the feedback factor βK is greater than one. Let us look at the typical amplifier response shown in Fig. 2. At the mid-frequencies, the amplifier gain is K.

Instead of using 180° as the phase limit, we shall use 150° to give us a safety or phase margin of 30°. At some low frequency the phase shift will reach 150° and the gain will be less. Let us say the gain is K/C at this frequency, where C is some number greater than one. In other words the gain is reduced by the fraction 1/C.

To meet the conditions of stability, the product β(K/C) cannot be more than one; the largest value we can allow for βK is simply C. This means that the feedback factor can be no greater than the amount by which the midband gain (without feedback) is reduced at the frequency where the phase shift is 150°.

In Fig. 2 the drop in gain at the 150° point is shown by A. We can reduce the gain by this amount when we apply feedback. If we use more feedback than this, βK becomes greater than the 150° point and the circuit is unstable.

Exactly the same conditions apply to the high-frequency end. Here we also use the 30° phase margin. In Fig. 2, C is the limit we must observe to keep the amplifier stable at the high end.

At more extreme high and low frequencies the phase shift will reach 180°. At these points the difference between the actual feedback and the amount the response without feedback has fallen is called the "gain margin." These are indicated by B and D in the response curve. The phase and gain margins are merely safety factors chosen so that the amplifier will not be running too close to its instability limits. A typical value for the gain margin is 10 db.

The phase shft can be allowed to be more than 150° as long as it dips back to that value. This is shown in Fig. 3. Point B on that curve is the one to use, and not A. This is true even if the curve dips below the 180° line at C. In this case, however, the amplifier is only conditionally stable and might oscillate when first turned on. It is best for the beginner to avoid such a condition because it is hard to handle.

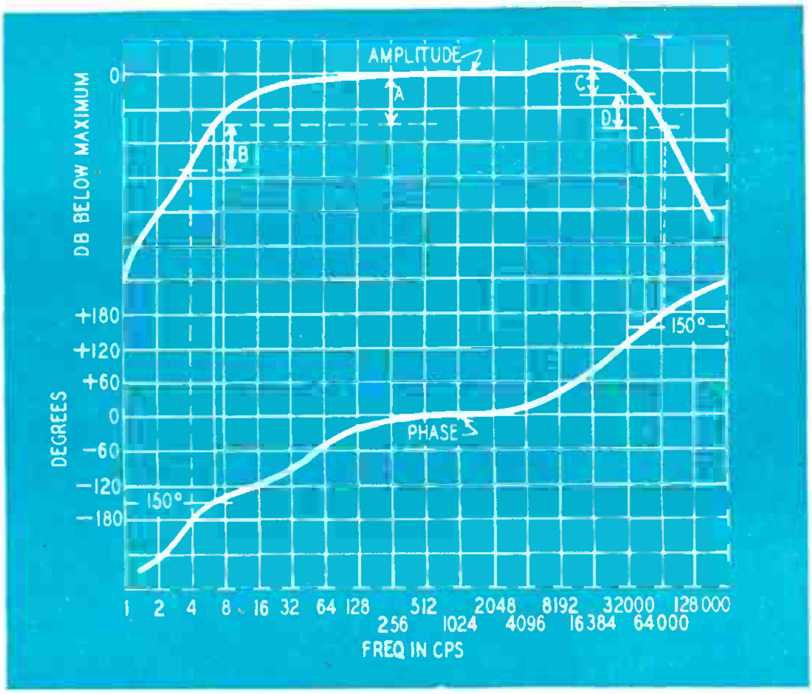


Fig. 2—Typical amplitude and phase characteristics of an audio amplifier.

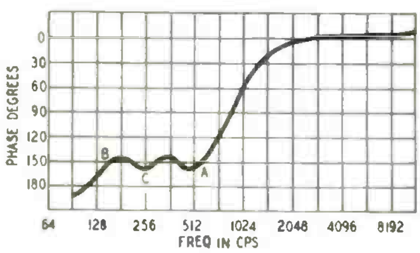


Fig. 3—Curve showing how the phase shift may go beyond the phase margin.

Calculated response

We are now faced with the problem of calculating the response of the amplifier. Let us first concentrate on the low-frequency end. Two things cause the low-frequency response to drop off. One is the reactance of plate, screen, and cathode decoupling capacitors; and the other is the reactance of the interstage coupling circuits. The effect of decoupling is usually considered a refinement and will be considered later in this series.

At the low frequencies the interstage coupling looks like Fig. 4-a, and a transformer-coupled output stage looks like Fig. 4-b in which L is the inductance of the transformer primary and R_g is the resistance presented at the transformer primary. If the transformer has a turns raito of n:1 and a secondary load of R_L, then $R_g = n^2R_L$.

Fig. 5 is the low-frequency response curve of the R-C interstage circuit of Fig. 4-a. This curve is "normalized," that is, the frequency marked as 1 is the frequency at which R_g is equal to

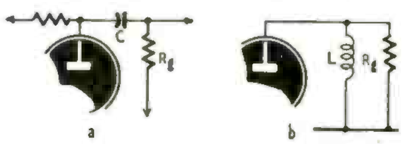


Fig. 4—Low-frequency equivalent circuit for R-C and transformer coupling.

the reactance of C. The curve can then be used for *any* similar coupling circuit regardless of the values of R and C. This frequency we shall call f_o, but we shall be more concerned with ω_o, the angular frequency, to save the trouble of multiplying by 2π every time we have a frequency. Thus $\omega_o = \frac{1}{R_g C}$, or in the case of the output stage,

$$\omega_o = \frac{R_g}{L}.$$

The numbers on the frequency axis of Fig. 5 are the ratio of the frequency at that point to the normalized frequency, or ω/ω_o.

You will notice that this curve is drawn on linear scales rather than the logarithmic one usually used for frequency-response curves. Various makers use different spacing for their logarithmic paper, and, since we are going to make a template from this curve, we could only use the template with the same make of paper if we use log paper. If you transfer this curve to centimeter-square paper or inch-square paper, you won't have this trouble. Besides, linear paper is much cheaper than log paper and an amplifier design may use up quite a lot of paper.

To make the template, transfer the curve to a stiff sheet of paper. Cut out along the curve itself and along the broken lines as indicated in Fig. 5. Draw in the numbers indicating frequency on the template which is now the upper part of the normalized response curve cut out.

A sample problem

Suppose we wish to draw the response curve of the amplifier shown in Fig. 6. The first step is to prepare a sheet of graph paper with the same size squares as are used on the template. Draw in the decibel scale the same as in Fig. 5 and put in a frequency (ω) scale. Notice that equal intervals on the frequency scale represent a doubling of frequency.

Now we determine the three values

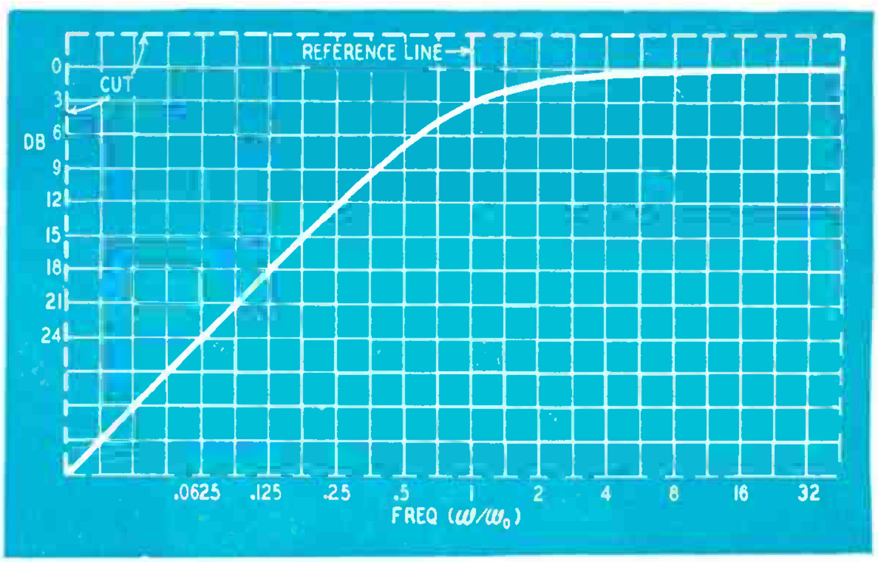


Fig. 5—The amplitude characteristic of amplifier coupling circuits. To make the template, cut out along the curve and along the broken lines as indicated.

of ω_o for the three coupling circuits. R3 is the resistive load on the plate of the output stage.

$$\omega_1 = \frac{1}{R1\ C1} = 1{,}000 \ (160 \text{ c.p.s.}),$$

$$\omega_2 = \frac{1}{R2\ C2} = 100 \ (16 \text{ c.p.s.}),$$

$$\omega_3 = \frac{R3}{L} = 125 \ (20 \text{ c.p.s.}).$$

First place the template on the paper so that the reference line is at $\omega_1 = 1{,}000$ and trace the curve. Move

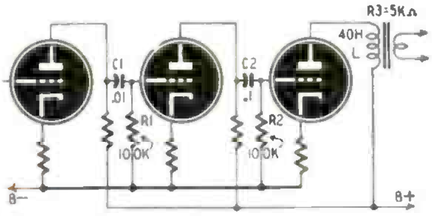


Fig. 6—A simplified amplifier circuit to illustrate the interstage coupling.

the template sideways so the reference line is opposite $\omega_2 = 100$, and trace another curve. Then place the reference line opposite $\omega_3 = 125$ and trace the third curve. Now you should have three curves like 1, 2, and 3 on a graph that looks like Fig. 7. Each of these curves shows the low-frequency attenuation of the coupling circuit in question.

To get the over-all response add the attenuation of these three curves. At some frequency, measure the distance from the 0-db line to curve 2 (a pair of dividers or a compass is handy for this). Then, below curve 1 mark a point equal to this distance. On our curves, for example, at 50 cycles we mark off distance A to curve 2, then mark off this same distance A below curve 1. If you do this for a number of points, you will have points on curve 1 plus curve 2. In exactly the same way measure the distance from the zero line and mark off this distance below the new curve (1 + 2). Draw a continuous line between these points and you have the sum of the three curves—the over-all response curve of the amplifier.

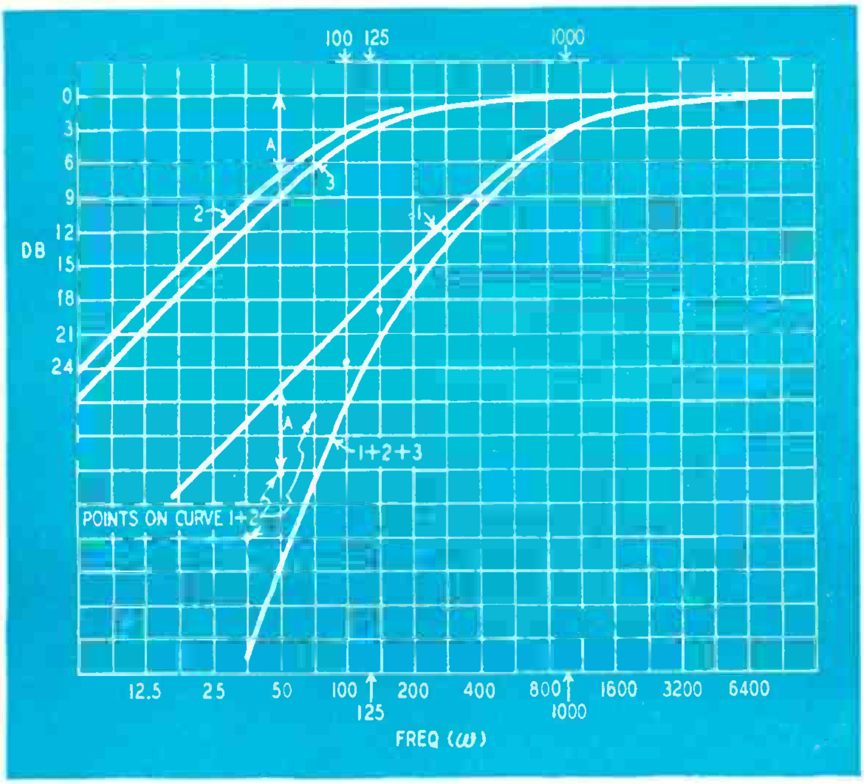


Fig. 7—Graph showing the amplitude response of each of the three coupling circuits and the final curve (1+2+3) which results when the three are added.

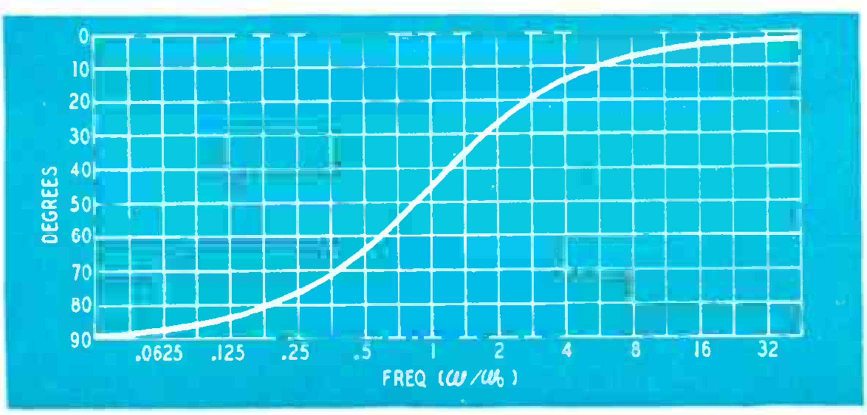


Fig. 8—The phase curve of the coupling circuits. This curve is normalized too.

The phase characteristic is constructed in exactly the same way using a template made from Fig. 8. It is surprising how quickly curves can be added in this way. When more than two curves are added, only the points need be plotted until the final curve is drawn.

By now we can see the course of the design. The first step is to decide what we want, thus settling the main outline of the amplifier. We then use the template find the amplitude and phase characteristics. The point where the phase curve cuts the 150° line is the critical point: the amplitude at this point must have fallen by more than the required feedback factor. If this condition is not met, we will have instability at the low-frequency end and must make some changes in the interstage coupling circuits.

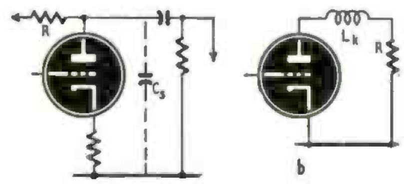


Fig. 9—The amplifier coupling circuits as they appear to the high frequencies.

The high-frequency response

At the high-frequency end we must repeat this process. The two basic circuits are shown in Fig. 9. The resistance-coupled stage has an anode load resistor R and stray capacitance C_s made up of the tube output capacitance, the input capacitance of the following stage, and other strays. Of these, the capacitance to ground of the coupling capacitor can be the most important. In one compact amplifier the stray capacitance to ground of a 0.1-μf capacitor in a rectangular metal can was 40 μμf.

The inductance of the circuit in Fig. 9-b is the leakage inductance L_k of the output transformer. Both these circuits can be represented by the curves of Fig. 6 except that they are backward. All we have to do is turn the template over. Now the normalized frequency is given by ω/ω_o. Thus if ω_o is 10 kc, the frequency 20 kc corresponds to ½. The response characteristic is constructed in the same way as for the low frequencies and the stability is checked by observing where the curve crosses the 150° line.

Of course this calculated response curve will not exactly match the actual response curves of the completed amplifier because there are many little things that cannot be accounted for without an undue amount of work; but if all steps in drawing it are carefully carried out, it will be close enough so that the amplifier's performance can be predicted with surprising accuracy. The effort of making the curves is rewarded with a good amplifier.

In the next article we shall examine the characteristics of an amplifier of known design.

Electronics and Music

Part V—Basic L-C oscillator circuits and how to multiply their frequencies

By RICHARD H. DORF*

In last month's article we began the discussion of monophonic instruments, those which produce melodies only, without chords. As was indicated, heterodyne oscillators and code-practice-type relaxation oscillators can be used to generate the necessary tones for such instruments.

It is more common, however, to use more or less simple L-C oscillators and to vary the frequency by substituting either different capacitors or different inductors in the tank circuit. The reason is that an oscillator is most stable when there is just enough feedback to sustain oscillation. Audio-frequency oscillators are not necessarily more stable (in percentage terms) than r.f. oscillators, but when the latter are used in a heterodyne arrangement, the small percentage of inadvertent frequency variation at r.f. produces a very large and intolerable percentage of variation at audio. For that reason it is seldom practical to control a beat-frequency electronic musical instrument with ordinary keys which introduce fixed frequency changes; the changes simply will not remain fixed.

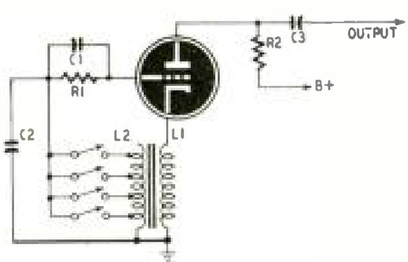


Fig. 1—A simple oscillator circuit in which the pitch is varied by selecting taps on the transformer grid winding.

At audio frequencies, almost any kind of L-C oscillator can be varied in frequency in fixed steps by having the keys operate switches which substitute various values of L or C in the tank circuit. Representative circuits appear in Figs. 1 and 2, which show methods for inductive and capacitive tuning.

*Audio and Television Consultant, New York City.

Oscillator circuits

The oscillator of Fig. 1 uses feedback from the cathode to the grid through a transformer to create oscillations. L1 is the transformer primary and L2 the secondary. R1-CI is a grid leak bias arrangement, C2 the tank capacitor, C3 the output blocking capacitor, and R2 the plate load resistor.

The frequency is varied in fixed steps by using taps on L2. Each key controls an s.p.s.t. switch to determine how much of L2 should appear across C2. If two or more keys are inadvertently pressed simultaneously, the one putting the least amount of inductance in the circuit is effective and the highest note sounds.

The circuit of Fig. 2 is an ordinary plate feedback oscillator with a tickler winding on the oscillator transformer. The frequency is varied with a string of capacitors that may be tapped at any point. The method of calculating or finding experimentally the correct capacitor values for the various notes requires a little explanation. For this purpose only five notes are provided for in the diagram.

With all switches open, all the capacitors are in series and the effective capacitance across the tank coil

$$C = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \frac{1}{C4} + \frac{1}{C5}}.$$

This is the minimum possible capacitance and corresponds to the highest note.

With S1 closed by pushing the appropriate playing key, C1 is shorted and the net capacitance is the reciprocal of the sum of the reciprocals of only C2, C3, C4, and C5, which increases the C in the tank and gives the next lower note. With S2 closed, only C3, C4, and C5 remain, and the result is the second lower note.

It might seem simpler to use a switching system like that in Fig. 3, where each capacitor is the only one across the tank when its key switch is closed and series values need not be calculated. The danger, however, is that the player may accidentally hit two or more keys at a time, throwing two of the capacitors into the circuit. The result would be that the C in the tank would be the sum of the two and would tune the oscillator to a note entirely different from either one alone—and probably one that had nothing to do with the scale. In Fig. 2 that is not possible, since hitting two keys at a time would simply short fewer or more of the capacitors; the note sounded would be the lower of the two. In other words, it is not possible to put strange values of capacitance across the tank.

In designing or constructing the circuit of Fig. 2, start with the lowest note. Place a single capacitor across the tank and select the value that gives the lowest musical note desired from the instrument. For the next higher note, select a capacitor which, in series with the first, will give the desired note, and so on up the scale. Any but very rough calculations are entirely unnecessary, since a good deal of experiment is required anyway, due to relatively large tolerances in marking capacitors.

The waveform of the oscillator output depends largely on the amount of voltage fed back from the tickler winding, which, in turn, depends on the relative number of turns in tickler and tuning coil and on the value of the resistor in series with the tickler. Experiment also with grid-leak values.

Multirange instruments

In general, it is difficult to construct an oscillator which will be stable and have the same waveform over a very large frequency range. For that reason,

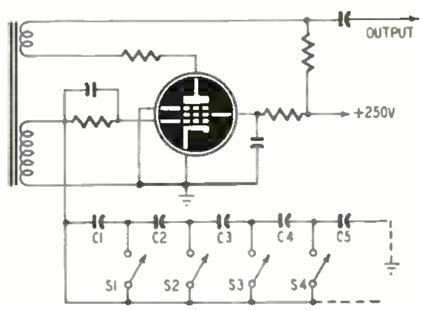


Fig. 2—In this circuit a series combination of capacitors is selected to get the desired pitch. When all of the switches are open the pitch is highest.

some designers of monophonic instruments have used oscillators with a relatively narrow range—one to three octaves, using frequency multipliers or dividers to provide the other octaves as they are needed.

Fig. 4 shows a simple arrangement for a string of frequency multipliers which needs no d.c. power for its operation. It is designed as a series of simple fullwave rectifiers identical to those used in receiver and amplifier power supplies.

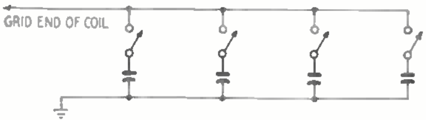


Fig. 3—Parallel switching like this cannot be used because it will produce off-key notes when two keys are hit.

Every radioman knows that the output of a 60-cycle full-wave supply contains 120-cycle ripple because the rectifier takes every negative alternation of the original a.c. (dotted lines in Fig. 5) and places it above the base line to make it positive. There are then twice as many positive alternations as before. Now when the d.c. pulsating at the doubled frequency is taken through a capacitor or transformer which will pass only a.c., the base line moves to the effective center of the waves and we get the a.c. shown in Fig. 5-b, which is twice the frequency of the original sine wave signal.

In Fig. 4 we have three full-wave rectifiers in cascade. If the primary of the first transformer is fed a frequency corresponding to C_{16}, 65.41 cycles (see frequency chart on page 42, August, 1950, issue), each rectification will provide the next octave C above. If the master oscillator is variable over one octave beginning at C_{16}, then the topmost note available from the third rectifier will be C_{64}, two octaves above middle C. In the diagram of Fig. 4 the outputs are labeled f, 2f, 4f, and 8f, to indicate the appropriate multiple of the master oscillator frequency f. Each frequency is taken from the secondary of a transformer through a capacitor and a "leveling" resistor. Since there is some power loss through each rectifier and transformer, the values of the leveling resistors may be adjusted to have the output voltage at all points the same. The load on the last rectifier is a resistor.

As the drawing of Fig. 5-b indicates, the output of each rectifier is not the original sine wave. The presence of the sharpened negative alternations will introduce even harmonics, which may or may not be desirable. If it is not, a fairly large capacitor may be placed across the primaries of the second and third transformers and across the terminating resistor, as indicated by dashed lines in Fig. 4. If these capacitors are large enough, they will round the negative peaks fairly effectively. They will also, of course, reduce the available output voltage, but that is not serious if the level is high enough in the first place. Alternately, a pi-section lowpass filter may be inserted in each output following the leveling and isolation resistor.

If the waveform remains unaltered after the first rectifier, the shape of the output of the second rectifier will be different again, for the sharpened negative peaks will have been transferred above the baseline. The second rectifier output will look something like Fig. 5-c, and subsequent rectifier outputs will be even more complex. Again, the designer must determine whether this is desirable for the particular instrument in which the circuit will be used.

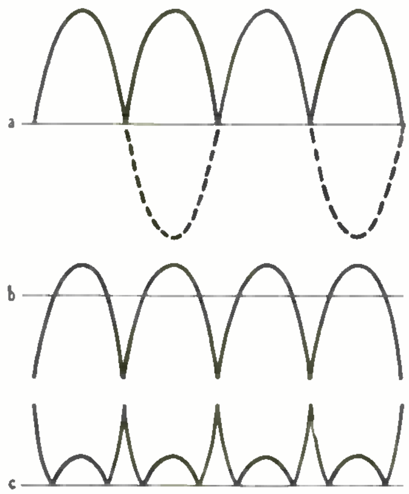


Fig. 5—Output waveforms of the first two frequency multipliers of Fig. 4.

Obviously, the number of rectifiers actually used may be greater or smaller than in Fig. 4. 1N34 crystal rectifiers may be used instead of vacuum tubes (but watch the currents through them) so that no power supply of any kind is necessary. The transformers may be interstage units with 1-to-1 ratios or perhaps slight stepups. If level is sufficient, the primary of the first transformer may be used as the inductance of the oscillator tank circuit, depending on the type of oscillator circuit that is used.

In the next article, more complex frequency multipliers and dividers will be introduced.

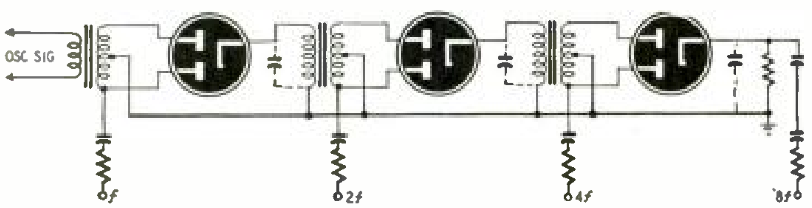


Fig. 4—A string of multipliers for extending an oscillator's frequency range.

An Eye For Music

By OLIVER HORNUNG

"That symphonic music wouldn't irk me so much, if only a.v.c. was actually what it is supposed to be."

Jim was the fellow who spoke that way. He was only a radio repairman and not a connoisseur of finer music. Or maybe he thought of that poor loudspeaker cone, laboring so pitifully because of some excited musicians were trying to out yell each other.

"Please, can't you turn down the volume a little?" he yelled.

"Why, this is good music," retorted Eddy who did his repair work on a bench close by. "I'm listening to Warbucksy's most famous symphony. He was inspired by a beautiful woman."

"Beautiful?" gasped Jim, "why that conglomeration of sound couldn't have been inspired by a witch . . ."

"You just don't understand good music! You don't realize its depth . . ."

"Sure, sure, I've heard that malarky before. All I've got to do is get used to it. If an Indian fakir can sleep on a bed of spikes, I should be able to."

Well, anyone's nerves would have been a bit on edge after struggling a couple of hours with a new-fangled, three-speed record changer. The tone arm was so light it jumped those microgrooves when the changer was shaken just the slightest bit. And to make things worse, Mr. Swiderski had written: "It *still* jumps grooves when we dance the polka."

"Oh hum," Jim muttered to himself, "it will take more than a 5-gram pickup arm to weather the floor-shaking properties of the Polish Hop. I'll just send this changer back to him and tell him to . . ."

"Don't put it back in the box yet," just then spoke a feminine voice, "I would love to hear this record first."

Jim looked around and saw Marie, that opera-loving office girl who could be a pest at times.

"And now what must I endure?"

"Oh, I know you will love this . . . it is Pili Pontinta's most famous aria!"

Jim connected the amplifier, pushed in the linecord plug and put the new record on the changer. The amplifier was warming up, the record had dropped, and Eddy was coming over to listen.

After a bit, Jim began to stare at them both. Next he gazed at the changer and than back at Marie and Eddy. He also shook his head.

"Tell me, do you really enjoy her screaming? If she isn't in actual agony, I'll be a . . ."

"Her voice is simply wonderful!"

"Yes, if you only had an ear for music, you would appreciate her voice."

Jim reached for the changer; his hand grasped a knob which he turned from a number 45 to a number 33⅓.

"Doesn't she sound more happy now? Sometimes my ear tells me to use my eye . . . I do have an *eye* for music!"

Getting Rid of TVI For Improved Video

By ROBERT F. SCOTT

IF YOUR TV receiver suffers from a constant barrage of interfering signals which rips your picture to shreds just follow along while we point out causes and cures for about 95% of all TVI. You have probably read the article "TV Interference Problems," by William L. Kiser, in the January, 1950, issue. If you haven't, refer to that issue or send to this magazine for a free reprint of the article.

Because a television broadcasting channel is 6 megacycles wide, a receiver's tuned circuits cannot be made selective enough to eliminate all interference adjacent to them. Furthermore, the picture and sound i. f. channels usually are in the 21-27-mc range and respond to strong signals in this range so that interference patterns appear in the picture.

Because the front end of a TV receiver cannot completely reject signals outside the 6-mc channels, such signals must be kept from the active circuits of the receiver. Exaggerated adver-

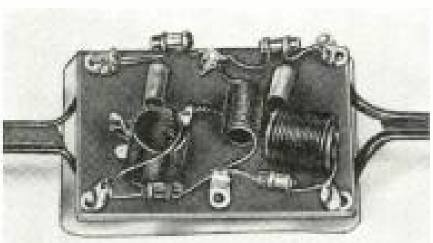


Photo of the 300-ohm highpass filter.

tising has led the average set owner to believe that a TV receiver is a perfect piece of equipment and that all interference must be eliminated at its *source*. This is not true!

All users of shortwave transmitters have become TVI conscious and most of them have taken steps to keep harmonic radiation within the limits specified by the FCC—still there remains plenty of TVI. Now that transmitters are being cleaned up, the rest is up to set owners and manufacturers. Some sources of interference which can be cured by shielding, traps, or filters at the receiver are:

Shock excitation

Strong signals below 54 mc may be picked up by the antenna and lead-in and fed to the front end of the receiver. These signals appear on the grids of the r.f. or mixer stages and may so overload them that harmonics are generated in their plate circuits. Because the plate circuits are tuned to TV channels, harmonics in this range will be emphasized and heterodyned into the i.f. channels by the mixer.

Signals most likely to cause this trouble may be generated by commercial shortwave, police, fire, public utility, and amateur transmitters; and scientific, electro-medical, and industrial heating equipment operating below 54 mc. Shock excitation causes interference which blanks out all channels—active and inactive.

If the frequency of the interfering signal is known, series- and parallel-tuned traps, open quarter-wave or shorted half-wave stubs, or highpass filters may be inserted in the antenna lead-in close to the tuner. The design and construction of such rejection circuits will be described later in this article.

Cross modulation

The receiver's oscillator may radiate a fundamental or harmonic which beats with signals outside the TV channel. This may produce heterodynes (cross-modulation) which fall inside the channel to which the receiver is tuned. For example: When the average receiver is tuned to channel 3, its oscillator is operating on 87 mc. Some of this 87-mc signal may appear on the grid of the r.f. stage and beat with a 2-meter signal on 148 mc to produce a 61-mc heterodyne (148-87 = 61) which falls directly on the video carrier of a channel. 3. This unwanted signal will be amplified by the 60-66-mc tuned r.f. amplifier, heterodyned by the mixer, and fed into the video i.f. amplifiers. Thus the set creates its own interference.

Likewise, when a receiver is tuned to channel 5, its oscillator—on 103 mc —can beat with a local TV station on channel 7 or 8 to produce beats in the 71-77- or 77-83 -mc ranges. These beats span the carrier frequencies of channels 5 and 6 and produce interference patterns. Similar types of interference can be produced on other channels whenever the receivers' oscillator radiates signals which will heterodyne extraneous signals into the TV channel being received.

The simplest way to reduce or eliminate interference of this type on a given channel is to connect a shorted half-wave stub across the set's antenna terminals. Cut the stub to the receiver's oscillator frequency. If the oscillator frequency is not in other TV channels, the stub may be permanently connected across the lead-in. In other cases, a switch may be needed to cut the stub out of the circuit. Sometimes a half-wave stub cut to the interference will do the job. If this type of interference occurs on several channels, you may have to cut separate stubs for each channel and switch them in as the receiver is tuned to different channels.

Radiation from other sets

Table I shows the TV channel limits and the carrier and heterodyne oscillator frequencies for video i.f.'s of

TABLE 1

Channel Number	Channel Freq. (mc)	Picture Carrier (mc)	Sound Carrier (mc)	Het. Osc. Freq. (mc)
2	54-60	55.25	59.75	81
3	60-66	61.25	65.75	87
4	66-72	67.25	71 75	93
5	76-82	77.25	81.75	103
6	82-88	83.25	87.75	109
7	174-180	175.25	179.75	201
8	180-186	181.25	185 75	207
9	186-192	187.25	191.75	213
10	192-198	193.25	197.75	219
11	198-204	199.25	203 75	225
12	204-210	205.25	209.75	231
13	210-216	211.25	215.75	237

25.75 mc. and sound i.f.'s of 21.25. Note that when a receiver is tuned to channel 2, 3, 7, 8, or 9, its oscillator is tuned to channel 5, 6, 11, 12, or 13. Sets with other i.f.'s may have oscillator radiation in different channels. Radiation from the oscillator may reach the antenna and be broadcast into neighboring receivers.

The oscillators of most FM receivers tune between 77.3 and 97.3 mc. Radiations from them will fall in channels 5 and 6 whenever the offending FM receiver is tuned between 88 and 98.7 mc.

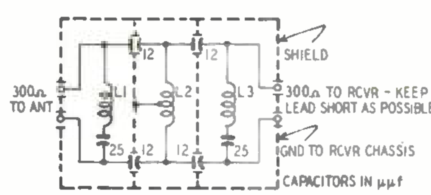


Fig. 1—Circuit of the 300-ohm filter.

The oscillator operates below the signal frequency on the high bands of some Motorola receivers and it will radiate signals which fall in channel 7, 8, or 9 when the set is tuned to channel 11, 12, or 13.

Old TV receivers with 8.25-mc i.f.'s are also offenders in this respect. The oscillator, displaced from the signal frequency by only 8.25 mc, it is more likely to cause interference on adjacent TV channels. This is particularly true when the receiver is tuned to channel 4 and its oscillator is on 80 mc—well within the limits of channel 5.

Traps, stubs, and filters are usually useless in eliminating interference which falls directly on a TV channel; but if the interference is weak, cut a half-wave stub for the channel being received. Try shorting the stub with a carbon resistor between 22 and 220 ohms. Sometimes you can eliminate the interference without losing the video and sound carriers. Use the largest resistor that will reduce the interference so it is not objectionable. If this method does not work, try to locate the offending receiver. Once it is located, advise the owner to connect a booster in front of his receiver. A booster will help to attenuate oscillator radiation into the offending set's antenna. It will *not* help if the radiation is direct, rather than through the antenna.

If the receiver happens to be one of the Motorolas with the oscillator frequency below the signal on the high band, advise its owner to take the set to a Motorola distributor or service technician who will modify the front end to eliminate the trouble. This change is made without cost to the set owner.

Audio amplifier pickup

Pickup in the audio amplifiers is similar to that in the video amplifiers. Direct pickup in the a.f. amplifier is present when the volume control fails to attenuate the sound interference. Such interference is most common in TV-radio-phono combinations having the a.f. circuits on a separate chassis.

When the interfering signal is coming through, touch a 3-foot test lead to each audio grid in turn until the interference gets louder. Try bypassing the grid of this stage to ground with

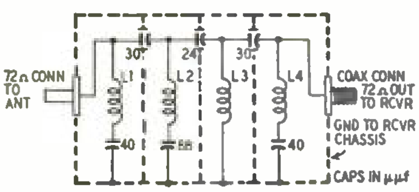


Fig. 2—Circuit of the 72-ohm filter.

a .0002- or .0003-μf mica or ceramic capacitor. Keep the leads as short as possible. If this does not work, add a 47,000-ohm resistor in series with the hot lead to the grid. The resistor and capacitor will form a lowpass filter which shunts r.f. to ground and prevents its being detected in the a.f. amplifier.

Diathermy

Interference from electromedical, scientific, and industrial heating equipment is usually below 50 mc and can be prevented from entering the receiver via the antenna by using a highpass antenna filter. As additional precautions. try line filters and a shield around the receiver chassis.

Constructing rejection circuits

Details for constructing m-derived highpass filters for 300- and 72-ohm transmission lines are shown in the photos and in Figs. 1 and 2. The 300-ohm filter will cut off all signals below 45 mc. L1 and L3 are 15 turns of No. 20 enameled wire close-wound with an inside diameter of ½ inch. L2 is a center-tapped coil of 16 close-wound turns of No. 20 enameled wire on a ¼-inch form. Similar filters are available as kits and as wired units.

The 72-ohm filter shown in Fig. 2 is more elaborate than the 300-ohm model. It was used to prevent 75- and 20-meter fundamentals from reaching a TV receiver which had its antenna within 5 feet of the transmitting antenna. All coils are wound with No. 22 enameled wire and are ½ inch in diameter and ½ inch long. L1 and L4 have seven turns, L2 has four and one-half turns, and L3 has four turns.

The layout and construction are important to the performance of highpass filters. The 300-ohm filter was not shielded because this was not necessary. If the TVI is severe, the filter must be placed in a shielded box, as was the 72-ohm job. Individual shields between the coils of the filter may also be necessary. But in most cases it is sufficient to mount the coils with their axes at right angles to each other. The components are soldered to lugs riveted to a sheet of Bakelite. The broken lines in Figs. 1 and 2 show how shields between the coils are placed.

Figs. 3-a and -b show parallel- and series-tuned traps made from Ohmite r.f. chokes and miniature variable capacitors. Table 2 shows the values of inductance and capacitance for traps having different ranges. Ohmite chokes which can be used are shown in the column next to the inductance.

The length of a half-wave stub in inches can be calculated from the formula:

$$\frac{5904 \times v}{\text{Freq. (mc)}},$$

and the length of a quarter-wave stub from:

$$\frac{2952 \times v}{\text{Freq. (mc)}}.$$

The factor v is the velocity of propagation of the signal in the line, expressed as a fraction of the speed of light, and is equal to .659 for coaxial cables, .68 for 75-ohm ribbon, and .82 for 300-ohm ribbon.

10- and 11-meter ham signals

The 11-meter band (27.160-27.430 mc.) is within, and the 10-meter band (28.00-29.70 mc) is close to the i.f. passband of the average TV receiver. Because the receiver's i.f. channel is 6 mc wide, its tuned circuits cannot keep out signals only one mc away. Interference from nearby 11- and 10-meter transmitters will be picked up even when such equipment is operated well within the FCC requirements.

Interference from these sources generally appears as blanketing on all channels. Remove the antenna from the receiver. If the interference is still present. the components in the i.f. channels are picking up the signals directly.

This interference can be eliminated by shielding the receiver and using r.f. filters in the power line. Because the interference can enter the shielded receiver on the antenna lead-in, it may be necessary to use a highpass filter in the lead-in.

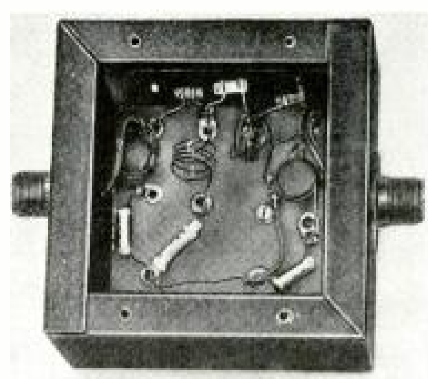
6-meter amateur signals

The 6-meter amateur band (50-60 mc) is adjacent to channel 2 (54-60 mc). The tuned circuits in the front of the receiver are not selective enough to eliminate entirely a strong signal from a transmitter on the high end of the 6-meter band while receiving a channel-2 video carrier on 55.25 mc.

Because the 6-meter band is so near channel 2, highpass filters are not too effective in reducing 6-meter pickup. Series- or parallel-tuned traps tuned to the interfering frequency will work well. For best results, the stubs or traps should be tunable to follow the transmitter as it shifts from one end of the band to the other.

FM stations

The second harmonics of FM broadcast stations fall between 176 and 216



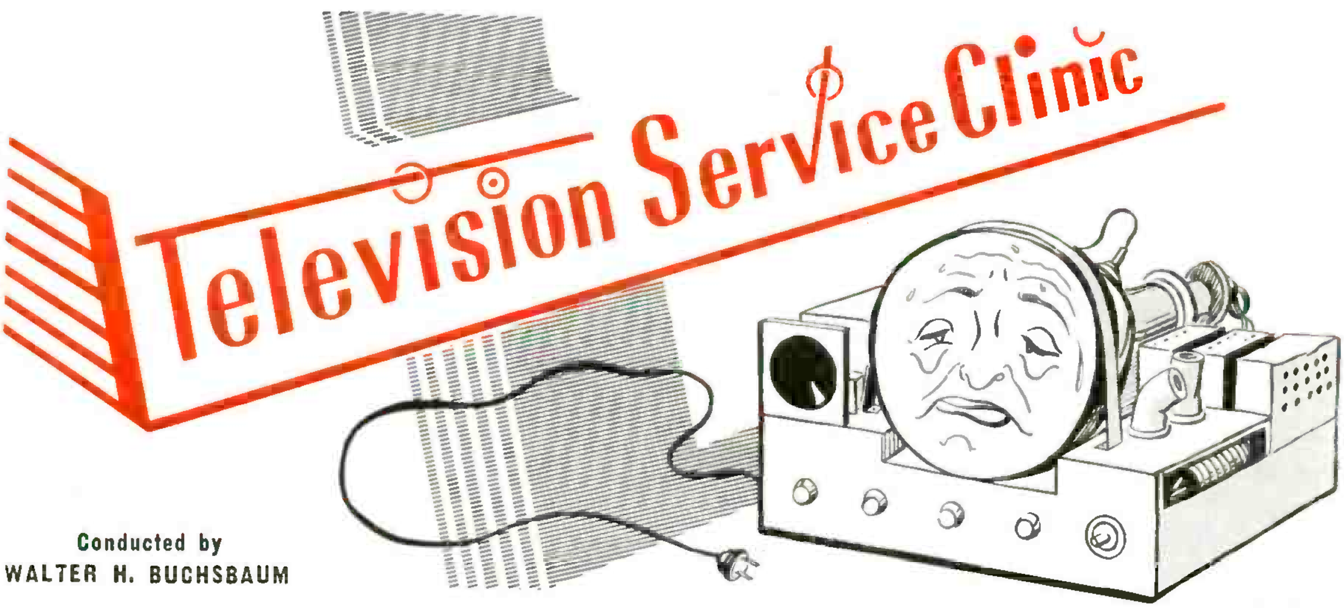
The highpass filter for 72-ohm coax.

mc and can cause interference on all high-band TV channels, and images of 103- to 106-mc FM stations fall on channel 2. As the interfering signals are directly on the TV channels, traps and other rejection circuits are not practical. This type of interference problem can best be solved by using a highly directive, beam-type, high-band TV antenna with a high front-to-back ratio. The antenna should be oriented so the FM signals arrive from the back or side. You are out of luck if the FM and TV stations are in the same direction from the receiving antenna.

Electrical appliances

Cash registers, electric signs, motors, hair dryers. and numerous other elec-

Television Service Clinic



Conducted by
WALTER H. BUCHSBAUM

A NUMBER of readers have asked about buzz in the sound of television receivers using the intercarrier system. This system uses all picture i.f. stages to amplify both the sound and picture i.f. signal. At the second detector the picture i.f. carrier beats against the sound i.f. carrier and a second i.f. of 4.5 mc is produced. This 4.5-mc signal is frequency-modulated with the audio signal and amplitude-modulated with the picture signal. In the sound section a limiter stages removes most of the AM components and a ratio detector, relatively insensitive to AM, removes the FM sound signal from the carrier.

The buzzing noise often heard in these receivers is due to the vertical synchronizing pulses which pass through and are amplified by the audio system. The theory of intercarrier requires that the sound i.f. carrier be at the bottom of the i.f. response curve, at least 20 db below the picture carrier. The solid line in Fig. 1 shows what frequently happens. The 21.25-mc sound carrier is on the slope of the curve and definitely *not* 20 db below the 25.75-mc picture carrier. One method to improve this condition and thereby reduce the buzzing noise considerably is to realign the i.f. section and make sure that the sound i.f. is well below the picture carrier. In some receivers the i.f. design does not permit proper adjustment. Then it may be advisable to insert a trap.

The 21.25-mc sound trap shown in Fig. 2 is used in the cathode circuit of one of the i.f. amplifiers. The reason for using a cathode trap is that it does not require any major circuit change. The alignment of the other i.f. coils is not affected by the cathode trap except that the trap, when properly aligned, will reduce the strength of the sound carrier as indicated in Fig. 1.

Reduced sound signal will mean a weaker signal at the ratio detector and in turn less chance of a strong AM buzz to ride through. The ratio detector is quite sensitive to weak FM signals, but strong AM signals can ride through.

Another frequent cause of buzz is sync pulse clipping in the first video amplifier. This distorts the AM envelope of the 4.5-mc signal and causes buzzing. To overcome this type of defect the video detector load resistor should be reduced in value. This will reduce the video signal, but in many receivers the gain control is set to less than maximum anyway, especially on strong stations, and on these stations buzzing is most prevalent.

Occasionally an audio lead may pick up the 60-cycle pulse while passing near a vertical sweep section component. The vertical blocking oscillator and the output transformer are especially strong radiators and audio leads

GETTING RID OF TVI FOR IMPROVED VIDEO (*Continued from previous page*)

trical appliances produce sparks and arcs which generate damped waves over a wide band of frequencies.

The source of the interference can usually be located by looking for this obvious one and by timing the interfering signals to determine if they have a particular pattern or cycle. For example, if the interference is on and off for 50-second intervals, it may be caused by a traffic light; if it is more frequent, look for flashing signs in the neighborhood. Once you locate the offending device, make a report to its owner and to the power company. Urge the owner of the equipment to install line filters and shields to eliminate the trouble. If you cannot get action in the matter, make a report to the radio inspector in your district or write to the Secretary of the Federal Communications Commission, Washington 25, D.C. In the meantime, it may be worthwhile to try a highpass filter in your lead-in and a filter in the power line.

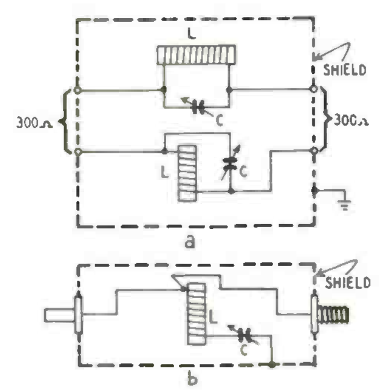


Fig. 3—Shunt- and series-tuned traps.

Video amplifier pickup

The video amplifier of the receiver responds to signals ranging from low audio frequencies to 3.5 or 4.5 mc. Strong signals below 4.5 mc will cause serious interference if they get into the video amplifier. This is particularly true of 3.5-4.0-mc amateur transmitters. Most of this type of trouble is from direct pickup by power lines and unshielded components in the video amplifier. Shield the receiver and install filters in the lead-in and power line to prevent it. Sometimes, shielded or coaxial transmission line will eliminate the interference that is picked up by the video amplifiers.

TABLE 2

L µh	Ohmite type	C-µµf at 3.5-10 mc	C-µµf at 7-21 mc	C-µµf a 21-56 mc
.02	Z-28	100		
.007	Z-50		75	
.00085	Z-235			70

should be kept away from them as much as possible. Often the pickup is magnetic, and ordinary copper shielding is not sufficient. The best remedy is to re-route these audio leads.

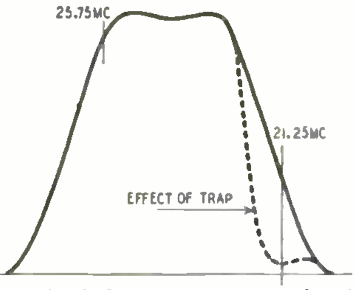


Fig. 1—An i. f. response curve showing the effect of inserting a sound trap.

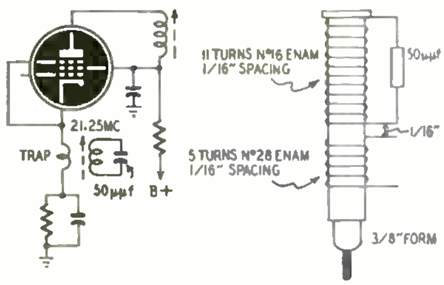


Fig. 2—The sound trap in the cathode circuit, and winding data for the trap.

In a few receivers the diode used for limiting the sync pulse in the sync separator circuit is part of the ratio detector and audio amplifier tube, such as the 6S8-GT or the 6T8. In this case the buzz may be picked up inside the tube. The only remedy is to use another diode, possibly a crystal like the 1N34, located near the sync separator tube socket.

Picture distortion

The top portion of the picture on my Motorola 10VK12 appears blown up compared to the rest of the picture. The lines at the top appear further apart than those at the bottom.—R. G. B., Albuquerque, N.M.

I suppose you have tried adjusting the vertical height and linearity controls. The top part of the picture is controlled largely by the resistance on the cathode of the vertical output amplifier and the linearity control is part of this resistance. Check to see if the cathode of this output tube is shorted to ground. This could be due to a shorted 250-μf, 25-volt electrolytic.

With at least 1,000 ohms in the cathode of the vertical output amplifier the top part of the picture cannot stretch. With the set turned off, measure the d.c. resistance from this cathode to B-minus. Check for a positive d.c. voltage on the cathode when the set is operating.

New rectangular tube

Can you tell me when and where I will be able to get the new 14-inch rectangular tube? I would like to substitute it for the 10BP4.—G. L., Bronx, N.Y.

The 14BP4 is an all-glass rectangular kinescope with a 70° deflection angle and requiring a second anode voltage of 12 kv. It is manufactured by Hytron, Sylvania, and several other manufacturers and should be available now.

The new tube *cannot* be substituted for the 10BP4 because most receivers using the 10-inch tube supply only about 7 kv and only enough sweep for a 52° deflection angle. To use the 14BP4 you would have to change the horizontal flyback circuit and put in a new flyback transformer and deflection yoke.

A.c. hum

On programs originating in Washington the picture on my Hallicrafters T54 is normal and steady. When the programs originate in other cities, a dark line appears on the screen, stretching horizontally across and moving slowly up or down.—J. W., Washington, D.C.

The cause for this dark bar lies in the power supply. Your local programs have their 60-cycle pulses synchronized to the power frequency of the Washington, D.C., power companies. Since your receiver is connected to the same power line, any a.c. ripple will be locked in with the picture and will not be noticeable.

In other cities the power frequency may be slightly different from that in Washington and therefore will be different from the ripple frequency in your receiver. As a result a 60-cycle bar appears on your screen and moves up or down, depending on the frequency difference between the distant station and Washington.

The remedy for this condition is to improve the filtering in your receiver power supply. Try shunting each filter capacitor with one of identical value. If this does not help, connect a 200-ohm, 2-watt resistor in series with the B-plus lead to the picture i.f. stages and bypass this resistor on both sides with an 80-μf electrolytic capacitor. Improving the filtering will at least reduce the a.c. hum on the picture.

Poor brightness and focus

I am using a Meissner 24 TV television receiver to drive a 16-inch tube but the brightness is only fair and the retrace lines cannot be eliminated. I would like to add gated a.g.c. and also improve the focus.—A. P. H., Inglewood, Calif.

To get better brightness and probably also better focus you should increase the second anode voltage. Since your set did not originally have a 16-inch tube, you can increase the high voltage by using a high-efficiency flyback transformer. I recommend any of the available conversion kits such as the Tech-Master Hi-Sweep Kit or the Guthman-G-E 77J1 flyback transformer.

If the poor focus persists, a larger focus coil, RMA No. 109, may help. This coil requires the same focus current but produces a stronger field.

Gated a.g.c. can be installed in your receiver, but this is a job for an experienced technician only. Suitable kits are available at most radio jobbers.

Retrace lines usually appear when the picture signal is not strong enough to blank out the retrace period. A new video amplifier tube or more i.f. gain may remedy this defect.

Sound in picture

My late-model Magnavox seems to be working all right but frequently a series of dark waves appear on the screen when there is a loud voice, applause, or orchestral music.—M. E. M., Rochester, N.Y.

These horizontal dark waves traveling vertically across the screen may be due to a number of causes. If your case it is undoubtedly connected with the TV sound signal and may be caused by:

A microphonic tube. A video i.f. amplifier or the second detector may be microphonic and strong sound waves from the speaker cause it to vibrate.

Improper alignment of the i.f. amplifier, especially the sound traps. Incorrect a.g.c. bias on the i.f. amplifiers may also be the cause.

Deterioration of a decoupling resistor and capacitor in the audio amplifier.

Horizontal white line

A stationary white line runs horizontally across the screen of my Transvision 7-inch receiver. Replacing the picture tube did not get rid of it and it is rather objectionable.—M. S. K., Elizabeth, N.J.

See if this line remains stationary when the vertical hold control is adjusted to let the picture roll. If it remains stationary, the most likely source is the high-voltage section. A filter or decoupling capacitor may be bad.

If the white line moves when the vertical hold is adjusted, then the defect is in the vertical sweep circuit. Replacing the 6SN7 oscillator and output amplifier is the first step. Next try a resistance and voltage check through the vertical sweep section. As a last resort the coupling and sweep discharge capacitors in the vertical sweep section should be changed.

Convert to 16-inch tube

I would like to convert my Motorola VT105 for use with a 16-inch tube instead of the 12-inch tube it now has.—J. L., Detroit, Mich.

Several changes are required to make this conversion.

If you plan to use a 16AP4, the metal envelope tube, you must get a plastic mounting ring and hood to insulate the hot metal shell. You will also have to rearrange the mounting brackets, the deflection yoke, and focus coil hood. You can use the 16AP4 with no electrical changes.

If you wish to use any round glass 16-inch tube, the mechanical changes mentioned will also have to be made. In addition you will have to install a 63° deflection yoke in place of the present 54° type. It is desirable to increase the high voltage, but since this requires a new flyback transformer and some major changes it is best omitted.

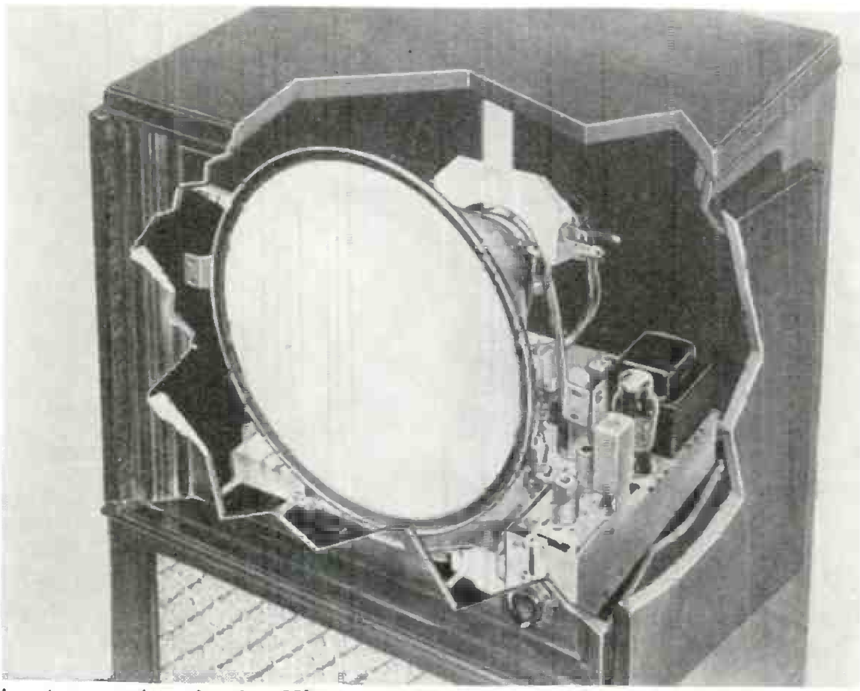
A 16-inch rectangular tube cannot be used with this set because there will probably not be enough deflection and high voltage.

Radio Set and Service Review

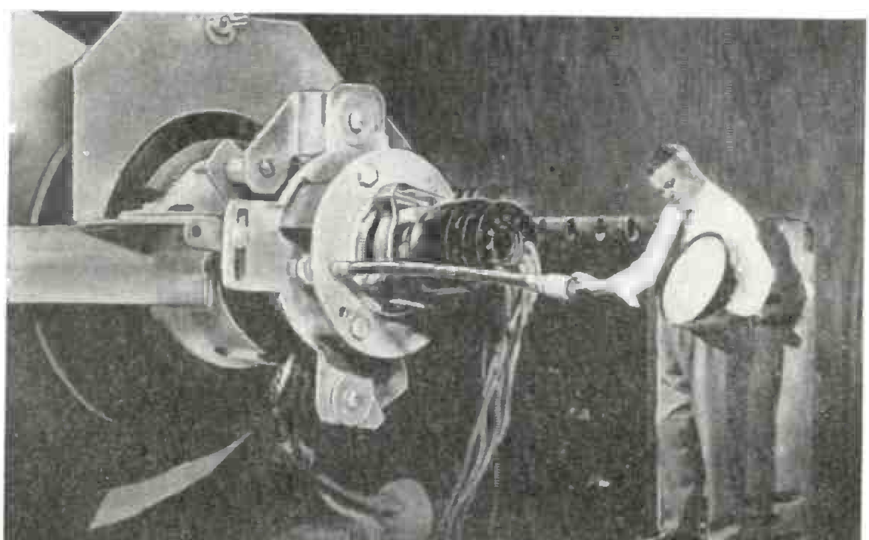
The RCA "Million-Proof" sets have several all-new features

TO IMPROVE stability, operating efficiency, and interference rejection in fringe areas, a number of new electronic circuits are incorporated in the new RCA MP (Million Proof) TV chassis. Mechanical changes in the chassis are designed to eliminate many steps in the installation procedures and make circuit components more accessible for ease of servicing and adjustment.

A new centering lever which moves up and down and side to side replaces the three interacting screws which were used as centering adjustments on earlier models. The new focusing adjustment is a flexible shaft extending through the back cover of the cabinet so the picture can be focused while watching the face of the C-R tube. This adjustment permits correct focusing when anode voltages are in the 7.5–14-kv range. The horizontal oscillator frequency adjustment has been placed atop the chassis in a spot easily accessible from the rear. A three-position a.g.c. control switch replaces the a.g.c. threshold control used on a number of other chassis. This switch can be set for best a.g.c. operation for any signal.



A cut-away view showing MP chassis. The 2-tube KRK8 tuner is plainly visible.



This trick photo shows how easy it is to focus the set while watching picture!

Twelve high-frequency oscillator adjustments are available from the front without pulling the chassis. In earlier models, oscillator adjustments for channels 6 and 13 were made from inside the cabinet.

Circuit analysis

The latest RCA TV chassis use the type KRK8 front ends, the circuit of which is shown in Fig. 1. Having a 6CB6 r.f. amplifier and 6J6 oscillator and mixer, this unit is designed for a better signal-to-noise ratio in fringe areas and for minimum oscillator radiation. The 6CB6 has low input conductance with low-noise characteristics. Its low grid-to-plate capacitance helps to prevent the oscillator signal from feeding through into the antenna circuit where it will be radiated as interference. The antenna feeds into a highpass filter consisting of C202, L200, C20[illegible], L202, C201, L201, L203, and C203. L203 and C203 form a parallel-tuned FM trap which is adjustable from the top of the chassis and tunable from 90 to 110 mc. The 100-μμf capacitor C202 reduces AM broadcast interference and blocking in strong signal areas. The entire input circuit is shielded to eliminate stray pickup.

The r.f. amplifier is biased by a 27-ohm cathode resistor bypassed by a 12-μμf capacitor. These values are selected to limit changes in input capacitance with changes in a.g.c. bias. At low values of bias, the apparent grid-to-cathode capacitance rises and reflects this added capacitance across the antenna circuit to tune it to a slightly lower frequency. When the bias increases, the capacitance decreases and the antenna shifts to a higher frequency. Thus, when the r.f. curve is aligned flat for normal signals, the picture carrier will rise slightly above the sound carrier at a low bias level—when the signal strength is low. With the picture carrier level boosted, the set has an apparent improvement in the signal-to-noise ratio in low signal-strength areas.

Microphonics in the front end are reduced by connecting the oscillator circuit to the section of the 6J6 which does not support the getter and by using low L-C tuning constants. Coupling between oscillator and mixer is adjusted by varying C7. This capacitor is adjusted for optimum conversion efficiency.

A series-tuned network C8-L44 in the mixer plate circuit is tuned above the highest TV frequency so it reflects—by Miller effect—a capacitive reactance into the mixer grid circuit. This reflected capacitance provides the proper loading effect over the TV channels. The 10,000-ohm resistor across the primary of the converter transformer broadens the response of this circuit.

The converter transformer is link-coupled to the first video i.f. transformer through 75-ohm coaxial cable. Oscillator radiation is further reduced because of the shielding and the low voltage in the low-impedance circuit.

The a.g.c. line to the r.f. amplifier is also connected directly to the paralleled diodes in the 6AV6 first a.f. amplifier. The purpose of this diode connection is to clamp the r.f. bias at −0.1 volt in a type of delayed a.g.c. arrangement until there is sufficient a.g.c. signal voltage (0.2 volt) to overcome the clamped bias and bias down the r.f. tube on strong signals. This connection increases sensitivity to weak signals and reduces sensitivity on strong ones so the r.f. and picture i.f. circuits are not overloaded.

The video i.f. amplifier circuit consists of the double-tuned converter transformer followed by four stagger-tuned i.f. stages tuned 0.25 mc *lower* than in previous models. This slight shift in the i.f. eliminates interference due to video i.f. harmonics. The first three i.f. stages are controlled by a.g.c. voltage. Their cathodes are overcompensated to cause a slight rise at the picture-carrier end of the response curve when the input signal is reduced. This improves the signal-to-noise ratio on weak signals and makes some improvement in the picture resolution on strong signals. In other respects, the video i.f. system is similar to that used in earlier models.

The video detector and amplifier circuits are shown in Fig. 2. Note that the video detector, pins 2 and 5 of the 6AL5, is tapped down on coil L102. This reduces loading on the coil and provides the correct input signal level for the video amplifiers. The video detector is returned to ground instead of a high negative bus as in some sets. This change reduces the heater-to-cathode potential in the tube and reduces the possibility of tube failures due to shorts and breakdowns.

The a.g.c. rectifier, pins 1 and 7 of the 6AL5, is connected across the entire coil so it is supplied with approximately three times the voltage at the detector.

A novel noise clipper

The peak-to-peak voltage at the grid of the first video amplifier varies over a range of approximately 2 to 1. A novel circuit clips noise at this grid. This tube is operated so the tips of the sync signals are close to cutoff voltage. The plate voltage for this stage is taken off the junction of R210 and R211, dropping resistors for the plates of the first and third video i.f. amplifiers. These stages are controlled by the a.g.c. signal so the drop across the resistors is greatest for weak signals. After filtering, this voltage, which varies from 60 with a weak signal to 140 with a strong one, is applied to the plate of the first video amplifier. Thus the tips of the sync signals are always near cutoff, and noise above the sync tips will be clipped. This circuit helps

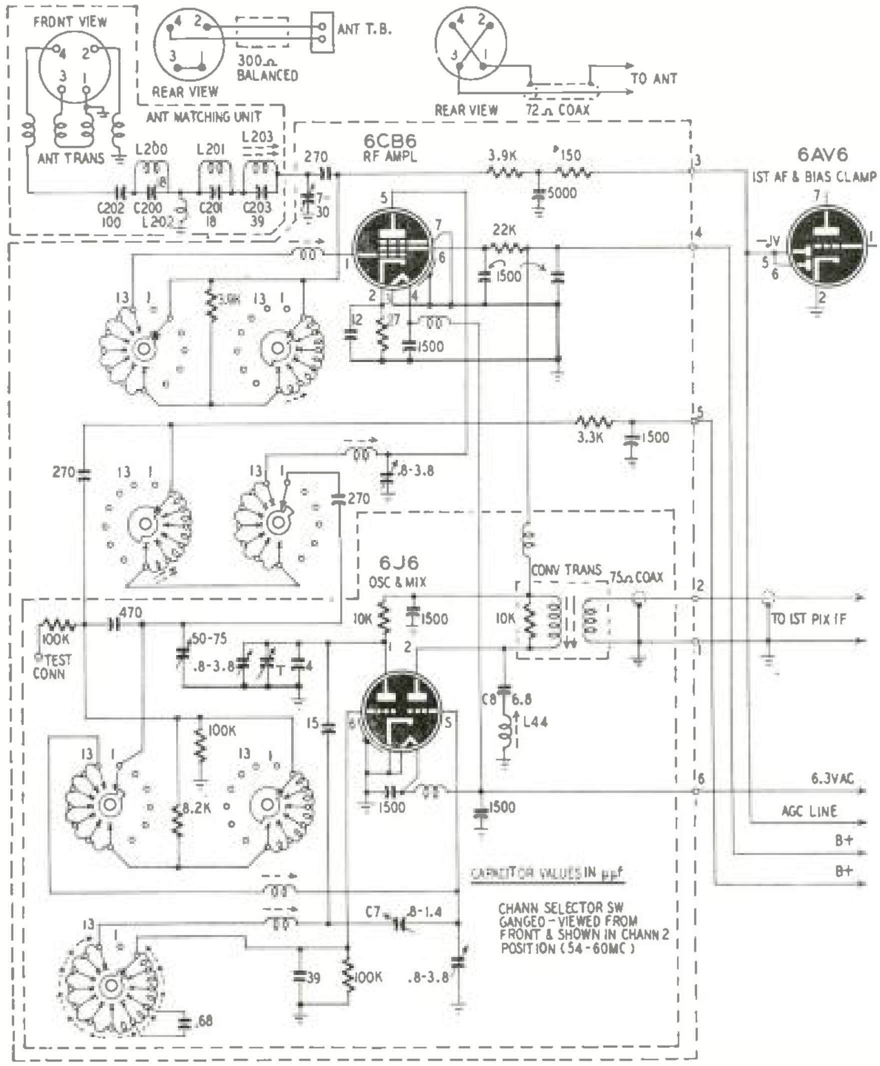


Fig. 1—The new KRK8 tuner has only two tubes instead of three as in earlier models. A highpass filter in the antenna input circuit minimizes interference.

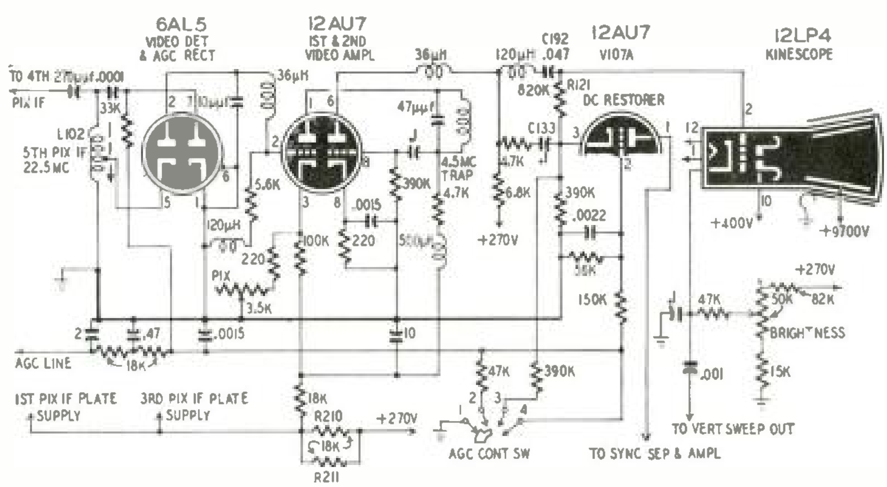


Fig. 2—Video detector and amplifier. Novel circuit reduces ignition noise.

to improve the synchronization of the sweep oscillators.

The a.g.c. switch is adjusted for optimum performance under different signal levels. Position No. 1 is for normal signals. The switch should be advanced to position 2 if impulse-type interference prevails in the receiving locality. Position 3 is for weak-signal areas where impulse-type interference is encountered. In this position, a.g.c. is removed from the set and the receiver may overload on signals over 200 microvolts.

Poor alignment of the fourth video i.f. amplifier or a bad 6CB6 in this stage can also cause overloading. Check the alignment of this stage and try several new 6CB6's to find one which will develop enough a.g.c. voltage to prevent overloading in strong-signal areas.

V107A is the d.c. restorer and first sync clipper. The a.c. video signal is applied to the grid of the C-R tube through C192 and R121. A portion of the composite video signal is rectified by V107A and applied to the grid of the C-R tube. Because C133 holds most of its charge for the duration of one line and is recharged by each sync pulse, the d.c. level on the grid of the C-R tube is held at the correct level with respect to the picture information and sync sent from the transmitter. The plate voltage of this tube is adjusted so the video information is clipped and only the sync pulses appear in the plate circuit.

The negative sync output from the plate of V107A is directly coupled to the grid of V107B, the second sync clipper. This section of the tube (Fig. 3) is biased so the sync tips are clipped due to cutoff and compressed due to plate saturation.

The deflection circuits

The vertical sweep generator is a free-running multivibrator of unusual design. When the set is first turned on, minor circuit disturbances cause a positive pulse to be fed from the plate of the vertical output stage through C179 to the grid of the vertical oscillator tube. This positive pulse causes the oscillator grid to draw current, charging capacitors C139 and C140. The end of the pulse finds these capacitors charged negatively so the oscillator tube is cut off until nearly all the charge has leaked off through R200, R148, and the hold control. While these capacitors are holding the vertical oscillator tube at cutoff, capacitor C141 is charging through the power supply and resistor R155. This voltage is applied to the grid of the vertical output tube, causing its plate voltage to decrease. When most of the charge has leaked off C139 and C140, the oscillator conducts and C141 discharges rapidly through it. The rapid discharge of C141 causes the plate voltage to rise on the output tube and send another positive pulse to the oscillator grid to keep it running at a frequency slightly lower than the normal vertical sweep frequency.

When a signal is tuned in, positive sync pulses are applied to the oscillator grid. If the oscillator is cut off because of the charge on C139 and C140, the positive sync pulse will overcome the negative charge and cause the oscillator to conduct prematurely and discharge C141. By eliminating the blocking transformer—an essential component in many circuits—servicing has been simplified and the overall weight of the set is reduced.

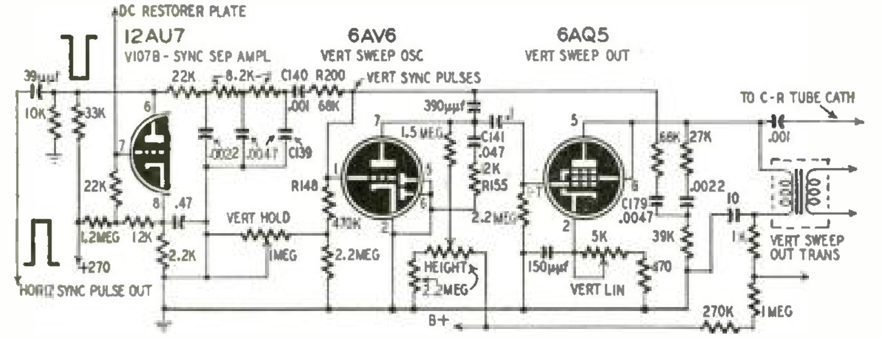


Fig. 3—An unusual multivibrator is the heart of the vertical deflection circuit.

Another unusual feature of the vertical deflection circuit is that the positive retrace pulse from the output stage is applied to the cathode of the C-R tube. The amplitude of this pulse is sufficient to cut off the picture tube during the retrace period, making the retrace lines invisible.

The high-voltage and horizontal deflection circuits are shown in Fig. 4. The horizontal oscillator and its control circuit are similar to the synchroguide used in earlier models. The oscillator frequency is controlled by the position of the slug in winding A-C on the blocking transformer and the bias on the oscillator tube.

The oscillator control tube is biased almost to cutoff so it passes current only during the positive peaks of a signal applied to its grid. This incoming signal is a complex one composed of a part of the sawtooth generated by the oscillator and the positive sync pulse from the sync clipper or separator. The phase relationship between the sawtooth and the sync pulse will determine the amount of conduction in the control tube and the charge which it places on C147 and C148 in its cathode circuit. The voltage on these capacitors is applied as bias to the grid of the blocking oscillator. Because the speed of the oscillator is a function of grid bias and the developed grid bias is determined by the phase relationship between the sync and oscillator voltages, the oscillator is automatically locked in with the sync pulses transmitted by the station. Winding C-D and capacitor C150 help to stabilize the blocking oscillator.

The signal from the oscillator is fed to the grid of the horizontal output tube through a capacitive voltage divider consisting of the 560-μμf coupling capacitor and the horizontal drive range control. By varying this capacitor, it is possible to control the conduction of the output stage.

The sweep output circuit is the conventional direct-drive type used in earlier sets.

The sound strip consists of two 6AU6's as 21.0-mc i.f. amplifiers coupled through a single-tuned transformer, a 6AL5 discriminator, 6AV6 a.f. amplifier, and a 6AQ5 power output stage. The sound i.f. signal is picked up at the grid of the third video i.f. stage.

The low-voltage power supplies are conventional. A 140-volt power transformer and two selenium rectifiers are used in a voltage-doubler circuit in the 12½-inch models and a 375-volt supply with a 5U4-G rectifier is used in the 16- and 19-inch models.

The circuit features described here apply directly to the 12½-inch models. Minor circuit variations will be found in the larger models.

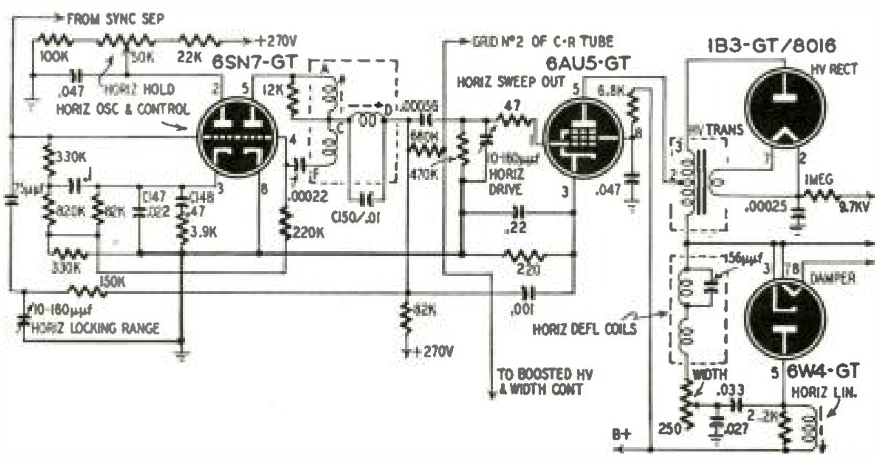


Fig. 4—The horizontal oscillator uses the familiar synchroguide a.f.c. circuit.

Television DX Reports

THE peak of the dx season now seems to be over and the flood of letters that swamped us during the summer months is now getting back to normal. While it is difficult to come to any definite conclusions about long distance TV reception, we do know that reception over distances of a thousand miles or more are not uncommon.

One such dx reception resulted in a Gardner, Kansas, family getting a much wanted puppy through a program they saw on WPTZ in Philadelphia. Roy Neal, conductor of a daily show on WPTZ, recently offered a puppy to the person who wrote in the best letter on why he would give it a good home. Two days later Neal got a reply from Mrs. Arthur Pearce of Gardner, some 35 miles from Kansas City. She had seen the show and wrote that she needed a pup to replace one that had recently been killed on their farm. Mrs. Pearce guaranteed wonderful care for the puppy.

The Pennsylvania SPCA, who sponsored the give-away, immediately got in touch with SPCA authorities in Kansas who saw to it that the Pearce family got a pup.

WPTZ claims no regular audience in Gardner, Kansas.

Again we extend our thanks to those readers who have sent in reports. Our dx'ers—and we seem to have developed quite a clan—have shown much enthusiasm. There seems to be a certain thrill in picking up a station a thousand or more miles away, presumably because it isn't supposed to happen.

Actually these reports are valuable from another standpoint. One of the reasons the FCC has imposed the present ban on additional TV station allocations is that no one knew much about the way signals at these frequencies would behave. Engineers calculated that TV transmissions would be line-of-sight, and accordingly it would be safe to have stations on the same channel as close together as 200 miles, and adjacent-channel stations only 85 miles apart. As soon as a number of stations went on the air, it was obvious that theory and practice are not the same, and the FCC had to stop authorizing additional TV stations. Many stations were interfering with each other, and in some locations you couldn't tell which station you would get when you turned on your set.

This is where the dx reports come in. They are a convincing addition to the evidence that something must be done if we are to have interference-free TV serving all parts of the country. The problem is an important one, and we hope that publishing these reports will be a help in emphasizing the urgency of the problem and also in solving it.

The tables below list this month's dx reports and include only those of 1,000 miles or more. Table 1 shows the station received, time of reception, and the mileage from receiver to transmitter. Table 2 shows the receiver location and the receiver, booster and antenna data.

TABLE 1—REPORT OF RECEPTION

STATION	REPORTED BY	TIME RECEIVED	MILEAGE
KOTV Channel 6 Tulsa, Okla.	W. T. Reed	6 18, 5.45 pm	1,000
KPHO-TV Channel 5 Phoenix, Ariz.	Q. R. Smith	8 15	1,200
KPRC-TV Channel 2 Houston, Tex.	W. T. Reed	6 9 16, 18, 19, 26 7 9, 14, 6-8 pm	1,100
KRLD-TV Channel 4 Dallas, Tex.	W. T. Reed J. Monon	6 16, 18, 19, 6-7 pm 5 10	1,000 1,100
WAGA-TV Channel 5 Atlanta, Ga.	E. W Fenderson	7 9	1,010
WBAP-TV Channel 5 Ft. Worth, Tex.	W. T. Reed	6 18, 19	1,050
WBRC-TV Channel 4 Birmingham, Ala.	E. W. Fenderson		1,110
WCBS-TV Channel 2 New York, N Y.	J. C. Rhea H. L. Gerischer	7 12, 14, 24 7 15, 17	1,000 1,060
WDSU-TV Channel 6 New Orleans, La.	E. W. Fenderson	7 12	1,410
WJBK-TV Channel 2 Detroit, Mich.	C. H. Baldwin	7 22, 11.30 am	1,000
WKY-TV Channel 4 Oklahoma City, Okla.	J. I. Weinschenk J. W. Collier H. L. Caldwell	7 8, 2 pm 8 1, 8.30-10 pm 7 27, 10 am	1,235 1,175 1,110
WMAR-TV Channel 2 Baltimore, Md.	H. L. Gerischer	7 21	1,000
WMBR-TV Channel 4 Jacksonville, Fla.	E. W. Fenderson J. C. Rhea	6 26 6 9, 12, 22, 24	1,150 1,000
WMCT Channel 4 Memphis, Tenn.	E. W. Fenderson	7 14	1,180
WNBT Channel 4 New York, N. Y.	H. L. Gerischer J. C. Rhea	7 15, 16, 17 6 7, 12, 14, 24	1,100 1,000
WNBW Channel 4 Washington, D. C.	H. L. Gerischer	7/16	1,000
WOAI-TV Channel 4 San Antonio, Tex.	J. Monon W.T. Reed	6 21 6/18, 19 7/12	1,330 1,000
WOC-TV Channel 5 Davenport, Ia.	E. W. Fenderson	6 26	1,000
WOI-TV Channel 4 Ames, Ia.	E. W. Fenderson	6 26	1,160
WPTZ Channel 3 Philadelphia, Pa.	H. L. Gerischer	7 15, 16	1,020
WTAR-TV Channel 4 Norfolk, Va.	H. L. Gerischer	7 16	1,080
WTTG Channel 5 Washington, D. C.	H. L. Gerischer	7 16	1,000
WTVJ Channel 4 Miami, Fla.	E. W. Fenderson J. I. Weinschenk J. Monon J. C. Rhea	6/27 6 13, 3 pm, 6 15, 2 pm 7/16 6/24	1,380 1,215 1,220 1,220

TABLE 2—RECEIVER DATA

NAME	LOCATION	RECEIVER	BOOSTER	ANTENNA
C. H. Baldwin	Dallas, Tex.	Transvision Television Assembly Co.		Circle X
H. L. Caldwell	Dana Point, Cal.			folded dipole and reflector
J. W. Collier	Kilmarnock, Va.	Emerson 631		stacked conical
E. W. Fenderson	Portland, Me.	RCA 10-inch		double V
H. L. Gerischer	Slayton, Minn.	Admiral 24 16	Astatic	Ward stacked array
J. Monon	Brantford, Ont.	Transvision	Jerrold	Yagi
W. T. Reed	Marion, Ind.	Motorola 10VK9	Regency	stacked circular
J. C. Rhea	Mt. Moriah, Mo.	Sentinal TV-408	Anchor	Lazy H
Q. R. Smith	Seattle, Wash.	Hoffman 12-inch		Walsco V
J. I. Weinschenk, Jr.	New Castle, Pa.	Admiral 20Y1	Masco	2-bay conical

How to "Soup up" TV Receivers For Better Fringe Reception

By LESTER S. PEARLMAN

IN fringe areas the service technician is often faced with the problem of getting usable pictures on the television screen when the signal strength is very low. The antenna must be the one best suited for the job, its height and location as good as possible, and its orientation and matching as accurate as possible. But when all that has been done and the sync still doesn't hold, the sound is a chirping whistle and the picture looks like the Blizzard of '88, the service technician can still do more than shrug his shoulders and recommend a better set or a preamplifier for slight improvement.

Sets are designed for the more or less realized aim of getting sharp, steady pictures and clear sound over a fairly wide range of operating conditions. Many sets will do a fair job in weak or noisy locations. The procedures outlined in this article will give a noticeable improvement in operation that may mean sales instead of returns in borderline cases. In some cases the improvement in picture quality will be startling.

Use better tubes

The first thing to work on is the tubes. I don't mean replacing bad tubes; we're assuming the set is working normally. Tubes vary over fairly

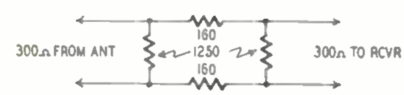


Fig. 1—Hookup for a 6 db attenuator.

wide limits. Production tolerances on good tubes are ± 30% approximately; the tubes can run anywhere from 70% to 130% of average on any characteristic and still be classified as good tubes. A high-limit tube will be almost twice as hot as a low-limit tube.

Test a number of tubes of the type used in the i.f., r.f., and video amplifiers, on a mutual conductance or similar tube checker. Put all high-limit tubes in the set. In the case of 6AG5's, for instance, where the normal transconductance on tube checkers should read 3,000 μmhos, it is easy to find tubes that run between 4,000 and 4,300. You will find that tubes made by some manufacturers run higher on the average than those of others, and this will make your selection of the hot tubes easier.

The 6BC5, a new type recently released, is an exact replacement for the 6AG5 except for being hotter. The 6CB6, another new tube very much like the 6AG5 but hotter, has a separate suppressor grid connection. Replacing 6AG5's by these types will give the same result as selecting hot 6AG5's. (When using the 6CB6, connect the suppressor (pin 7) to ground; and the cathode (pin 2) to ground through a 47-ohm unbypassed resistor. This resistor is not large enough to supply the required minimum grid bias of 1.5 volts. If existing bias arrangements in the set will not supply this, add a 120-ohm resistor bypassed with a 1500-μμf ceramic capacitor in series with the 47-ohm unbypassed resistor.) If the tubes in the set were average, the gain will increase up to 30% per stage and this is a remarkable improvement for any TV receiver.

If you don't have an adequate tube tester on hand, the slower method is to replace an i.f. tube by several others until you find one that gives a noticeably higher gain. Use that for a standard and dig up other tubes that are about as good. The gain can be checked by measuring a.g.c. or peak-to-peak picture voltage at the video detector, with a constant test pattern signal coming in.

Don't discard or return for replacement the lower-limit tubes. They are perfectly good and can be used in other sets in normal locations, or perhaps in the same set in the sound i.f. if there is plenty of sound volume.

Touch up alignment

Television sets are aligned on a production basis. The set manufacturer has certain minimum limits and sets which meet them are passed and shipped. By individual alignment using the factory recommended method you can always get a little more out of any set. The final touchup method suggested here will give you still better results. The important rule is to duplicate the operating conditions. You don't want the set to work at its best in your shop or under ideal conditions within line-of-sight of the transmitters; you want best performance in the customer's home—not any customer's home, but the one where the set will be installed.

The bandwidth and i.f. response curve will vary with signal strength and a.g.c. voltage. All final alignment should be made with about the same signal strength fed to the set as will be present in the customer's home. Some adjustment can be made when the set is delivered, but it is best to do the alignment in the shop where all the equipment is available and you can do a thorough job.

First, use a field-strength meter when installing the antenna and record the readings on all channels received. Then, in the shop, attenuate the signals with a balanced step attenuator, such as the

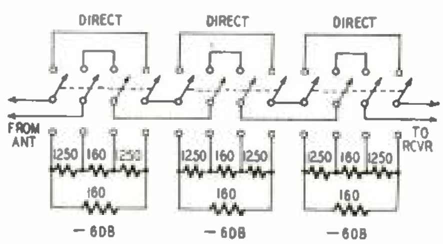


Fig. 2—Several attenuators in series are useful for weak signal alignment.

one to be described, until the signals are about the same as those recorded at the installation.

Check the alignment of the set according to the manufacturer's instructions. Then connect the attenuator and go through all the i.f. and front-end adjustments for the best possible picture at that signal level. You may have to sacrifice some bandwidth for gain in contrast. Vary the i.f. tuning of each stage by a wide amount each way; be patient and go through all the adjustments several times. It will pay off in a big improvement in picture quality and contrast. If the alignment gets too far off and the optimum can't be found, re-align the set according to the instruction sheet and start over again. The result will be well worth the effort, and the pictures received in the shop through the attenuator will be the same as those the customer will receive at his location.

After you have made many installations in various areas you won't need to make field-strength measurements. You will have enough accumulated data to make a close guess of the microvolt signal strength in any particular house. It is always best to take the actual readings at the receiver location, however.

A practical attenuator

A simple 6-db attenuator pad which matches 300-ohm line is shown in Fig. 1. This will cut the incoming signal in half. Two pads in series will cut the signal to ¼, three to ⅛, etc. Use a field-strength meter to check the signal output from the pads and compare it with that of the installation.

The leads on the resistors in the pads should be short and the lead-in from the antenna should be kept away from the ribbon line from the pads to the set. No other precautions are necessary.

For greater flexibility the pads can be built to plug in one to another or to connect in series by short lengths of ribbon line. A more convenient arrangement, using four-pole, double-throw switches, or two d.p.d.t. switches per pad is shown in Fig. 2. This was designed by the author for use in a regular factory test on receivers.

Circuit changes

Do not change the circuit except in the worst possible locations. The steps previously outlined will give adequate pictures in any reasonable location on most sets. If the customer is really down in a hole or very far from the stations and would be satisfied with poorer quality as long as he can see something, then try the following.

Increase the value of the loading resistor across an i.f. stage that is tuned to the high-frequency end of the response curve, that is, near the picture carrier. How high you can go depends on the particular set. Try several values until the set starts to oscillate, then choose a slightly lower value. The

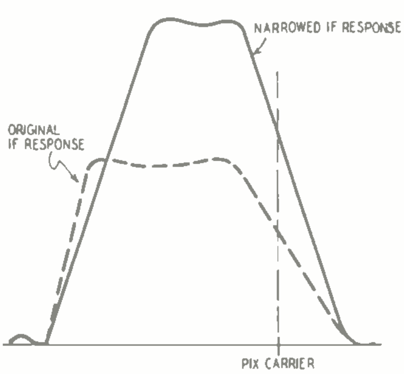


Fig. 3—A narrower i.f. response will increase gain but cut down definition.

set may not oscillate with higher values but there won't be any noticeable improvement for values higher than about 22 000 ohms, because the tube and circuit will then be limiting the Q. Then realign the set for best picture. This will increase the gain of the lower-frequency picture components; the contrast will improve, but the definition will be poorer. The gain in signal-to-noise ratio will make this worth while in bad areas. Fig. 3 shows what the new i.f. response curve should look like.

The video loading resistors in either the video detector or video amplifier circuits can be increased and will have the same general effect on the picture. Video load circuits generally consist of a series peaking coil, a shunt peaking coil, and a resistor as shown in Fig. 4. Increasing the value of the resistor R will tilt the video response curve, making it higher at the low-frequency end as indicated in Fig. 5. The resistor shouldn't be increased to more than double its original value.

A.g.c. voltage is another point to work on. If the a.g.c. comes from the video detector there will always be some bias applied to the i.f. and r.f. stages even on weak signals or no signal. This voltage is from contact potential of the a.g.c. diode section and rectified noise voltage. Cutting down this a.g.c. voltage, particularly on the r.f. stage, by a high-resistance voltage

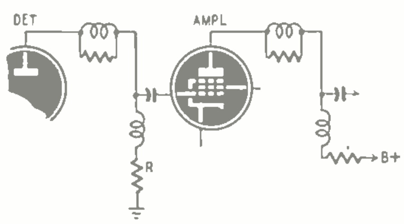


Fig. 4—Typical compensating circuits in a video amplifier. Increasing the value of R improves low-frequency gain.

divider also increases the gain and does not affect the picture quality. In some sets, the r.f. stage may be disconnected from the a.g.c. and its grid return grounded. If there are strong stations in the vicinity, this is not good practice because these stations will overload the receiver.

Using boosters

A booster can still be used after the set has been souped up but the system may oscillate because of the high set sensitivity. Minimize this by moving lead-in, connecting lead, and booster around. Usually these are best when in a straight line with the set and with the booster away from the set. Try several makes of preamplifier to see which works best.

To check the effectiveness of a booster, compare the results with the lead-in connected directly to the set to those with the booster hooked up and operating. Testing the set with the booster connected and using its switch to cut it out of the circuit will give false results. The picture is always poorer with the booster hooked up and turned off than with the antenna lead-in connected directly to the set.

Selection of set

The experienced technician should recommend sets which will give the customer best results. A sensitive receiver with full 4-megacycle bandwidth, four high-gain i.f. stages, and a good front end will obviously give better results than one with three stages using lower-gain tubes. If the receiver has only a 3-megacycle bandwidth, the improvement in sensitivity by further narrowing the bandwidth will be less, and the final results poorer than if the set has full bandwidth and high sensitivity to begin with.

You can't do the impossible. If there is no signal, nothing will bring in pic-

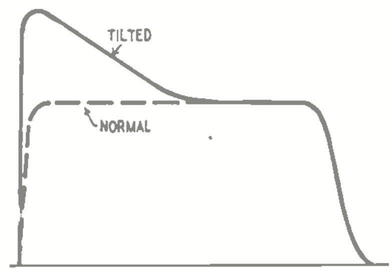


Fig. 5—Video response curves showing effects of raising low-frequency gain.

tures. But with a good installation job and the steps covered in this article you can get pictures where others have failed.

TV LIGHTNING HAZARD

Lightning Hazard from TV antenna installations has brought a flood of inquiries to the National Board of Fire Underwriters. The National Electrical Code, in Article 810 and revisions appearing in the 1949 supplement cover TV installations.

Arresters for ordinary antennas are not suitable for TV, but proper arresters are available. Each conductor of a ribbon line lead-in should have an arrester, and the same applies to both inner and outer conductor of a coaxial cable. If the outer conductor of the coax cable is grounded, the arrester may be omitted.

Antenna poles or towers, if made of metal, should be properly grounded. The National Electrical Code requires not smaller than No. 14 wire for grounding, but if the installation is a high metal tower, the grounding conductor should approach the dimensions of a lightning rod down conductor.

Be sure that you protect your property when making a TV antenna installation by using the proper precautions against lightning. The small extra work and cost of using proper arresters is a worthwhile insurance.

TV TAKES TO POLITICS

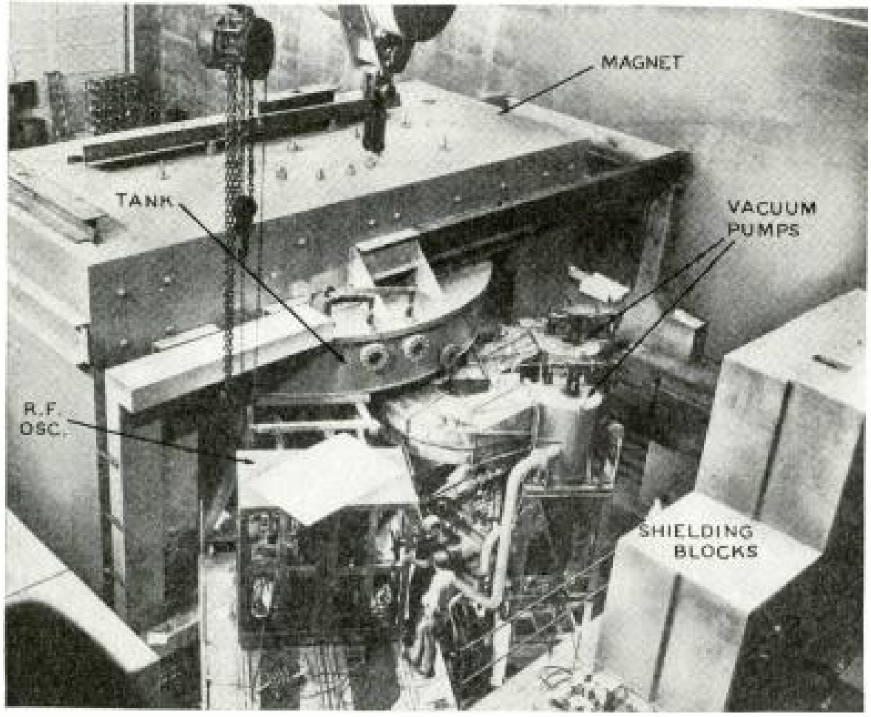
Television may be a vital factor in the presidential campaign of 1952, according to Brig. General David Sarnoff, chairman of the Board of the Radio Corporation of America. Speaking at John Carroll University, Gen. Sarnoff said by the time that campaign gets under way, America should have a coast-to-coast television network and more than 20,000,000 sets in use. His advice to each candidate is: "He will have to be telegenic, wear the right haberdashery, flash a friendly smile and *be sincere*. How sincere the candidate looks to the voter may be more important than how eloquent he sounds; a smile may be worth more than 10,000 words."

New Tool for Nuclear Study

By WARREN F. GOODELL, JR.*

A PARADOX of modern science is the tremendous size and complexity of equipment needed to study the smallest and simplest particles known to man. Protons, neutrons, and mesons, a few of the building blocks of nature, are weighed in units of billionths of billionths of billionths of ounces, yet require cyclotrons and similar machines weighing thousands of tons to study them. One such machine now in operation is the 385-million electron-volt frequency-modulated Nevis cyclotron of Columbia University. Located on a 55-acre Hudson River estate north of New York City, it is now furnishing information about these building blocks and how they are grouped to make our world.

*Nevis Cyclotron Project, Columbia University



An overall view of Columbia University's 385-million electron-volt cyclotron. The two men in the foreground give an idea of the vast size of this nuclear tool.

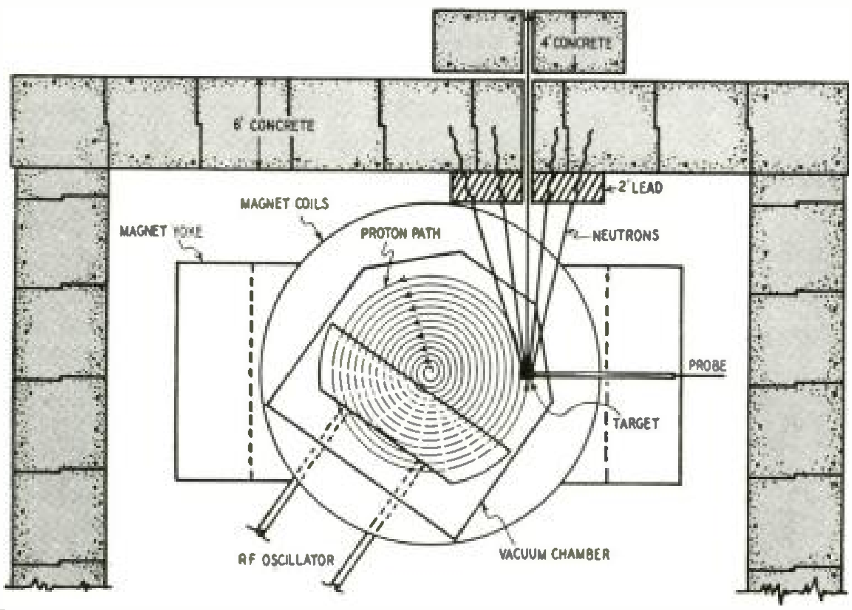


Fig. 1—A plan of the Nevis cyclotron showing how the neutron beam is formed and also the thick concrete shielding. The protons begin their flight in the spiral center and are accellerated each revolution by the oscillator voltage.

Protons, the tiny electrically charged central suns or nuclei of the hydrogen atoms, are whirled in ever-widening spirals by the combined action of a 40-kilowatt frequency-modulated r.f. oscillator and a 2,500-ton magnet, until their speed is almost three-quarters that of light. If it were not for the stopping effect of the air, these particles could go from New York to San Francisco in about 1/50 second. Even so, they have a range of some 200 yards in air, and can penetrate 5 or 6 inches of solid copper or lead.

The magnet takes 1,800 amperes of 260-volt direct current, and produces a magnetic field of 17,000 gauss over a 164-inch diameter pole tip. The leakage flux is strong enough to make it impossible to use oscilloscopes within 30 feet of the magnet. The r.f. oscillator consists of two type 880 water-cooled transmitting tubes driving a quarter-wave resonant line. It is frequency-modulated from 28 to 17 megacycles 120 times a second by a rotating variable capacitor loading the quarter-wave line. The electrical oscillations provide the impulses which accelerate the protons, while the magnet bends the paths of the protons into circles, allowing the oscillator to deliver a kick each time the particles come around. The protons make about 100,000 revolutions in a chamber 15 feet square and 18 inches high before reaching their maximum speed. If air were allowed to remain in the chamber, most of the particles would collide with air atoms somewhere along their 300-mile path and be lost. Therefore the whole chamber is evacuated to a high vacuum by two continuously operated oil-diffusion vacuum pumps, the largest ever built.

A neutron beam is formed

One method of operating the cyclotron is to insert a light material, such as carbon or beryllium, on a probe and let the protons crash into this material and knock out neutrons, particles of almost equal size but with no electrical charge. These neutrons are the same particles as those found in an atomic explosion, but are traveling at much higher speeds and with much more energy for each individual particle. However, since at most only a few million million neutrons are produced each second, the total power output of the cyclotron is somewhat less than that needed to operate a soldering iron. (As the magnet alone requires 600 kilowatts, a cyclotron-propelled automobile seems to be rather unlikely.)

These neutrons stream out of the machine as shown in Fig. 1. As most experiments require a small pencil-like beam of neutrons, most of them are stopped in the massive concrete and

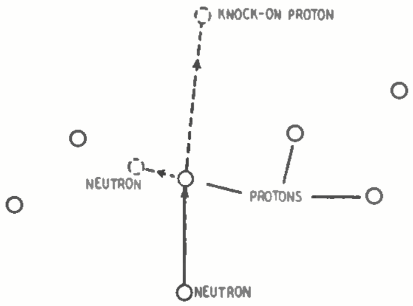


Fig. 2—Protons and neutrons act like billiard balls. This effect is used to determine the neutron beam's energy.

lead shielding surrounding the machine. A 4-foot chunk of concrete with a hole through its center sharply defines the beam of neutrons. A neutron can travel for nearly ¼ of a mile in the air or for 1½ ft. in concrete before colliding with another particle. Since several collisions are needed to reduce the energy of the neutron to a low value, the shielding is at least 6 feet thick in all directions. This 2,000 tons of concrete, when added to the 2,000-ton weight of the building itself and the 2,500 tons of the magnet, makes the cyclotron laboratory weigh the same as three light cruisers, or from 60 to 70 locomotives.

It is necessary to know the number of neutrons having each particular energy or speed as this knowledge is needed to interpret any experiments done with the neutron beam. This basic calibration of the energy spectrum of the beam is now under way, using the neutron-detecting telescope shown on the cover. Designed by members of the Nevis staff, the telescope will be used for this purpose and for later experiments which involve the scattering of the neutron beam.

Measuring neutron speed

Since the neutrons are hard to detect directly, an indirect billiard-ball method is used as shown in Fig. 2. The neutron, acting as the cue ball, collides with one of the proton billiard balls in a paraffin or other hydrogen-containing target. Some of the protons are knocked out in the forward direction, their speed depending upon the speed of the cue-ball neutron. Faster neutrons will knock out protons at a greater speed; and by measuring the speeds of the knock-on protons, the speeds of the original neutrons can be determined.

The direction of the protons is determined by the proportional counter telescope shown in Fig. 3. The proportional counter is one of a family of instruments similar in construction and use to a Geiger counter. The Geiger counter gives a large electrical signal whenever a charged particle of any sort passes through it. The proportional counter gives a much smaller signal, but the size of the signal varies with the type and velocity of the particle passing through. The signal from each counter in the telescope is then amplified by a video amplifier having a frequency-response curve flat within a few db from a few kilocycles to 10 megacycles. The signals from the three counters are compared in time; and if they all arrive within a millionth of a second, it is assumed that one proton has triggered off all three counters. The probability of the three counters being simultaneously triggered by three different particles is very small.

To find the energy and speed of the knock-on protons, various thicknesses of copper absorbers are placed between the second and third counters of the telescope. Only those protons having enough energy to penetrate the copper are able to trigger off the third counter. The coincidence telescope therefore counts the number of protons having at least this much energy. By inserting thicker and thicker absorbers, the telescope can be made to count only protons of higher and higher energies. By a process of subtraction one can find the number of protons of any given energy. By considering the billiard balls of Fig. 2, one can then compute the number of incident neutrons of any given energy.

Remote control for safety

While the thickness of the concrete shielding around the cyclotron is great enough to reduce the amount of radiation outside to a level safe for humans, there are still a large number of high-energy particles whose exact biological effects are not known. Mainly for this reason, much of the experimental apparatus must be controlled remotely. A remotely controlled wheel to change the thickness of copper absorber in the telescope is shown on the cover. Any of eight different absorbers may be brought into position by the motor-driven wheel. A pair of 400-cycle synchros run at reduced voltage on 60 cycles remotely indicates the position of the wheel, but a microswitch and pin arrangement does the actual positioning.

The whole telescope, including the changers, is mounted on an aluminum I-beam pivoted at the target, and may be rotated to detect protons knocked out of the target in directions other than straight ahead. The angular position of the table is also indicated remotely by synchros. All the electrical signals are carried by 125-ohm coaxial cables to the amplifiers and other electronic apparatus 300 feet away in the control building. An intercom box (the red box in the cover position) helps in making adjustments between the components of the system. The complete electronic equipment, with provisions for two four-counter telescopes and two additional monitors, requires about 400 receiving-type tubes, 200 crystal diodes, and approximately 4 kilowatts.

The beam of neutrons coming from the cyclotron can now be regarded as a stream of bullets of known speeds. The effectiveness of various materials for stopping the stream can be measured. Also, observing in what directions the bullets bounce from more complex nuclei gives some idea of the shape and size of these nuclei.

When the protons in the cyclotron chamber hit the target and knock out the neutrons discussed above, other particles, known as pi mesons, are also created. They are lighter than protons, but still weigh about 250 times as much as electrons. They may have a positive or negative charge, or no charge at all. The charged variety live a few hundredths of a microsecond, and then decay into lighter mu mesons. The neutral mesons live only one-millionth as long, and decay into two gamma rays, or bursts of pure energy. While these

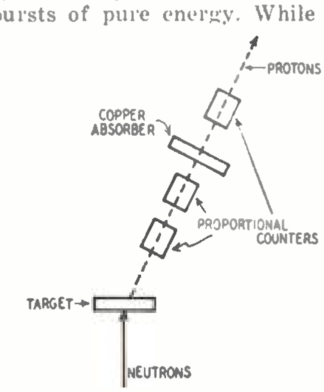


Fig. 3—Simplified diagram of the proportional counter telescope showing the three counters and the copper absorber.

mesons do exist in nature in cosmic rays, the cyclotron furnishes a controlled and intense source of them.

These are but a few of the uses of this multimillion-dollar machine. The cyclotron was financed jointly by Columbia University and the Office of Naval Research, and is under the direction of Dr. E. T. Booth and Dr. J. B. Dunning of Columbia. At present, the cyclotron is being used primarily for pure research in physics—finding out what protons, neutrons, and mesons are, and how they affect each other. This is considerably different from industrial research, which is aimed at the applications of new phenomena to everyday life and to the commercial gains that may be obtained from them. But remember that Hertz, in his pioneer experiments on radio, was merely testing a complicated mathematical theory proposed by Maxwell a few years before. He had no idea he was fathering the soap opera and the quiz show, as well as television itself, in his incidental observation of the photoelectric effect. This cyclotron and other similar machines may never lead to discoveries of such widespread use, but they may help man to live longer (by some possible medical applications), or even (by some of the industrial uses of tracer isotopes) to build a better mousetrap.

Radio-Electronics in the Home

The Winners of the Final Contest

THIS final installment of the contest has for its first prize winner a small bedside lamp that turns on or off at the touch of a hand. No fumbling for a tiny switch in the dark. The second prize goes to an electronic baby sitter that keeps an ear on baby while you watch your neighbor's TV. Third and fourth prizes go to a telephone amplifier and to a sound switch with an automatic time delay.

This contest is being terminated because we have not been receiving enough suitable entries. However, RADIO-ELECTRONICS is still interested in novel applications of radio-electronics in the home and will give a special welcome to and will pay its best rates to articles describing such devices.

First Prize—Automatic Bedlamp

Thomas L. Bartholomew, Baltimore, Md.

A small metal bedlamp can be turned on and off by body capacitance. If you should be wakened during the night for

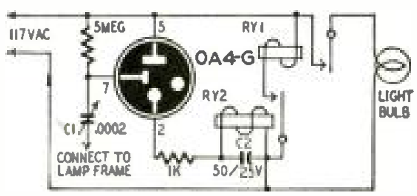


Fig. 1—Circuit of the capacitance-operated switch. It requires two relays.

some reason, you simply reach out and touch any part of the lamp and the light goes on. When you touch the light again, it goes off.

Photo of the capacitance-operated lamp. It is all metal and the circuit components are mounted in the large base.

While there are a number of circuits that will do this job, this particular one has a small number of parts and will give trouble-free service over a long period. (This lamp has been in service for seven years without requiring service.) Fig. 1 shows the circuit.

The relay RY1 operates on 115 volts a.c. at 60 cycles. The one in this circuit

The Winners

Automatic Bedlamp
Thomas L. Bartholomew $50

Baby Sitter
Leason K. Kington $25

Telephone Amplifier
Norman L. Chalfin $15

Sound Switch
John D. Layman $10

is an impulse-type relay, model 905 made by the Advance Electric Co. Any similar relay will also do the job. Relay RY2 may be any s.p.s.t. unit with a resistance from about 1,500 to 2,000 ohms.

When constructing such a lamp, mount all the components on a base made of some insulating material. Also make sure that the tuning adjustment of capacitor C1 can be reached easily after the device is assembled so that the sensitivity may be adjusted. When the wiring is completed and the circuit is ready to insert in the base of the metal lamp, plug in the circuit and cause the 0A4 to conduct. Then adjust the spring tension in the plate relay RY1 so that it works freely with the tube current.

The value of capacitor C2 may seem rather high, but it is necessary to bypass occasional flashes of the 0A4 caused by r.f. impulses on the line. The resistor in series with this relay is needed to limit surge currents that might burn out the tube in one operation. Many other grid glow tubes were tried, but the Sylvania 0A4 was the only one to give good results in this circuit.

After the device is installed in the lamp, put rubber feet or other insulating material on the base of the lamp so if it should ever be placed on a conducting material (metal table, etc.) the adjustment of the capacitor will not be affected.

Second Prize—Baby Sitter

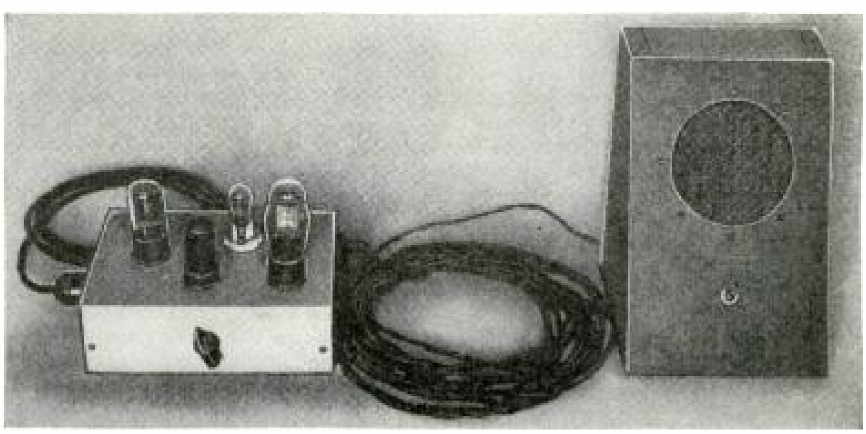
Leason K. Kington, Kenmore, N. Y.

When you and your neighbors have small children and you like to visit each other in the evening to play cards or watch TV, who watches the children? Baby sitters are expensive; but if you don't have one, you have to trot back and forth most of the evening to see if the little ones are all right. This circuit eliminates most of the unnecessary trotting.

The heart of the circuit (Fig. 2) is the 2050 thyratron. The line voltage is across this tube and a 6-watt lamp in series. Its bias is just negative enough so the tube will not conduct. The bias is supplied by two 1½-volt flashlight cells.

When a noise is picked up in the speaker, it is amplified by the 6SF5, and this voltage swings positive enough to cause the 2050 to fire. The thyratron current is limited by the lamp in series which lights up when the tube fires.

The lamp is placed in the window facing the house of the neighbors being visited. If it lights, the kids need



The electronic baby tender. The 6-watt lamp on the chassis serves as alarm.

attention. Operating the thyratron from the a.c. line has the advantage that the plate goes negative each cycle,

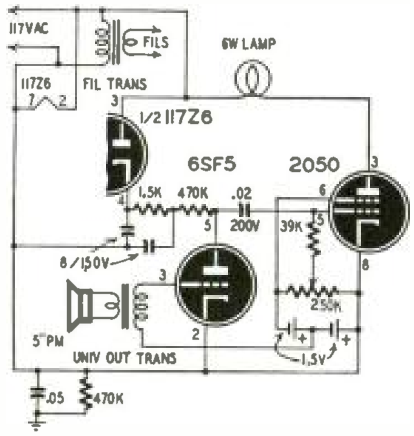


Fig. 2—The baby sitter circuit. When baby cries, the 6-watt lamp lights up.

and although any noise will light the lamp, it will not stay lit unless the noise persists. This saves running home if junior goes back to sleep.

Third Prize—Telephone Amplifier

Norman L. Chalfin, New York, N. Y.

This device was built so the user can talk on the telephone and at the same time keep his hands free to record data or do other work while talking and listening.

This setup has an exponential horn at the mouthpiece of the phone. In some trials with a carbon microphone and an oscillograph, a horn shape was devised that gives a gain of 5 at the carbon mike when the horn is directed at a source of continuous sound.

The induction pickup for the phone is a solenoid pancake of about 30,000 turns of No. 46 enameled copper wire. This wire needs great care in handling; but if it breaks, it can be repaired and the winding continued. The coil has a d.c. resistance of about 20,000 ohms.

Since the fields surrounding the telephone are stronger at some points than at others, the coil is mounted on a rotating assembly built from an old tuning capacitor frame. The coil can then be adjusted for best pickup.

The amplifier is conventional although it has somewhat more gain than the usual microphone amplifiers. The first unit built used a.c.-d.c.-type tubes, but these were later replaced by an amplifier using battery tubes as shown in Fig. 3. The advantage of this circuit is that the tubes need no warm-up time and a microswitch on the phone cradle puts the amplifier into immediate operation.

One very practical use of this device is when the youngster makes his Sunday call from school or camp. The rest of the family can all hear the call and can talk back to the caller.

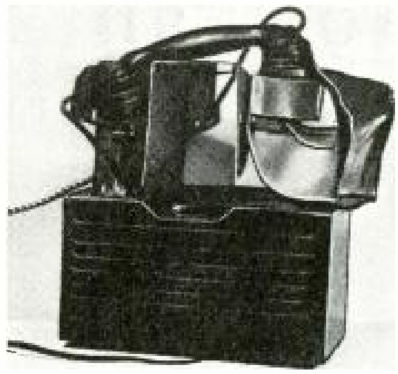


Photo of the telephone amplifier with the phone mounted. At the right is the exponential horn and the pickup coil on its rotating assembly is at left.

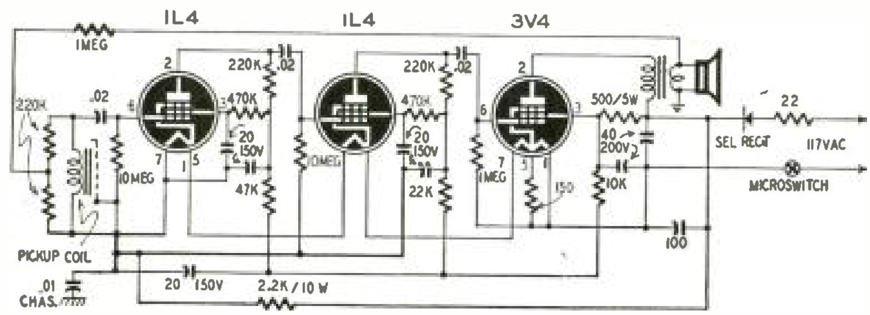


Fig. 3—The schematic of the telephone amplifier. The battery type tubes eliminate warmup time, and a microswitch on the phone cradle turns the circuit on.

Fourth Prize—Sound Switch

John D. Layman, Cloverdale, Va.

The best use for this device is to silence a radio for a predetermined length of time when a commercial comes on. It can also be used as a baby sitter, burglar alarm, or a number of other things.

As Fig. 4 shows, the device is an amplifier with either a speaker or carbon mike input. Following the two-stage amplifier circuit is a selenium rectifier and a relay circuit which operates the circuit to be controlled.

Two sets of terminals are mounted on the rear of the chassis. One set provides momentary switching action for low-wattage circuits. The other set prolongs the switching action for a controlled period after the triggering sound impulse has stopped. By opening S1, this second circuit also provides momentary switching for high-wattage circuits.

When a sound is picked up by either the speaker or microphone, it is amplified and energizes RY1. This relay remains picked up just long enough to close another circuit so that current flows in the coil of RY2, a 117-volt a.c. relay. This second relay is in parallel with a time-delay thermostat so that any voltage across the relay also appears across the thermostat. When current flows through the heating wires of the thermostat, the bimetallic strip bends until it touches an adjustable contact. This shorts out the relay coil and ends the timing cycle.

The time delay can be adjusted in two ways. One is by adjusting the spacing of the thermostat contacts, and the other is by adjusting the potentiometer R1. These two adjustments give a time range from about 10 seconds to several minutes.

To use the circuit as a radio silencer, connect either the normally open (NO) contacts across the voice coil, or the normally closed (NC) contacts in series with one speaker lead.

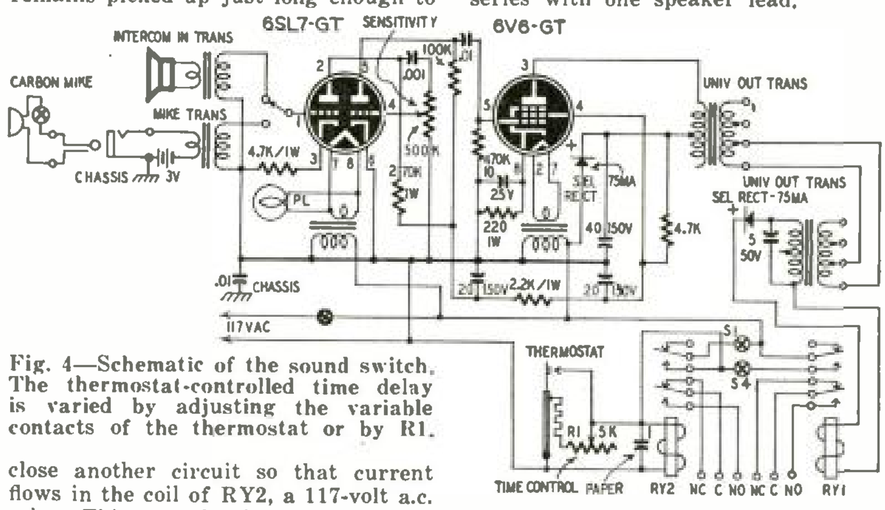
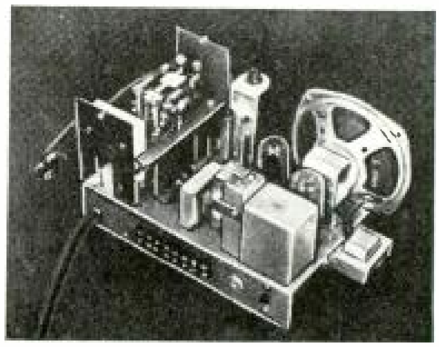


Fig. 4—Schematic of the sound switch. The thermostat-controlled time delay is varied by adjusting the variable contacts of the thermostat or by R1.



A view of the sound switch showing the control circuit contacts at the rear.

How an Electric Brain Works

PART II

Simon, the little moron described last month, now learns how to add

By EDMUND C. BERKELEY* and ROBERT A. JENSEN

IN the last article we observed how an electrical brain could store information in a register and transfer information from one register to another.

What do we mean by a "register" and "information"? A register is any physical equipment that can store information, and information is an arrangement of equipment that has meaning. For example, the registers we spoke of were relays, and the information stored in them was a pattern of 1's (relays energized) and 0's (relays not energized).

* Author: Giant Brains

Relays vs. tubes

Why use relays instead of tubes? After all, tubes can represent a pattern of 1's (conducting) or 0's (not conducting). And in changing its state from one condition to the other, a tube is very much faster than a relay. We shall discuss tubes later in these articles. In the meanwhile, there are several reasons for concerning ourselves with relays. In the development of electrical brains, relays were used before electronic tubes; and it is some help in explaining electrical brains to follow the course of their development. In the second place, a circuit involving relays can be understood simply by seeing whether current will flow or not. But understanding a tube circuit involves many more factors, such as plate voltages, nature and strength of signal, the tube characteristics, values of the resistances, etc. In the third place, one relay may take the place of a number of tubes. For example, a six-pole, double-throw relay has 20 terminals including those of the pickup coil; a considerable number of tubes is required to do as much as that one relay. And finally, after the logical relations of circuit elements have been expressed once in any one form such as relays, it is easier to translate them into other circuit elements such as tubes.

We have seen how we can store information in a register and transfer it from one register to another, and now we wish to manipulate that information according to mathematical and logical processes. That is calculating. And the first of the calculating processes is addition. How can we add and calculate with electrical circuits?

Calculation is possible only with a good system for representing information. For example, the decimal notation using Arabic numerals, considered one of the great human inventions, is a remarkably fine system for representing numerical data. As a counter-example, the ancient Greeks used letters of the alphabet in a rather unsystematic way for numbers, and never got far with arithmetic. To calculate with electrical circuits we first must understand systems for representing information.

Representing information

Suppose we write down a piece of information such as 1,011. We are referring to a number which is equal to one 1,000, zero 100, one 10, and one 1. The positions of the digits report *powers* of 10—1; 10; 100; 1,000; 10,000; etc. Numbers written in this style are said to be in *decimal notation*. This notation is convenient for a calculating machine that contains dials that may take one of ten positions, like the speedometer of an automobile.

But this notation, convenient as it may be for human beings and some machines, may actually be inconvenient for most digital electrical brains containing two-position circuit elements.

Numbers may be written in other more useful notations. Two of them

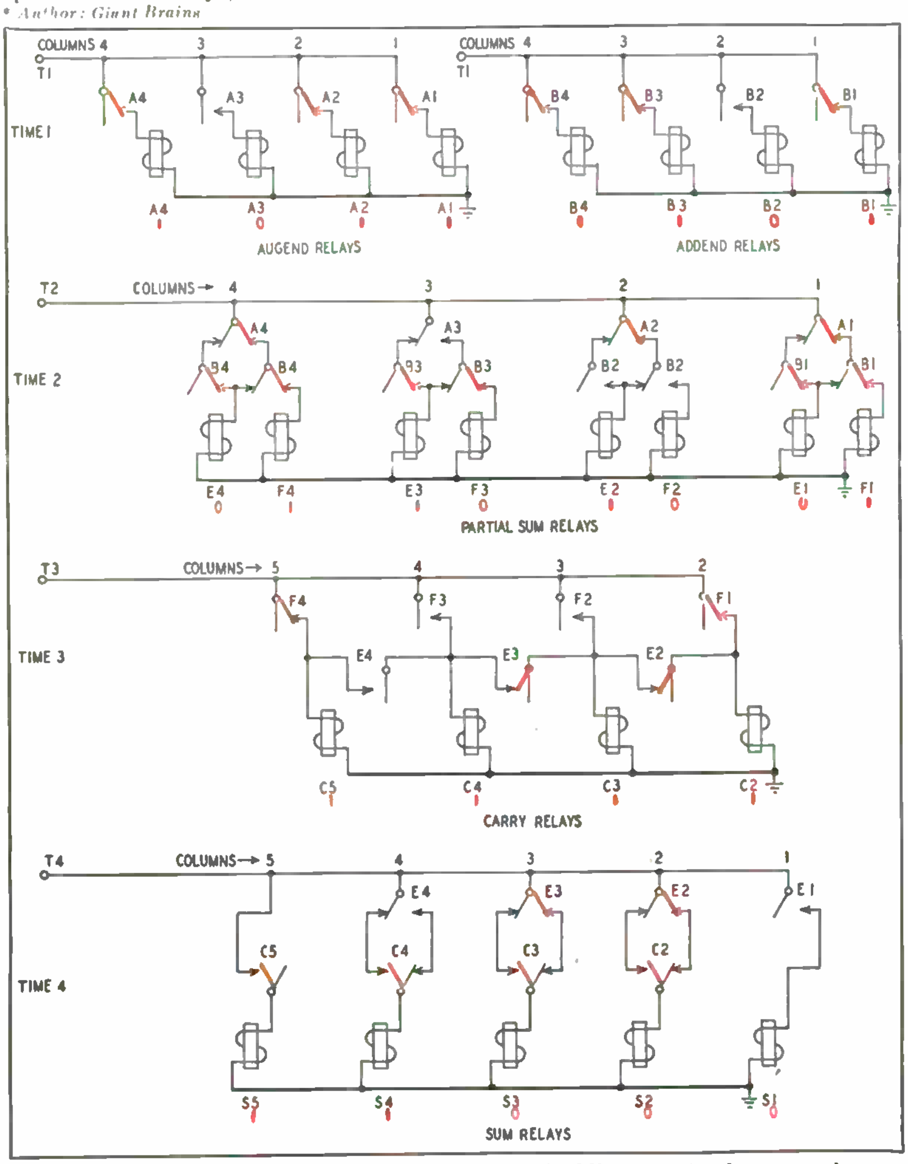


Fig. 1—A binary adding circuit that is capable of adding two 4-column numbers.

that are interesting and useful are the notations called *biquinary* (pronounced "by-kwy'nerry") and *binary* pronounced "by'-nerry").

Biquinary means counting by 2's and 5's; the "bi" refers to two and the "qui" to five. It is the notation expressed in a limited way by the hands and feet of human beings, Roman numerals in ancient style, and the earliest of all calculating machines, the *abacus* or bread-counting frame. For example, in writing the number CCLXXXVIIII (two 100's plus one 50 plus three 10's plus one 5 plus four 1's), we are using biquinary notation. The more recent Roman numerals used IX in place of VIIII but this later style is not biquinary.

Two of the big electrical brains that have been finished by Bell Telephone Laboratories use the biquinary system. Seven relays are used for each decimal digit in the pattern shown in Table I.

Table I—Biquinary Relay System

Decimal Digit	Name of Relay: 00	5	0	1	2	3	4
0	1	0	1	0	0	0	0
1	1	0	0	1	0	0	0
2	1	0	0	0	1	0	0
3	1	0	0	0	0	1	0
4	1	0	0	0	0	0	1
5	0	1	1	0	0	0	0
6	0	1	0	1	0	0	0
7	0	1	0	0	1	0	0
8	0	1	0	0	0	1	0
9	0	1	0	0	0	0	1

1 means "relay energized"; 0 means relay "not energized.") The first two relays are called 00 and 5 and the others 0, 1, 2, 3, and 4. To represent any digit, either 00 *or* 5 must be energized, and exactly one of the other five relays must be energized. If either of these conditions fails, then the machine gives an alarm and stops at once. When the operator examines the trouble-light panel, he detects the circuit that failed. The machine acts as its own policeman. This machine in months of operation has not allowed a single wrong result, except those due to human errors in instructing it.

There are still simpler notations for representing information in circuit elements having just two positions, such as relays or tubes. One of these is binary notation and its relatives. In pure binary notation, the *base* is not 10 as in decimal or alternately 2 and 5 as in biquinary. The base is 2, and the digits —which are only 0 and 1—report the powers of 2: 1, 2, 4, 8, 16, etc. Numbers 1, 2, 4, 8, etc., are represented by 1, 10, 100, 1,000, etc. Fractions ½, ¼, ⅛, 1/16, etc., are represented by 0.1, .01, .001, .0001, etc. For example, the figure 1,011 now means one 8 plus zero 4's plus one 2 plus one 1, and so equals 11.

Other samples of equivalents of decimal and binary numbers shown in Table II. The last binary number in the table is an example of a "recurring decimal" (or should we call it a *recurring binal?*) in binary notation.

Incidentally, if you, like the author, prefer to pronounce new words and signs under your breath, the binary numbers 10, 11, 1,000, and so on, should be pronounced "one-oh, one-one, one-oh-oh-oh" and so on. This way of referring to them gets away from confusion with decimal numbers.

Table II—The Binary Numbers

Decimal	Binary
0	0
1	1
2	10
3	11
4	100
8	1,000
16	10,000
17	10,001
32	100,000
0.5	0.1
0.25	0.01
0.125	0.001
1/3 or 0.33333....	0.01010101
or 0.$\dot{3}$	or 0.$\dot{0}\dot{1}$

As shown by these examples, we can convert numbers completely from the decimal system into the binary system. Some electronic brains do just that, for so doing it simplifies the circuits of an electronic machine. For example, the electronic brain known as Binac (Binary Automatic Computer), completed in 1949, handles all numbers in pure binary notation.

Adding in Binary Notation

Before we proceed to other forms of notation, let us consider how adding in binary notation is carried out—on paper, and by a relay circuit.

Adding in binary is carried out by this addition table:

	0	1
0	0	1
1	1	10

To add with this table, select one of the numbers you wish to add from the top outside row and the other from the left outside column. Draw a vertical line (imaginary if you wish) from the number selected in the top row down through the column of numbers on the inside, and a horizontal line from the number in the left column across the row of numbers on the inside. You will find the sum of the two numbers where the two lines cross. Thus 0+0=0, 0+1=1, 1+0=1, and 1+1=10, (i.e., 2).

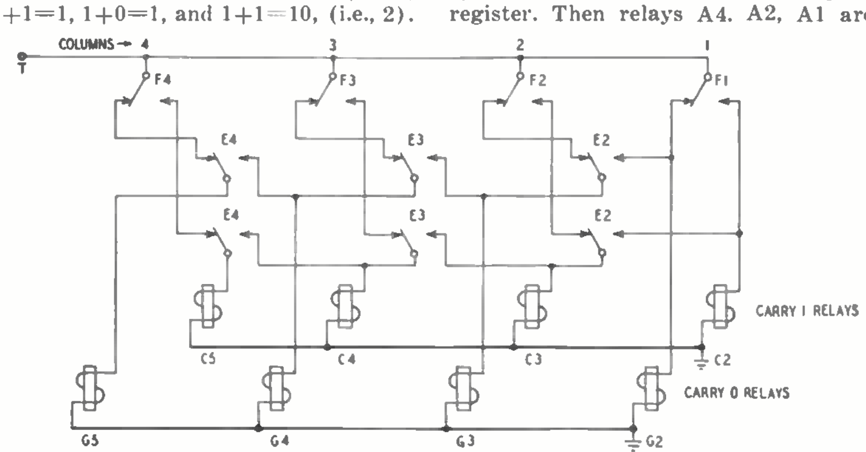


Fig. 2—A 4-column binary carry circuit that will carry 0 as well as carry 1.

No one could ask for a simpler addition table! Instead of the 100 entries of the decimal addition table, the binary addition table has only four.

For an example, let us add 1,011 (8 plus 2 plus 1, or 11) and 1,101 (8 plus 4 plus 1, or thirteen):

```
 1,011
 1,101
------
11,000
```

The result is 11,000 (16 plus 8, or 24). We may obtain it by the following "schoolboy" routine: (column 1, starting from the right) 1 and 1 is 10, put down 0, and carry 1; (column 2) 1 and 0 is 1, and 1 to carry, is 10, put down 0, and carry 1; (column 3) 0 and 1 is 1, and 1 to carry, gives 10, put down 0 and carry 1; (column 4) 1 and 1 is 10, and 1 to carry is 11, put down 1 and carry 1; (column 5) put down 1.

Binary adding circuits

Now let us design a set of circuits which will carry out the operation of addition in binary notation. We shall begin with a preliminary circuit, pre-

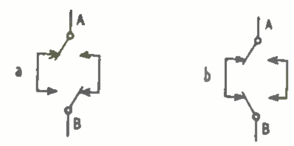


Fig. 3—A and B contact patterns that are used to simplify the adding circuit.

liminary because it uses many more relays and more successive impulses than are necessary. But it is useful because it shows the steps needed to reach a final circuit.

First, two binary numbers to be added, each of four binary digits, are stored in the two registers A and B (called Augend "to be increased" and Addend "to be added"). The relays marked A1 to A4 store the digits in the digit columns 1 to 4, counting from the right—first the one digit, then the twos, the fours, and the eights digits. (See time 1 of Fig. 1). At some previous time these relays have been picked up, and now terminal T1, through the hold contacts of these relays, holds them up while the later circuits operate. For example, suppose 1,011 is stored in the A or Augend register. Then relays A4, A2, A1 are energized and relay A3 is not energized. Suppose 1,101 is stored in the B or Addend register. Then relays B4, B3, B1 are energized, and relay B2 is not energized. In the diagram the relay contacts that will be closed for this particular state are shown in red. The energized coils are marked with a 1 and the unenergized coils with a 0.

Let us stop for a moment to explain the convention used in the figures. The coils of relays are *not* drawn next to their corresponding contacts, as is common in radio work, but follow a practice common in electrical diagrams: The contacts of a relay are labeled with the label of the coil. For example, in time 2 of Fig. 1 more contacts of the A and B relays of time 1 appear, all drawn in the unenergized state. To find which of the partial sum (E.F) relays will be energized corresponding to A 1,011 and B 1.101, follow the red contacts.

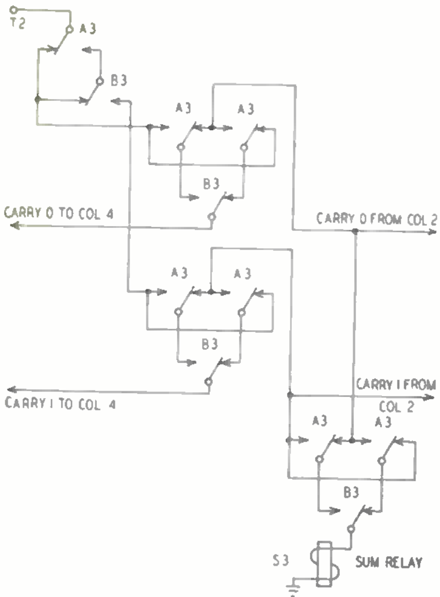


Fig. 1—The final adding circuit after simplification. The four parts of Fig. 1 are all combined in this one circuit.

Returning now to the discussion of the circuit of Fig. 1, at the second time (time 2) terminal T2 is energized, and the E and F relays are picked up and held. The E relay is picked up if there is just a 1 and a 0 in the digit column, and the F relay is picked up if there are two 1's in the column, causing the sum (without carry) to be 10. In other words, the F relay of a column signals that a carry originates. The E relay of a column reports two facts: (1) the sum of the digits without carry in that column is 1; (2) if there is a carry into this column, it should be transmitted into the next column.

Third, at time 3, terminal T3 is energized, and the C relays (C for carry) are energized. Contacts from the F relays report the originating of a carry, and contacts from the E relays do the transmitting of the carry.

Fourth, at time 4, terminal T4 is energized, and the binary sum is recorded in the S (S for sum) relays. Any sum relay will be energized under two conditions: (1) the sum without carry in a column is 0, and there is a carry of 1 arriving in that column; (2) the sum without carry in a column is 1, and there is no carry of 1 arriving in that column.

Some circuit tracing

To test the circuit of Fig. 1, let us follow through the addition of the first two columns of the two numbers we are adding (1,011 and 1,101). These two columns will have 11 as the augend and 01 as the addend. To begin with, A1 and A2 are both energized to indicate 11; and B1 is energized and B2 is not energized to indicate 01. When terminal T2 is energized, F1 is picked up to indicate that the sum of the first column is 1+1=10 and that the 1 in this sum must be carried to the next column. E2 is picked up to indicate that the sum of the second column is 1+0=1. So far we have added the two columns separately and have indicated where numbers are to be carried.

In the next step terminal T3 is energized. The carry from column 1 now takes place and C2 is picked up because contact F1 is closed. Adding the carry from column 1 to the 1 already in column 2 makes the sum of column 2 equal to 10 and the 1 of this sum must be carried to the third column. This carry takes place because E2 is closed to indicate a 1 already present in the second column. and the new carry is transferred to column 3.

In the final step T4 is energized. Now S1 is not picked up because E1 was not picked up when T2 was energized. S2 is also not picked up because E2 was energized, but so was C2 when we had to carry the 1 from column 1. So the first two columns of our addition will be 00, which we know checks with the sum of the two numbers we started with. By following through the circuit we can see that the rest of the circuit operates in exactly the same way.

A simplified circuit

The group of circuits in Fig. 1 can be considerably improved and condensed into a single circuit if we introduce the concept "carry 0" as well as "carry 1". In general, we carry 0 into a column if, and only if, the preceding column contains either both digits 0 or just a 1 and a 0 and is not receiving a carry itself. A circuit that will establish both carry-0 and carry-1 conditions is shown in Fig. 2. This circuit is the same as part 3 of Fig. 1 except that both make and break contacts of the E and F relays are used and an extra set of E relay contacts is needed to perform the carry-0 operation. The G relays record the condition of carry 0.

We can now replace the F relay make contacts with a pair of A and B relay make contacts in series. When this is done, the C relays are picked up only when both A and B relays are energized, which is the condition we need to indicate a carry.

We further simplify by replacing the E make contacts by the pattern of A and B contacts shown in Fig. 3-a and the E break contacts by the arrangement of Fig. 3-b. Now the G relay is energized through the A and B contacts only for the carry-0 condition and the C relays for the carry 1.

Instead of allowing the lines to lead down to the G and C relay coils we insert the E and C contacts of part 4 of Fig. 1, but immediately replace these with a pattern of A and B contacts. The circuit then looks like Fig. 4, which shows the relays only for column 3. (Note that the adjacent B contacts are combined in a single contact.)

There are four conditions when the S3 relay must be energized:

1. A3=0, B3=0, carry 1 in;
2. A3=1, B3=0. carry 0 in;
3. A3=0, B3=1. carry 0 in;
4. A3=1, B3=1. carry 1 in.

For condition 1, the S3 relay is picked up directly through the carry-1 line from column 2 and the carry 0 is applied to column 4. For conditions 2 and 3, S3 is energized directly by the carry 0 from column 2 and carry 0 is also fed to column 4. For condition 4, S3 is operated by the carry 1 coming in, and a carry 1 is fed to column 4. Under these conditions, but no others, will the S3 relay be energized. By similar reasoning, we can list the condition for which we want S3 to remain unenergized and whether we want a carry 0 or carry 1 to go to the next column. Then with a little more tracing we will see that the circuit of Fig. 4 will meet all these conditions. Doubtless this circuit also can be improved and simplified.

ENGINEERS WANTED

Electronics engineers specialized in the communications field are urgently needed to fill jobs in the Signal Corps research and development laboratories at Fort Monmouth, N. J. Salaries range from $3825 to $5400 a year.

Also in critical demand are experienced technical writers and training instructors with extensive electronics or communications equipment background at salaries from $3825 to $4600.

To qualify for the basic electronic engineering positions, applicants must have a Bachelor's degree from a recognized college or equivalent education or experience plus one year of professional electronic engineering experience or study for a Master's degree.

Technical writers must have at least 3½ years experience in preparing reports, manuscripts or manuals concerned with electronics. radio. radar or communications. Additional experience is required for the higher grades.

Four years of technical experience in such fields as microwave radio relay, radar. radio electronics and central office techniques, plus one year of teaching experience is needed to qualify for the training instructor jobs.

These jobs may be applied for by mail or in person at the Civilian Personnel Branch, Building 530, Fort Monmouth, N. J.

Brain Waves Control Anesthesia

WITH a new electronically-controlled device developed by Dr. Reginald G. Bickford of the Mayo Clinic, the patient himself controls the amount of anesthetic he receives, even when completely under its influence, because the control is automatic and is actuated by the patient's brain potential.

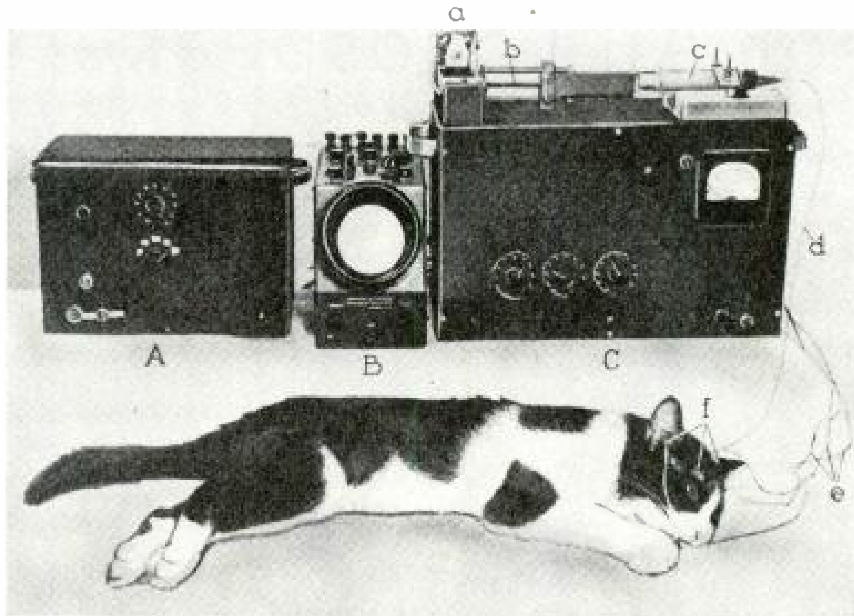
The brain potential is a minute electric potential that can be picked up by small metal electrodes from the surface of the scalp. (RADIO-ELECTRONICS, December, 1948, page 28.) A normal adult has a brain potential with an amplitude anywhere from 1 to 100 microvolts and a frequency from 1 to 40 cycles per second. The waveshape is very roughly sinusoidal.

Electroencephalographers (those who study these brain waves) have found that anesthetics have an effect on this electrical activity of the brain. The effect is rather complex because there are changes both in amplitude and in frequency; but the results can be simplified by using a summation of the brain potentials from some particular area. This is done by passing the brain potential through suitable rectifying and integrating circuits, which measure the brain's electrical output in terms of energy. The problem of complex frequency and amplitude changes is avoided because potentials of all frequencies and amplitudes contribute to the energy output.

When a patient undergoes anesthesia, the energy output of the brain increases at first while he is under light anesthesia. As the depth of anesthesia increases, the energy output gradually decreases as the effects of the anesthetic become stronger. Dr. Bickford's machine uses the brain energy output of a patient taking an anesthetic to control the rate of administering the anesthetic.

The electronic circuit of the apparatus is shown in Fig. 1. The brain potential, after first being passed through a preamplifier, is applied to the input. The input stage is biased to plate current cutoff so that it acts as a rectifier. The amplified and rectified brain potential charges the capacitor C1. When this charge reaches a certain predetermined value, the 6SN7 biased multivibrator fires and discharges C1. The discharge pulse fires the 2D21 thyratron which momentarily activates the stepping relay.

The photo shows the arrangement needed to keep a cat under automatic anesthesia. A is the preamplifier, B an oscilloscope for observing the brain potential, and C the integrator circuit and automatic injection device. The stepping relay is at a, b is a threaded shaft, c a syringe containing the anesthetic mixture, d a plastic tube that carries the anesthetic to tabby's veins, e are electrode leads, and f are electrodes applied to the scalp.



The setup in this photo keeps the cat under automatic anesthesia. Tabby is a part of a complex feedback network that is a variety of servomechanism.

When the stepping relay is energized as a result of the brain's energy output, the threaded shaft b is given a turn and more anesthetic is injected into the animal. The over-all circuit, including cat, is a feedback network. During the first stages of anesthesia, when the energy output of the cat's brain increases, the feedback is positive because the increase in energy causes an increase in the rate of applying the anesthetic. When the energy output begins to decrease, the feedback becomes negative and the rate at which the anesthetic is applied begins to decrease.

When the system is running automatically, an equilibrium is reached where the rate of administering the anesthetic exactly balances the rate at which the drug is removed from the body tissues. The depth of anesthesia depends on a number of factors, but it can be adjusted to any desired degree. The gain of the amplifying system is adjusted so that the input potential to the integrating circuit is about 5 volts. R2 and R3 are adjusted to bias the input tube to cutoff, and R1 adjusts the proportion between brain energy and anesthetic dosage. The latter adjustment can be made only by following calibrations made in previous trials to get the correct degree of anesthesia. This setting can be readjusted at any time during the process to establish a new equilibrium.

Because it is a feedback network, the apparatus tends to compensate for any disturbance that may occur in the system. For example, if the anesthetic should become diluted, it would automatically be applied at a greater rate to maintain the equilibrium condition. This compensation is not complete as a slight shift in the equilibrium point occurs, but it is good enough to keep animals automatically anesthetized for as long as two or three days with no readjustment.

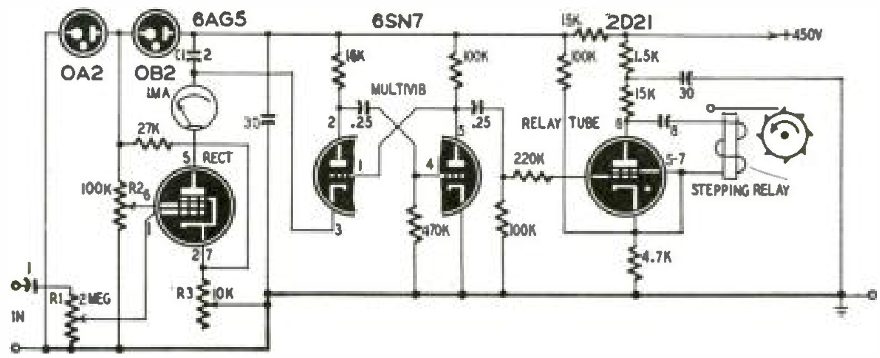
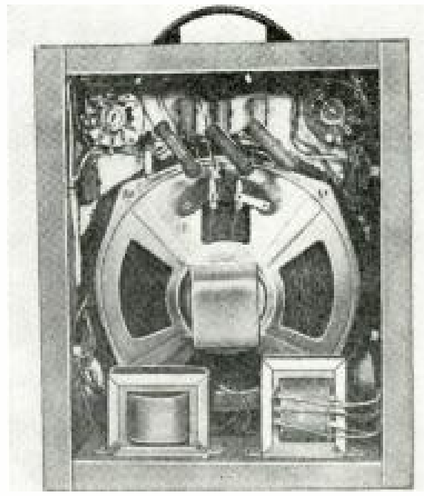


Fig. 1—Schematic of the control unit. The brain's energy output controls the firing of the multivibrator which in turn controls operation of the relay.

A Portable Test Unit For All Loudspeakers

By SAMUEL P. WEST



At left is a front panel photo of the portable loudspeaker test unit. Above is a rear view of the unit.

AMONG the many headaches peculiar to radio service technicians is the problem of nursing a loudspeaker to the shop and back again when a console chassis has been picked up for repairs. Speakers require more care than a crate of eggs. Several methods are commonly used to protect speaker cones but this substitute speaker has proved to be an excellent way of eliminating the time-consuming task of removing and replacing speakers in a customer's home. It has been in use now for over two years and should be a worthy addition to any service shop.

The features included in this unit are:

1. A test speaker with universal transformer connections for impedance matching.
2. Field coil connections for resistances from 400 to 1,800 ohms in 200-ohm steps.
3. An 0-75 and 0-250 milliammeter in the field coil circuit.
4. An output meter with five ranges of sensitivity.
5. Jacks for direct connection to the voice coil, primary of the output transformer, and the field coil.

The unit consists of a PM speaker, a universal output transformer, and a 400-ohm filter choke and series resistors which substitute for the speaker field in some sets. Three toggle switches are used to add resistance to the field-coil circuit. A meter having 75- and 250-ma scales may be used to measure the current drain on the B-supply. Shorted bypass or output filter capacitors will be detected immediately because of excessive current through the meter.

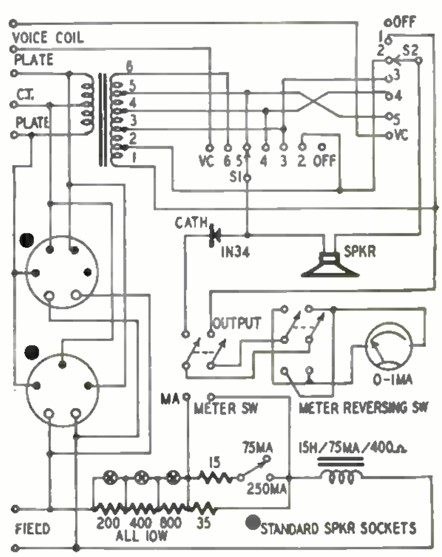
The meter and a 1N34 diode can be switched in series across the secondary of the output transformer to serve as a sensitive output meter. S1 and S2 enable the operator to connect the internal speaker to jacks on the front of the case so it can be used with sets which have the output transformer on the chassis. The primary of the output transformer is connected to three color-coded jacks. Blue is used for the plate terminals and red for the center tap.

Many sets have standard 5- or 6-prong sockets for speaker connections. A 5- and a 6-prong socket are mounted on the side of the case so the test speaker can be connected to these sets through cables fitted with plugs at each end. This cable can be used with sets having 5- or 6-prong speaker sockets. Just be sure that the voice-coil and field coil connections follow the standard wiring system. If you don't, you may end up with the primary of the output transformer in series with the B-plus line.

The meter used was a surplus 3-inch 1-ma movement with 0-75- and 0-250-volt scales. It was connected across a 35-ohm resistor in the field coil circuit for the 75 ma scale and by switching a 15-ohm resistor across this the meter then reads on the 250-ma scale. Any other available meter might be used by matching the shunt resistors to the meter scales. The meter reversing switch completes the circuit. To save space on the front panel, the meter is mounted coaxially with the speaker just as tweeters often are.

Using the speaker

In practically all cases the speaker in the set can be quickly checked to determine if repairs are needed. A PM speaker can be checked with a pocket ohmmeter. If it is O.K., a clear click will be heard and a reading will show on the meter when the test leads are touched to the primary leads of the output transformer. Field coils can also be checked with an ohmmeter or the plug can be loosened and voltage readings taken from each side of the field to ground. The field resistance can be marked on the set chassis for future use in connecting the test speaker.



Schematic of the loudspeaker test set.

Check the plate voltage of the output stage or measure the resistance of the primary of the output transformer to determine the condition of this unit. A click when the output tube is removed and replaced indicates that the speaker is probably O.K. If the speaker is good it's nice to be able to forget about it.

Connect the set to the speaker with one of the cables and flip the meter selector switch to MILLIAMPERES. The meter will then read the current in the field coil circuit on the scale selected by the range switch. When the set is in operation, the two rotary switches can then be varied until good tone quality is obtained. This eliminates referring to the impedance matching chart of the output transformer.

The field-coil resistance will be 400 ohms when the three toggle switches are closed. When any one of them is open its resistance is added to the circuit. All three up gives a total of 1,800 ohms. If the speaker is being used as a PM of course no field coil current will show on the meter. By flipping the meter switch (S2) to OUTPUT the meter then becomes an output meter. Its sensitivity can be varied by rotating switch (S1) from positions 2 to 6. When direct connection to the voice coil only is desired rotate both switches to the extreme right and plug in to the two jacks marked V-C (voice coil)

The unit can be built into any suitable cabinet that allows room for mounting the 8-inch speaker and the switches and jacks on the front panel. The parts layout is not critical and is designed strictly for convenience.

Materials for Test Speaker

Resistors: 1—800, 1—400, 1—200 ohms, 10-watt resistors.
Miscellaneous: 1—universal output transformer, Stancor A-3830 or equivalent; 1—meter, 1-ma. d.c.; 2—rotary switches, 1 circuit, 6 positions; 4—toggle switches, s.p.s.t.; 2—toggle switches, d.p.d.t.; 1—speaker, 8 inch, PM; 1—1N34 germanium diode; 7—pin jacks; 1—filter choke, 15 henries, 75 ma, 400 ohms (Stancor C-1002 or equivalent). Miscellaneous hook-up wire, sockets and plugs.

SCRATCH REMOVING PROCESS

Scratches in plastic escutcheons and radio cabinets and on refrigerators can be removed by the following process:

1. Remove scratch by sanding with wet No. 400 (wet or dry) type sandpaper. Use a free, easy, circular motion and finish with light feathering strokes. Use lots of water.

2. Clean the sanded area thoroughly by swabbing with wet cotton, then dry with another piece of cotton.

3. Apply a polishing agent such as Simonize Kleener, Johnsons Carnu, or Wright's Silver Cream, and rub in rapid, vigorous, circular strokes. It will take several minutes to obtain satisfactory results.

4. Remove all traces of cleaner by swabbing with wet cotton. If the results are satisfactory, dry completely and buff the entire surface with clean, dry cotton.—*Admiral Radio & Television Service Bulletin*

Stethoscopic Probe For Signal Tracing

By RUFUS P. TURNER, K6AI

BELIEVING that the radio service technician should be able to travel as lightly as possible when he is on outside service calls, we have developed an efficient, lightweight stethoscope for radio and audio signal tracing. This simple device may be used for following the progress of a signal throughout a set. The complete stethoscope weighs only a few ounces.

Basically, this signal tracer is a crystal probe. At the end of the probe is a miniature phone jack into which a pair of high-resistance headphones may be plugged for aural signal tracing. By using two 1N54 germanium diodes paralleled in a shunt rectifier circuit, sufficient audio output is obtained to produce a useful headphone signal, even when the test prod is touched to the antenna terminals of the receiver. The test signal may be supplied by an amplitude-modulated oscillator or may be picked up from the air.

The photo shows a Telex Monoset plugged into the probe. Any high-resistance phones can be used, but this unit is exceedingly light in weight, its frequency response is wide and its resistance high, and the plastic stethoscope-type ear tubes carry the smallest sounds directly to the ear where they are heard with minimum disturbance from nearby noises.

Fig. 1 is an exploded view of the probe. The housing is a metal shell cut from standard 1-inch aluminum, brass, or stainless steel tubing. The shell is 4 inches long. Two end discs or plugs are cut to fit into the ends of the shell. The front one, made of bakelite or polystyrene, holds the test prod. The rear disc, made of metal, holds the phone jack. A machinist can turn these discs on a lathe in a few minutes. Each disc is fastened to the shell by two 4-40 screws passed through clearance holes in the ends of the shell and into threaded holes in the discs. There is plenty of room inside the shell for the capacitor, two crystals, and phone jack. A length of paper tubing (or simply a wrapping of paper or plastic sheet) insulates the components from the shell.

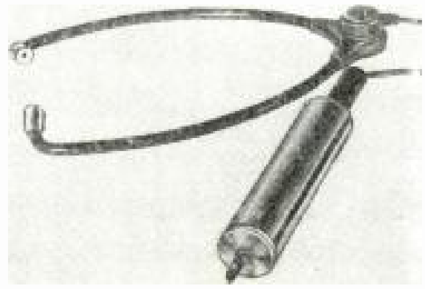


Photo of the test probe and headphones.

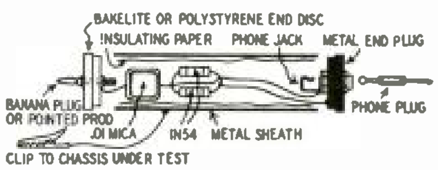


Fig. 1—Sketch of the construction details of the stethoscope signal tracer.

The stethoscope is used in the same manner as any other untuned signal tracer: simply apply a modulated signal to the input terminals of the receiver under test and move the probe through the receiver, touching the test prod to appropriate circuit points in each stage to determine presence of the signal and whether it is being amplified properly. Hum, distortion, and noise are spotted readily. As the probe is moved from the input end of the set toward the output, the volume control in the receiver must be turned down whenever amplification is great enough to cause an uncomfortable signal in the headphones. Signals may be traced in an audio amplifier in the same manner, progressing from the input terminals to the speaker voice coil and taking care to reduce the volume control setting as the test progresses.

The stethoscope probe will function also as an r.f. probe for a d.c. vacuum-tube voltmeter, with the meter plugged into the phone jack at the rear of the probe. The reading of the meter will be approximately equal to the peak value of the applied r.f. voltage (that is, to 1.414 times its r.m.s. value).

We believe that this type of signal-tracing stethoscope will meet with favor among busy technicians, because it is small and lightweight enough to be dropped (headset and all) conveniently into a coat pocket, requires no power, is tubeless, has surprising sensitivity, and can be constructed in a short time at small expense.

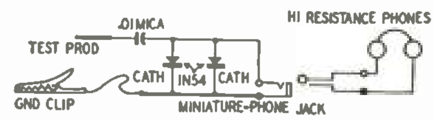


Fig. 2—Circuit of the signal tracer.

Some Hum Servicing Problems

By ROBERT M. FIELD

WHEN a set comes in with a hum complaint, most service technicians plug it in, turn it on, and back the volume control off to see if the hum is from the power supply or audio section of the receiver. If the hum is still there, chances are that filter capacitors are bad. Roughly three-fourths of all hum trouble can be traced to this source. The other fourth presents some interesting problems.

One of the most useful instruments for tracking down hum is an audio signal tracer. If the hum seems to be in the audio section, listen to the hum level at the receiver B-plus first. Electrolytic capacitors sometimes heal themselves when a new capacitor is shunted across them for test. By observing the B-plus hum level *before* you try another capacitor, you can determine if the hum level is decreased at that point. Then even though the set hum stays low after the shunting test, you can be almost certain that it was a capacitor and was not caused by a defect in some other circuit.

After using the tracer a little, you get to know what the hum level should be in most B-supplies and, if it is normal, you can proceed with a step-by-step test of other circuits without having to bother checking the filters further. Even if you cannot locate the hum with the tracer, you can eliminate many possible causes without waste of time.

Bad tubes, especially power output tubes, can cause a lot of hum. A small a.c.-d.c. set came in one day with a hum complaint. Backing the volume control off left the hum level the same. New filters were shunted across the old ones for a test. The hum level decreased slightly but not enough. The rectifier and audio tubes were O.K. in the tube checker. A v.t.v.m. check between the grid of the output tube and ground showed about 0.3 volt a.c. Going backward through the coupling capacitor to the plate of the first audio showed a slight decrease in a.c. voltage. A new output tube made the hum disappear. A fellow service technician pointed out that it would have been just as easy to replace the output tube without using the v.t.v.m. I agreed, but the v.t.v.m. was closer than the tube rack and the trouble might have been elsewhere. The signal tracer would have been just as effective here as the v.t.v.m.

A.c.-d.c. tubes are the main offenders because of the large cathode-to-heater potential. Cathode-heater leakage in the mixer tube of an a.c.-d.c. set, for instance, will modulate the oscillator's output. 35Z5's (and similar tubes) are another source of hum which does not always show up in the tube checker. When the hum level is above normal at B-plus and filters do not correct it, try a new rectifier.

Unbalanced emission of a full-wave rectifier is not often a cause of hum, but it does happen.

Very low hum levels

Occasionally a critical owner of an a.c.-d.c. set will complain of hum even though the hum level is as low as the manufacturer's design calls for. He will usually say that the set is used in the bedroom late at night, that the volume must be kept low and that, at low level, the hum is annoying. An easy way to decrease the hum level, is to provide an extra filter for the first audio plate. A decoupling network, consisting of a 10,000-ohm resistor and a 10-μf filter capacitor, in the plate-supply lead of the first audio will help quite a bit.

A set came in with a hum complaint. A power transformer had been installed in it during the war, and the customer was never satisfied with the set's operation afterward. Investigation showed that inexperienced hands had done a poor soldering job with wartime solder. Merely cleaning up the mess and resoldering all the connections with good solder and a hot iron restored the set to normal operation and eliminated the hum, which was caused by the high-resistance of the poor joints.

One of the worst types of hum is that caused by the sharp charging pulses of the input filter. These pulses contain a high percentage of harmonics, travel back through the house wiring, and are picked up in the antenna circuit. This trouble more often occurs where the house wiring is of the open type. The hum may be noticeable at any point on the dial or sometimes only on a narrow band of frequencies or only when a station is tuned in.

There are several remedies, any or all of which may be necessary. Try a new rectifier. Test a 0.1-μf, 600-v capacitor across the a.c. line. A 50-ohm resistor in series with the lead from rectifier cathode to the input filter is effective in some cases. A .01-μf, 600-v paper capacitor from rectifier plate to cathode in a.c.-d.c. sets is also worth trying. If the set is transformer supplied, you may have to bypass both rectifier plates to cathode with .001-μf micas. The old trick of reversing the line plug may be effective.

Sometimes the hum originates in a set other than the one under test. I once spent a half day trying to find the hum in a radio, only to discover that an office intercom (which was plugged in nearby) was causing the trouble. The intercom not only had to be turned off, but its cord had to be removed from the a.c. line before the hum would stop. The trouble was obscured by the fact that several other receivers on the test bench were not affected. I never learned why!

There are still a few old t.r.f. radios, using filament-type tubes, around. I do not usually repair these, but rather suggest that the owner buy a new set. However, some people are too fond of their sets to part with them and are willing to spend a great deal of money to have them repaired. Almost without exception, after getting the set to play, hum troubles appear. The filter capacitors are seldom bad. Most of the hum is from these: hum balance control off center, bad tubes, unbalanced push-pull output tubes, detector tube shield missing, one side of the push-pull output transformer open, or a poor ground connection in the home. One thing about them is certain: they never had as low a hum level as the newer sets have, and I have wasted much time trying to get rid of what sounded like excessive hum. After working on a set for a while, the faintest hum sounds like a roar.

Coupled-in hum

A case of excessive hum occurred in the a.c.-d.c. amplifier of a portable record player. I tried the usual filter and tube test and then noticed something unusual. The volume control was mounted separate from the chassis and the grounding wire carried, not only the volume control ground return, but also the a.c. from the line switch. Since the first audio tube's cathode went straight to chassis, the grounding wire was in the circuit between grid and cathode. In just a couple of inches of wire there was enough a.c. voltage drop to cause abnormal hum in the amplifier. Running a separate wire from the switch to chassis and clipping the lead from switch to volume control brought the hum level to normal.

One a.c.-d.c. set with a very loud hum defied all my efforts. A fellow service technician, whose specialty is electrical appliances, got tired of watching my aimless poking about in the set and came over to give me a hand. In a matter of minutes he located the trouble—a bare filament lead had been pushed over against the grid of the i.f. tube. I was so bent on locating a *mysterious* source of hum that I completely overlooked such a simple possibility.

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Fundamentals of Radio Servicing

Part XXI–Some Oscillator Circuits

By JOHN T. FRYE

OSCILLATORS are about as important to radio as women are to mankind. Every radio signal, from the tiny coded "peeps" of the weather balloon transmitter to the output of a multi-kilowatt broadcast station, is born from an oscillator.

Furthermore, after a radio signal has grown husky enough to leave home and has sallied forth into space from the transmitting antenna, it soon meets up with a radio receiver. If this receiver is a superheterodyne—and the odds are better than a 1,000 to 1 that it is—the exploring radio signal meets another shy little oscillator that reminds him of his mother. Our radio signal is no laggard in love and courtship and marriage take place in a fraction of a microsecond. Out of this union is born a beautiful little intermediate-frequency signal that is the "spittin' image" of its father; except, of course, that it is not so high.

Right there the analogy between oscillators and women ends. *Oscillators*, as you will see, are comparatively easy to understand.

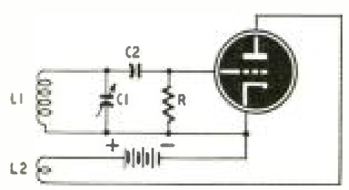

Fig. 1—The oscillator circuit. L1-C1 is the frequency-determining circuit. L2 is the in-phase feedback "tickler."

The word "oscillator" comes from a Latin word that means to swing back and forth. The rocking chair and the clock pendulum are good examples of mechanical oscillators. If an empty rocking chair is given a vigorous push, it will continue to rock back and forth through decreasingly smaller arcs until it finally stops. A subsiding oscillation like this is called a "damped" oscillation.

On the other hand, if enough aiding power is delivered to a swinging object to overcome the losses due to friction, air resistance, etc., the oscillation does not die out but continues as long as the power is fed to it. Such a continuing oscillator—and the clock pendulum is a fine example—is called a "driven" oscillator.

When we start thinking about an electrical counterpart of the mechanical oscillator, our mind naturally turns to the coil-across-capacitor combination discussed in Part VII (September, 1949, RADIO-ELECTRONICS) of this series. When a coil is suddenly placed across a charged capacitor, the electrons start rushing from the negative plate of the capacitor through the coil; and this current builds up a strong magnetic field about the coil. The collapse of this field continues to drive the electrons toward the plate that was positive, giving that plate a negative charge. Then the whole process is reversed. The electrons keep surging back and forth through the coil from one capacitor plate to the other until the losses of the circuit finally succeed in damping out the oscillation. The frequency of these oscillating surges of current is very nearly the resonant frequency of the tuned circuit.

It stands to reason that if we can put more electrical energy into this oscillating circuit—extra power that will *work with* the oscillating current, we can replace the energy lost and so keep the circuit oscillating indefinitely, just as the tiny pushes given to the clock pendulum through the escapement train keep it oscillating. What is more, since we can control the frequency of the electrical oscillation by changing the resonant frequency of the tuned circuit, such an oscillator is an a.c. generator (a generator with no moving parts!) that will operate on any frequency we choose, even up to many millions of cycles per second.

The trick is to inject those little extra pushes of current with precisely the right timing so that they will aid rather than oppose the oscillating current in the tuned circuit; and when you consider that the current may be swinging back and forth a hundred million times a second, that might appear about as difficult as trying to hurl an egg, intact, between the whirring blades of an electric fan. The feat is accomplished by connecting our oscillating tuned circuit to a vacuum tube in such a way that the oscillations themselves trigger and direct the insertion of this "booster" energy.

Vacuum-tube oscillators

Fig. 1 illustrates one way of doing this. L1-C1 is the variable tuned circuit. C2 applies the voltage appearing at the top of this circuit directly to the grid of the triode. The grid leak R furnishes bias for the tube in a manner to be described later. Current flows from the B-battery to the plate of the tube through L2, which is inductively coupled to L1.

Suppose now that a tiny disturbance in the grid circuit causes the grid to go slightly positive. This causes an increase in plate current. The magnetic field about L2 expands as this current increases and the lines of force cut the turns of L1 and induce a voltage in it. This voltage is of the proper polarity to add to the positive charge of the grid. A further increase in plate current results along with still more inductive coupling, or feedback, from the plate to the grid circuit.

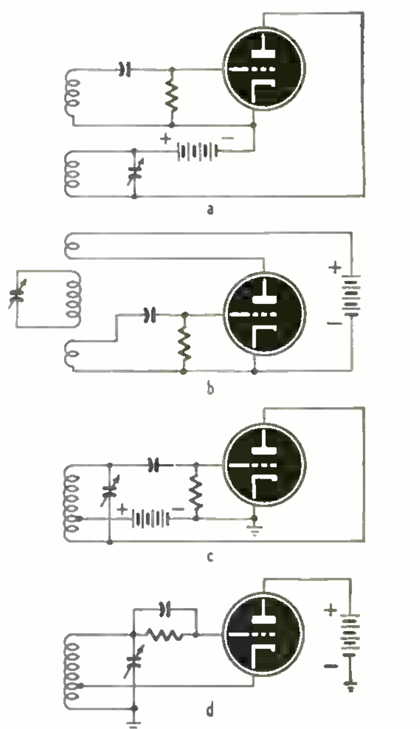

Fig. 2—Some of the more commonly used variations of the oscillator circuit.

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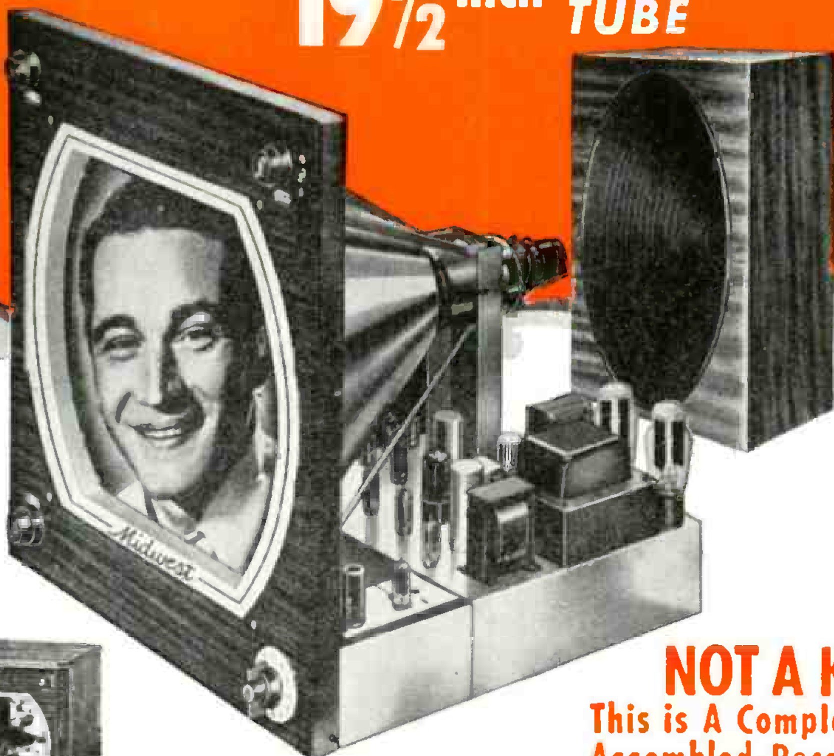

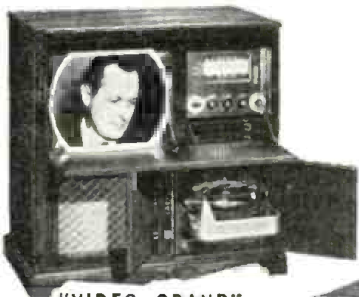

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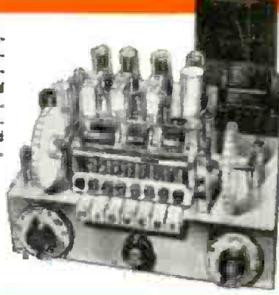

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This current-building-up process continues until the voltage drop across the reactance of L2 calls a halt. At this point the instantaneous voltage on the plate is so low that no more plate current can flow even though the grid does go more positive. The magnetic field about L2 stops expanding and starts to collapse. This induces a reverse voltage in L1 so that the charge on the grid starts to move in a negative direction. This negative-going grid voltage aids and abets the falling off of plate current, and the decreasing plate current, through the magnetic coupling, keeps driving the grid more and more negative.

Finally a point is reached where the plate current is zero and making the grid voltage more negative can produce no further change. Then the voltage ceases to be induced in L1 by L2, and the grid voltage starts to go positive again. The actual frequency of these reversing surges of current is determined by the resonant frequency of L1-C1. The energy fed back from the plate circuit simply helps the charge on the grid to move in whichever direction it is going. To be sure these oscillations will be sustained, enough of this energy must be fed back to compensate for the losses in the grid circuit. The actual amount of feedback depends upon the amount of coupling between the tuned circuit and the tickler coil L2.

The grid leak develops bias for the oscillator tube in exactly the same way it did for the grid-leak detector described in Chapter XVIII (August, 1950, RADIO-ELECTRONICS). While the grid is positive, it attracts more negative electrons to itself than can leak off to ground during the part of the cycle in which the grid is negative. The electrons thus trapped on the grid give it a negative bias.

When the tube is not oscillating, it has zero bias. The amplification is then maximum and the circuit is so unstable that the least disturbance will set into motion this chain of events that leads to sustained oscillation. Under the more stable conditions of fixed bias, the tube would be much harder to start oscillating.

Grid-leak bias, too, automatically adjusts itself to the best value for sustaining oscillation when the load on the oscillator changes. If power is taken from the tank circuit and the amplitude of the voltage swings is reduced, the grid attracts fewer electrons, the bias is lowered, and the plate current increases. The heavier plate current surges help replace the energy lost from the tank circuit to the load.

Some circuit variations

While these basic principles are true for all oscillator circuits, there are many ways to apply them. Fig. 2 shows some of the popular ones. We see in Fig. 2-a that the frequency-determining tuned circuit can be in the plate circuit instead of the grid circuit; or, as shown in Fig. 2-b, it can be in altogether a separate circuit that is inductively coupled to both the plate and grid circuits.

Fig. 2-c reveals that two separate coils are not needed. Here the plate current flows through part of the tank coil. Inductive coupling between this part of the coil and the whole coil gives us a transformer action just as if two separate windings were used. Fig. 2-d is a refinement of the basic Hartley circuit of Fig. 2-c. If you have trouble, at first, in seeing how 2-d provides coupling between the plate and grid circuits, just remember that the plate current also flows through the cathode circuit. The pulses of plate current appear between the tap on the coil and ground in 2-d just as they do in 2-c.

Fig. 3 reveals an oscillator circuit known as the Colpitts. Here the cathode goes to a tap on a capacitive voltage divider instead of an inductive voltage divider, as it did in the Hartley circuit. The amount of feedback depends upon the ratio of the capacitive reactances of C1 and C2. The Colpitts circuit is sometimes used in slug-tuned push-button oscillator circuits or for receivers working on the long-wave "weather" bands.

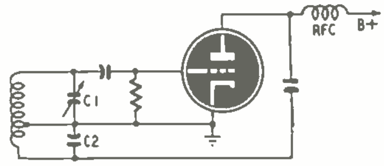


Fig. 3—This Colpitts oscillator circuit has a capacitive voltage divider.

This brief discussion by no means exhausts the many types of feedback oscillator circuits, but it has touched on the most popular types used in receivers. Just keep in mind that all you need do to make a tube oscillate is to feed back enough energy from the plate circuit to the grid circuit, in the proper phase, to overcome the circuit losses, and you are in business!

Incidentally, as the capacitance of the tuned circuit is increased, heavier currents circulate in the circuit and the losses go up. For this reason, an oscillator usually oscillates much more vigorously on the high-frequency end. You must always provide enough feedback to insure that the amplitude of oscillation is satisfactory at the low end.

However, as the little boy explained to the doctor who was treating him for green-apple colic, you can get too much of even a good thing; and feedback is no exception. If you have too much feedback, the oscillator is likely to develop a second, unwanted or parasitic mode of oscillation that will put birdies to twittering on the signals as they are tuned in, especially on the high-frequency end of the band.

Oscillator tracking

And now we come to the subject of tracking. Let me hasten to assure you that this has nothing to do with sort of trail-following at which the Lone Ranger's friend, Tonto, excels. Instead, it refers to the fact that the two tuned circuits shown in Fig. 4 must follow certain tuning paths if our superheterodyne receiver is to work as it should.

You will recall that we found out in Chapter XIX that the oscillator fre-

quency must always be spaced from the signal frequency you wish to receive by the intermediate frequency. Usually the oscillator operates on the high-frequency side of the signal. That means that if we wish to tune a band of from 540 to 1620 kc, and if our i.f. is 455 kc, the oscillator must tune through a range of 995 to 2075 kc.

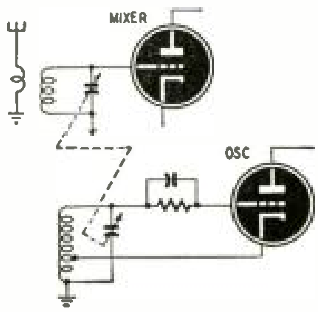


Fig. 4—In the superhet, the oscillator and mixer tuning capacitors are on one shaft as indicated by the dashed line.

In each case the total span of frequencies being 1,080 kc you might jump to the conclusion that identical tuning capacitors on a single shaft, used with two different values of inductance, would accomplish our purpose of keeping the oscillator circuit always 455 kc higher than the signal input circuit. But you would be wrong. The spans of frequency are the same, but the ratio of 540 to 1620 kc is exactly 1 to 3, while from 995 to 2075 kc the ratio is slightly less than 1 to 2. If identical capacitor sections are used to resonate the two coils to frequencies 455 kc apart at the high end of the band, the gap between the two tuned circuits steadily narrows as the tuning capacitor is tuned toward the low-frequency end of the band.

One way to keep the tuned circuits 455 kc apart is to use a tuning capacitor with two sections having different shapes and sizes of plates. One section of this capacitor varies from 8.7 to 170.7 μμf, while the larger section goes from 11 to 431 μμf. When such a capacitor is used with proper coils, the oscillator will always be tuned 455 kc higher than the signal input circuit for any setting of the capacitor shaft.

The padder capacitor

This method, unfortunately, can only be used on a single band—unless you want to use more than one tuning capacitor! However, a padder capacitor together with a capacitor section that has uncut plates can make that section seem as though the plates were tailored to the oscillator circuit needs; furthermore, different padders can be used on different bands so that the same tuning capacitor section can be used to track the oscillator correctly on each of these bands.

Fig. 5 helps understand how this is done. The tuning capacitor C_t and the padding capacitor C_p are in series across the coil. When two capacitors are in series, their total capacitance is equal to their product divided by their sum. Let us assume that the maximum capacitance of C_t is 431 μμf, just as is the section tuning the signal input circuit. C_p is a semivariable capacitor adjustable by a screwdriver. If we adjust this capacitor to about 280 μμf, we find that the series combination of C_t and C_p is very close to the 170.7 μμf maximum capacitance furnished by the cut-plate section of the other tuning capacitor.

As the frequency of the oscillator is tuned higher, the fixed capacitance of C_p has less and less reactance. At the same time the reactance of C_t steadily increases. By the time the high-frequency end of the band is reached, the reactance of C_t is so much greater than that of C_p that the tuning capacitor is almost entirely responsible for the tuning of the oscillator circuit. As the circuit is tuned toward the low-frequency end of the band, however, the padder capacitor reactance has more of a "hobbling" action on the tuning capacitor and makes the effective maximum capacitance much less than it would be without the padder. By using the proper value of inductance and the proper padder, an oscillator circuit can be made to track exactly at three different points in the tuning range and the deviation from the exact frequency at other points is so small as to be negligible.

Oscillator failures are usually due to defective coils, bad grid-coupling capacitors, or defective grid-leak resistors. The best way to check an oscillator is

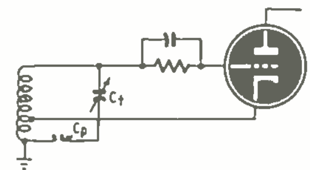


Fig. 5—For correct tracking, a padder capacitor is placed in series with the tuning capacitor as in this circuit.

to measure the negative voltage on the grid with a vacuum-tube voltmeter. No voltage indicates an oscillator that is not functioning, and the amplitude of the voltage at different settings of the tuning capacitor reveals whether there are any weak spots in the oscillator's output. But, as pointed out before, some falling off in output is to be expected as the oscillator is tuned to the low end of its range.

"Sure, I called both of you boys—I want competitive bids on fixing my little set."

When television won its wings

How multiple uses for airborne cameras and equipment were revealed by experiment

No. 10 in a series outlining high points in television history

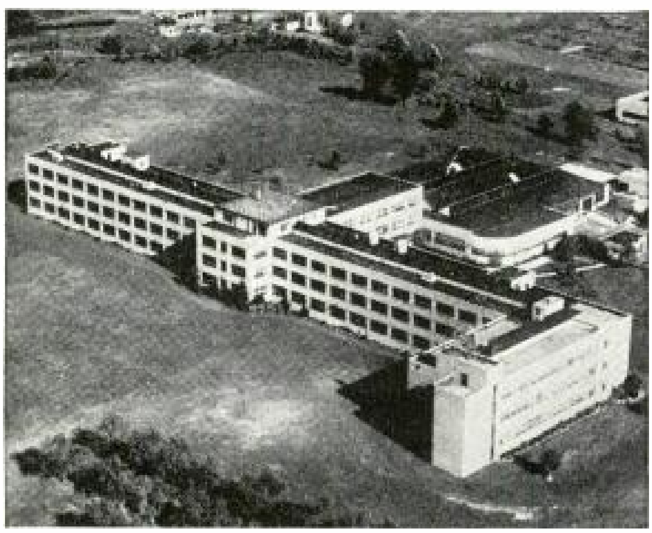
Photos from the historical collection of RCA

Mounted in the nose of an airplane, *special RCA airborne television equipment will give ground observers a sharp, clear, bird's-eye view of land and sea.*

• Put a television camera in the nose of an observation plane, and generals—many miles away—can watch and direct the course of a battle. Such, in World War II, was one of the suggested uses of airborne television as an "optic nerve."

Feasible? Absolutely—yet this is only one of the many ways in which television can serve in fields outside those of news and entertainment. The entire subject of the use of television cameras and receivers in the air has been carefully investigated by RCA.

Not too long ago, at the time when plans for our inter-city television networks were in discussion, the idea of making telecasts from planes high in the air was proposed.



RCA Laboratories in Princeton, N. J., *as seen from the air. New uses for television—including, for example, its adaptation to aviation—are one part of this progressive institution's research program.*

From New York, a plane equipped with a television receiver, set off on a flight to Washington—200 miles away. When above Washington, at an altitude of 18,000 feet, passengers in the plane clearly saw Brig. General David Sarnoff, of RCA, talking to them from Radio City! Later, RCA placed a camera and transmitting equipment in an airliner, and a bird's-eye view of New York was successfully telecast to observers below!

It has also been proposed by authorities, that a television camera might be used as the "eye" of a guided missile. Placed in a rocket's nose it would let a distant operator see where the missile was headed. If need be he could steer it in any direction to hit a moving target.

But less on the destructive side, and more important to us now, are the possible uses of television in "blind flying" conditions, when airports would normally be closed in from bad weather. With a television receiver in the cockpit, and a transmitter sending information from the landing field ahead, the pilot could clearly see conditions on runways and approaches—come in with far greater security than when guided by radio alone!

Radio Corporation of America

WORLD LEADER IN RADIO—FIRST IN TELEVISION

First Aid For The Radio

By HARRY LEEPER

A ROLL of adhesive tape carried in the service kit has "saved the day" for many service technicians. Adhesive tape is usually thinner than friction tape and adheres better to many materials.

Some suggested uses of ordinary and moleskin tape are illustrated below.

Photo 1. A strip of adhesive tape will provide insulation in close quarters in an auto radio for usual voltages to chassis.

Photo 2. A few inches of tape unrolled and folded over will stick to the bench and also provide a sticky surface for small screws and bolts and hold them in place.

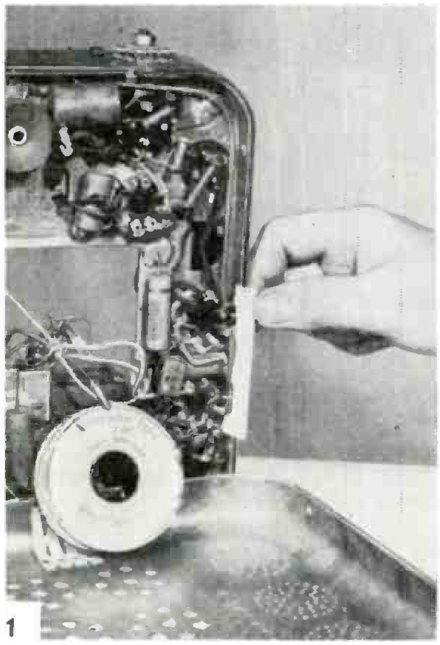
Photo 3. Many loop aerials may be held in position and protected from damage caused by sliding chassis in and out of cabinet by a strip of tape as shown.

Photo 4. Glass dial indicators often loosen and vibrate or rattle at certain frequencies. A layer of tape over each end of the glass will usually correct this condition.

Photo 5. Loose ends of loop aerials when not connected to external antenna are best taped to the cabinet.

Photo 6. If not practicable to tape to cabinet or other part, the end of the aerial may be folded over and then taped. Fingernail polish may be used to change color of tape and to make it more lasting or to seal it.

Photo 7. Many small test meters have smooth cases and are light in weight. It is easy to knock the meter from bench to floor. Moleskin adhesive tape is soft on one side and when attached to a small meter eliminates the slippery finish.



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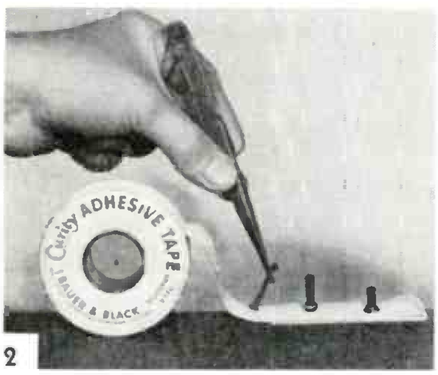

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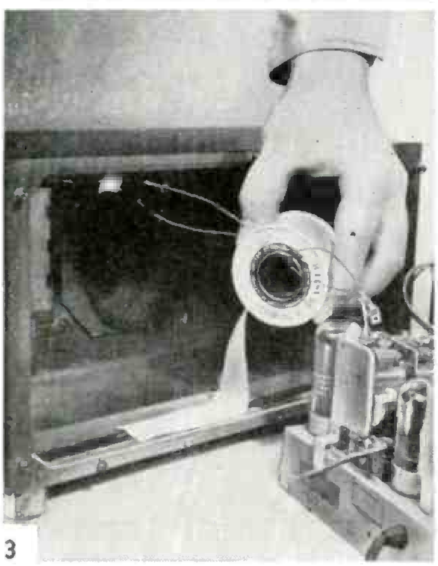

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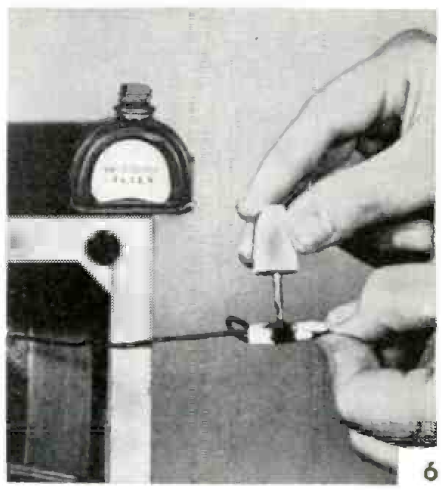


6

7

You GET THE BEST IN *Heathkits*

Heathkits are the Quality Line of TEST INSTRUMENT KITS

Famous HEATHKIT PARTS

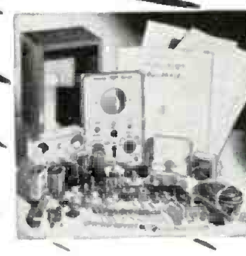
- MALLORY FILTER CONDENSERS
- WILKOR PRECISION RESISTORS
- GRIGSBY ALLISON SWITCHES
- ALLEN-BRADLEY RESISTORS
- GENERAL ELECTRIC TUBES
- CHICAGO TRANSFORMER
- CENTRALAB CONTROLS
- SIMPSON METERS
- CINCH SOCKETS

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 kepr 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

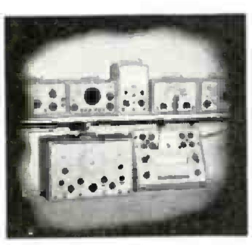
Wherever required, the finest quality 1% ceramic resistors are supplied. These require no aging and do not shift. No matching of common resistors is required. You find in Heathkit the same quality voltage divider resistors as in the most expensive equipment.

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.

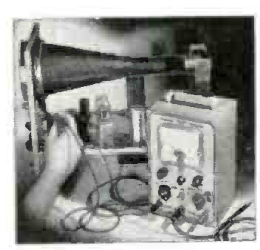
Complete INSTRUCTION MANUALS

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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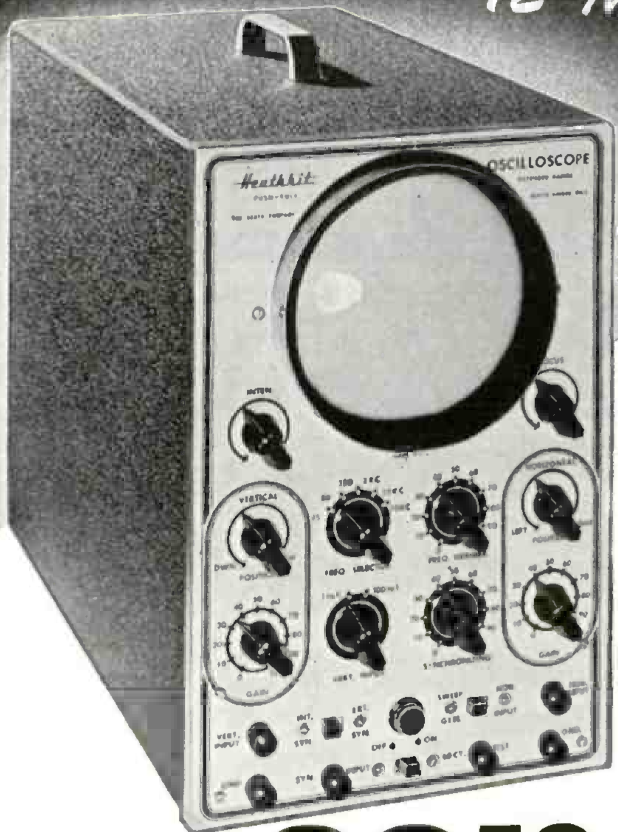
The HEATH COMPANY
. . . BENTON HARBOR 20, MICHIGAN

12 Improvements IN NEW 1951

MODEL O-6 PUSH-PULL

Heathkit OSCILLOSCOPE KIT



- ★ 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.

Only $39.50

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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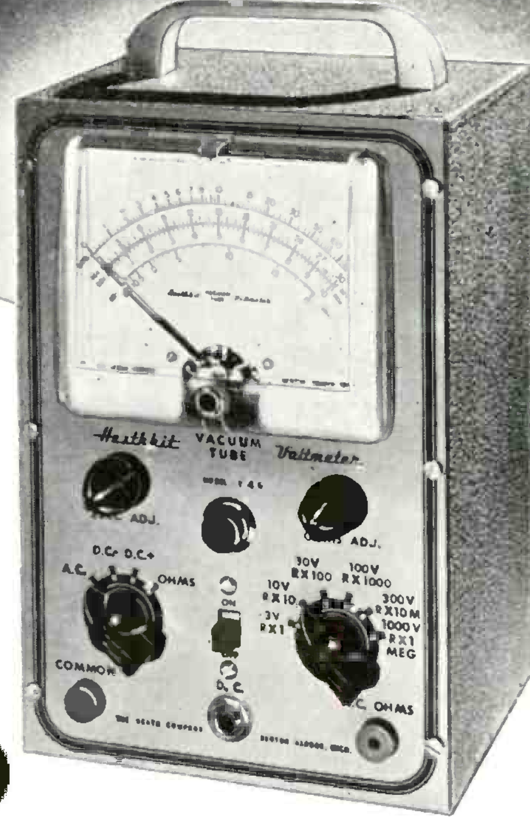
New 1951 • • MODEL V-4A *Heathkit* VTVM KIT

HAS EVERY EXPENSIVE *Feature*



- ★ Higher AC input impedance, (greater than 1 megohm at 1000 cycles).
- ★ New AC voltmeter flat within 1 db 20 cycles to 2 megacycles (600 ohm source).
- ★ New accessory probe (extra) extends DC range to 30,000 Volts.
- ★ New high quality Simpson 200 microampere meter.
- ★ New ½% voltage divider resistors (finest available).
- ★ 24 Complete ranges.
- ★ Low voltage range 3 Volts full scale (⅓ of scale per volt).
- ★ Crystal probe (extra) extends RF range to 250 megacycles.
- ★ Modern push-pull electronic voltmeter on both AC and DC.
- ★ Completely transformer operated isolated from line for safety.
- ★ Largest scale available on streamline 4½ inch meter.
- ★ Burn-out proof meter circuit.
- ★ Isolated probe for dynamic testing no circuit loading.
- ★ New simplified switches for easy assembly.

New LOW PRICE $23.50

The new Heathkit Model V-4A VTVM Kit measures to 30,000 Volts DC and 250 megacycles with accessory probes — think of it, all in one electronic instrument more useful than ever before. The AC voltmeter is so flat and extended in its response it eliminates the need for separate expensive AC VTVM's. + or − db from 20 cycles to 2 megacycles. Meter has decibel ranges for direct reading. New zero center on meter scale for quick FM alignment.

There are six complete ranges for each function. Four functions give total of 24 ranges. The 3 Volt range allows 33⅓% of the scale for reading one volt as against only 20% of the scale on 5 Volt types.

The ranges decade for quick reading.

New ½% ceramic precision are the most accurate commercial resistors available — you find the same make and quality in the finest laboratory equipment selling for thousands of dollars. The entire voltage divider decade uses these ½% resistors.

New 200 microampere 4½" streamline meter with Simpson quality movement. Five times as sensitive as commonly used 1 MA meters.

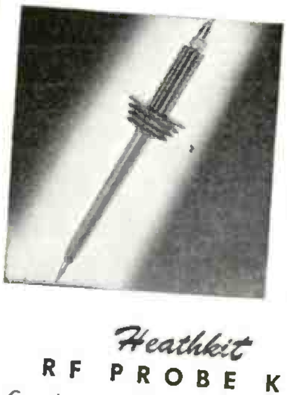
Shatterproof plastic meter face for maximum protection.

Both AC and DC voltmeter use push-pull electronic voltmeter circuit with *burn-out* proof meter circuit.

Electronic ohmmeter circuit measures resistance over the amazing range of 1/10 ohm to one billion ohms all with internal 3 Volt battery. Ohmmeter batteries mount on the chassis in snap-in mounting for easy replacement.

Voltage ranges are full scale 3 Volts, 10 Volts, 30 Volts, 100 Volts, 300 Volts, 1000 Volts. Complete decading coverage without gaps.

The DC probe is isolated for dynamic measurements. Negligible circuit loading. Gets the accurate reading without disturbing the operation of the instrument under test. Kit comes complete, cabinet, transformer, Simpson meter, test leads, complete assembly and instruction manual. Compare it with all others and you will buy a Heathkit. Model V-4A. Shipping Wt., 8 lbs. Note new low price, $23.50



New 30,000 VOLT DC PROBE KIT

Beautiful new red and black plastic high voltage probe. Increases input resistance to 1100 megohms, reads 30,000 Volts on 300 Volt range. High input impedance for minimum loading of weak television voltages. Has large plastic insulator rings between handle and point for maximum safety. Comes complete with PL55 type plug.

No. 3366 High Voltage Probe Kit. Shipping Wt., 2 pounds. **$5.50**

Heathkit RF PROBE KIT

Crystal diode probe kit extends range to 250 megacycles = 10% comes complete with all parts, crystal, cable and PL55 type plug.

No. 309 RF Probe Kit Shipping Wt., 1 lb. **$5.50**

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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**

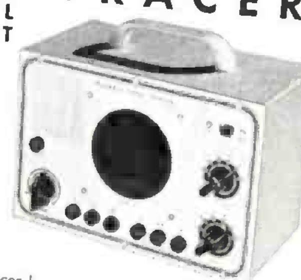
Features

- 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 space for future types. Fast action brass gear driven roller chart quickly locates the settings for any type tube. Simplified switching cuts necessary testing time to minimum and saves valuable service time. Short and open element check. Simple method allows instant setup of new tube types without waiting for factory data. No matter what the arrangements of tube elements, the Heathkit flexible switching arrangement easily handles it. Order your Heathkit Tube Checker Kit today. See for yourself that Heath again saves you two-thirds and yet retains all the quality — this tube checker will pay for itself in a few weeks — better assemble it now. Complete with instructions — pictorial diagrams — all parts — cabinet — ready to wire up and operate. Model TC-1 Shipping Wt., 12 lbs.

$29.50

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The HEATH COMPANY

. . . BENTON HARBOR 20, MICHIGAN

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.

$34.50

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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. . . BENTON HARBOR 20, MICHIGAN

New LABORATORY INSTRUMENT KITS

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Heathkit IMPEDANCE BRIDGE as Standard

Features

- Measures inductance 10 microhenries to 100 henries
- Measures resistance .01 ohms to 10 megohms
- Measures capacitance .00001 MFD to 100 MFD
- Measures "Q" and power factor.

Measures inductance from 10 microhenries to 100 henries, capacitance from .00001 MFD to 100 MFD. Resistance from .01 ohms to 10 megohms. Dissipation factor from .001 to 1. "Q" from 1 to 1,000. Ideal for schools, laboratories, service shops, serious experimenters. An impedance bridge for everyone — the most useful instrument of all, which heretofore has been out of the price range of serious experimenters and service shops. Now at the lowest price possible. All highest quality parts. General Radio main calibrated control. General Radio 1,000 cycle hummer. Mallory ceramic switches with 60 degree indexing — 200 microamp type binding posts with standard 3/4" centers. Beautiful birch cabinet. Directly calibrated "Q" and dissipation factor scales. Ready calibrated capacity and inductance standards of Silver Mica, accurate to 1/2 of 1% and with dissipation factors of less than 30 parts in one million. Provisions on panel for external generator and detector. Measure all your unknowns the way laboratories do — with a bridge for accuracy and speed.

$69.50

Internal 6 Volt battery for resistance and hummer operations. Circuit utilizes Wheatstone, Hay and Maxwell circuits for different measurements. Supplied complete with every quality part — all calibrations completed and instruction manual for assembly and use. Deliveries are limited. Model IB-1. Shipping Wt., 15 lbs.

NEW Heathkit LABORATORY RESISTANCE DECADE KIT

Features

- 1/2% Accuracy
- Birch Cabinet
- Ceramic Switches
- Covers 1 ohm to 99,999 ohms

The new Heathkit Resistance Decade is a handy tool for laboratory, school and service shop. Ideal for test setups, calibrating instruments, bridge measurements, selecting multipliers, etc.

$19.50

Uses the finest Centralab ceramic switches, 1/2% ceramic decade resistors and heavy birch cabinet matching other laboratory equipment. The range is 1 ohm to 99,999 ohms in one ohm steps.

Finest quality throughout to withstand school usage — heavy aluminum panel — laboratory type binding posts — the fine decades are extremely simple to assemble — complete kit. Model RD-1. Shipping Wt., 4 lbs.

NEW Heathkit LABORATORY POWER SUPPLY KIT

Features

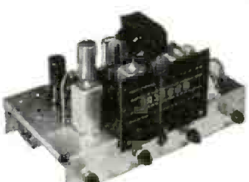
- Supplies 6.3 V. AC at 4.5 Amps.
- Heavy duty construction.
- Handy for schools, labs., and service shops.
- Supplies variable DC 50-300 Volts.
- Shows voltage or current on 3 1/2" meter.

This new Heathkit Variable Power Supply Kit fills hundreds of needs — use it for experimental circuits — no need to build a separate power supply — use it for a test voltage to determine proper coefficients in unknown circuits — calibrate instruments with its variable voltage, etc. This new Heathkit supplies 50 to 300 Volts continuously variable DC together with an AC filament voltage of 6.3 Volts at 4.5 Amperes. A built-in 1 MA 3 1/2" meter has proper shunts to read 0-500 Volts and 0-200 Milliamperes. The circuit uses a 5Y3 rectifier, two 1619 tubes as electronic control tubes to vary the output voltage with a single potentiometer. Case measures 7 1/8" x 13" x 7 1/8". Has instruction manual for assembly and use. Model PS-1. Shipping Wt., 18 lbs.

$29.50

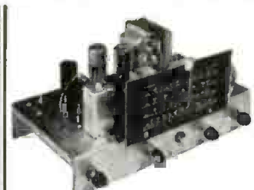
Heathkit RECEIVER & TUNER KITS for AM and FM

TWO HIGH QUALITY Heathkit SUPERHETERODYNE RECEIVER KITS



Model BR-1 Broadcast Model Kit covers 550 to 1600 Kc. Shipping Wt., 10 pounds.

$19.50



Model AR-1 3 Band Receiver Kit covers 550 Kc. to over 20 Mc. continuous. Extremely high sensitivity. Shipping Wt., 10 lbs.

$23.50

Two new Heathkits. Ideal for schools, replacement of worn out receivers, amateurs and custom installations.

Both are transformer operated quality units. The best of materials are used throughout — six inch calibrated slide rule dial — quality power and output transformers — dual iron core shielded I.F. coils — metal filter condensers and all other parts. The chassis has phono input jack — 110 Volt outlet for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.

TRUE FM FROM Heathkit FM TUNER KIT

$22.50

The Heathkit FM Tuner Model FM-2 was designed for best possible tonal reproduction. The circuit incorporates the most desirable FM features — true FM — ready wound and adjusted coils — 3 stages of 10.7 Mc. I.F. (including limiter).

Tube lineup: 7E5 oscillator, 6SH7 mixer, two 6SH7 I.F. stages, 6SH7 limiter, two 7C4 diodes as discriminator, 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. The R.F. coils are ready wound — mounted on the tuning condenser and the condenser is adjusted — no R.F. coils to wind or adjust.

A calibrated six inch slide rule dial has vernier drive for easy tuning. The finest parts are provided with all tubes, punched and formed chassis, transformers, condensers and complete instruction manual. Model FM-2. Shipping Wt., 10 lbs.

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... BENTON HARBOR 20, MICHIGAN

ENJOY MUSIC AT ITS *Finest* WITH *Heathkit* AMPLIFIERS

NEW *Heathkit* HIGH FIDELITY 20 WATT AMPLIFIER KIT

$21.50

Features

- Push-pull 6L6's.
- Full 20 Watts output.
- Fully enclosed chassis.
- Provisions for reluctance pickup compensation stage.
- Cased high fidelity output transformer.
- Treble and bass boost tone controls.
- Full range of output impedances 3.2 ohms to 500 ohms.

The finest amplifier kit we have ever offered — check the features. This inexpensive amplifier compares favorably with instruments costing five times as much. Nothing has been spared to provide the best reproduction — an ideal amplier for the new Heathkit FM Tuner listed below.

Dual tone controls for control of both treble and bass. Bass control is of the boost type for maximum listening pleasure. Optional preamplifier stage for use with G. E. reluctance pickup or microphone. Uses inverse feedback to give excellent response over entire range. Tube lineup: 6SJ7 preamplifier stage, 6J5 phase splitter stage, two 6L6's in push-pull and 5Y3 rectifier. (6SC7 as optional compensation stage).

Uses highest quality Chicago Transformer Corporation cased output transformer with taps of 3.2, 8, 15, 60 and 500 ohms to match any speaker combination. Power transformer is conservatively rated for continuous operation in sound systems. Tone control gives maximum bass boost of 6 db at 70 cycles. Amplifier has maximum gain of 75 db. Response within 3 db 20 to 20,000 cycles. Shipping Wt., 17 lbs. Complete with all parts, tubes and instruction manual.

Model A-5A Amplifier with preamplifier for G. E. cartridges or microphone **$23.50**
12" 20 Watt Speaker, No. 326 .... **7.50**

Heathkit ECONOMY 6 WATT PUSH-PULL AMPLIFIER KIT

$12.50

No. 304, 12-inch Speaker... **$6.95**

This new Heathkit Amplifier was designed to give quality reproduction at a very low price. Has two preamp stages, phase inverter stage and push-pull beam power output. Comes complete with six tubes, quality output transformer (to 3-4 ohm voice coil), husky cased power transformer and all other parts. Has tone and volume controls. Instruction manual has pictorial for easy assembly. Six watt output with response flat ± 1½ db from 50 to 15,000 cycles. A quality amplifier kit at new low price. Better build one. Model A-4. Shipping Wt., 7 lbs.

Heathkit RECEIVERS and TUNER CABINETS

$4.95

Order No. 350 for FM tuner.

Blonde birch veneer cabinet for either the receivers or tuner. Modern styling is an asset to any room. 5" speaker fits in end of cabinet when used with receivers. Size 7 x 13½ x 8¼ inches. Shipping Wt., 5 lbs.
Order No. 345 for either receiver

Metal professional type communications receiver cabinet. Finished in deep grey to fit the panel supplied with Heathkit BR-1 and AR-1 Receivers (panel shown not included with cabinet). 5" speaker mounts in end of cabinet. Gives professional appearance to Heathkit receivers. Size 7 x 14 x 7¾ inches. Shipping Wt., 6 lbs.

5" Permoflux Speaker for either cabinet for use with either Heathkit Receiver No. 320 5" Speaker **$2.75**

$4.50

No. 335 Cabinet for receivers only.

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Power Supply For The BC-224A Receiver

By JOSEPH ZELLE

THE BC-224A communications receiver is an earlier version of the popular BC-348. Although certain basic circuits are the same in all these receivers, they usually have different tube complements and just enough variations that no diagram except the specific one can be trusted. Diagrams of the older model receiver were hard to get and so one had to trace out circuits with the continuity meter.

The power supply was first removed as a unit. Then the shield can was stripped of the generator and all resistors and filter capacitors in it. (The label on the generator states that it was driven by 13.3 volts and produced 250 volts d.c. at 0.050 ampere or 50 ma.)

A completely new power supply was built with a plate transformer delivering 300 volts, rectified by a type 80 tube. The filter circuit consisted of the two original filter chokes attached to the shield can. A third choke, for the filament circuit, was not used in the new supply.

The regular B-plus choke could be determined easily because it has a red lead leaving the can and going to the B-plus post in the receiver. The negative lead choke can be determined because one side of it is grounded. This negative choke supplies the bias voltage for the final audio type 41. *Wire the circuit as in Fig. 1* since a shorted choke will leave no bias on the 41 and ruin it. Polarity must be obeyed strictly and the bypass capacitor for the 41 cathode circuit may be critical.

The 6-volt filaments were connected in parallel, in two sets of four. The two sets of parallels were then connected in series through a small resistor to operate on the original 13.3 volts. The leads leaving the parallel sets were snipped off and each set of parallels connected to twisted leads that went directly to the two little fuses and then to the 6.3-volt filament winding on the power transformer.

The dial light socket was re-arranged to work off 6.3 volts and the leads connected together with the type VT76.

The filament switch leads in the original were cut off and the hot side of the a.c. placed on it before going to the power transformer. Incidentally, the a.c. leads were fed through the other two little fuses first before going into the receiver circuits.

All excess capacitors and resistors tied across the original filament circuits were removed. The filament leads were checked and rechecked until all these components were definitely cleared out. For instance, the 80-ohm resistor in series with the two parallel sets of filaments was thus discovered and removed.

Some care must be taken with the power plug. The two lowest prongs on the plug are those of the output transformer. These can be determined easily with a continuity meter, because the phone jack is directly across the output winding. One side of the winding is grounded. Two impedances were supposed to be available, 3,000 and 300 ohms. In purchasing a speaker, however, the matching transformer was included in this conversion and replaced the original.

The two prongs immediately above the output leads will be found to be the B-plus, interlocking the receiver mechanically. This prevents the output transformer operating unloaded should the speaker plug be disconnected inadvertently. In this particular conversion, the Jones plug was cumbersome and the receiver would not sit right. An ordinary four-prong tube socket and plug were substituted.

The plug was mounted on the coil shield and the other side soldered to the power supply shield can. The two small prongs carried the d.c. while the large prongs carried the voice-coil current. In this way, the danger of getting heavy d.c. accidentally in the voice-coil winding was obviated.

To have a standby switch, the grounded side of the negative choke was lifted from ground and connected to that part of the volume control switch which had been used originally to control the voltage of the generator. The bleeder was left in the power supply circuit as shown in the diagram to keep it loaded at all times. Therefore, when this switch is in the MVC or the AVC position, B-voltage will be supplied to the receiver. When in the OFF position, only the filaments will be on, while the d.c. will flow through the bleeder resistor only.

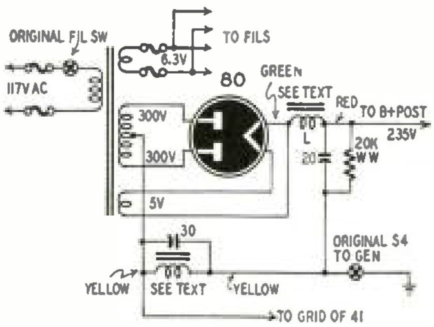

Fig. 1—Schematic of the power supply.

HAM RADIO MAKES FINE HOBBY FOR GRANDMA

She may be Grandma to some, but to hams she is W4NUB. Mrs. C. C. Hand, 67, of Bay Minette, Ala. took up amateur radio a year ago to keep daily contact with her son who lives 100 miles away. Mrs. Hand is an enthusiastic ham and hopes to get a class-B ticket soon.

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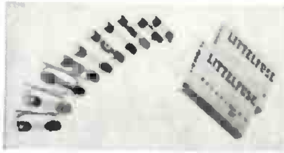
New Devices

FUSE KIT

Littelfuse, Inc.
Chicago, Ill.

For quicker on-the-spot servicing, this fuse kit contains the ten most-needed fuses in a 2¼ x 1½-inch package. Eight basic types are included, of which two



are duplicated to give more adequate coverage of the most popular types used in TV receivers.

The kit is made in a distinctive green with black and white lettering for easy identification.

SOLDERING GUN

Weller Electric Corp.
Easton, Pa.

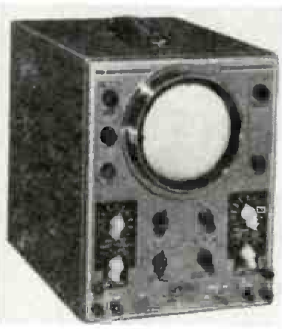
Dual spotlights on the new Weller soldering gun eliminate shadows and improve visibility. This new model is

considerably smaller and lighter than the previous 135-watt models. Other features are dual heat (100/135 watts), 5-second heating time, trigger-switch control which adjusts heat to the work, and a chisel-shaped tip for faster heat transfer and speedier soldering. The tip is replaceable.

OSCILLOSCOPE

Jackson Electrical Instrument Co.
Dayton, Ohio.

The model CRO-2 oscilloscope uses the 5-inch 5UP1 C-R tube. The vertical amplifier response is uniform from 20 cycles to 4.5 mc. Sensitivity is .018 r.m.s. volts per inch with response uniform to 100 kc. Vertical input impedance is 1.5 megohms shunted by 20 μμf. Horizontal input impedance is 1.1 megohms.



The sweep oscillator provides a sawtooth wave from 20 cycles to 50 kc in 5 steps. A 60-cycle sine wave sweep is also available. Direct connection, through capacitors, can be made to the C-R tube deflection plates. A demodulation probe to use for signal tracing in television or radio receivers is also available.

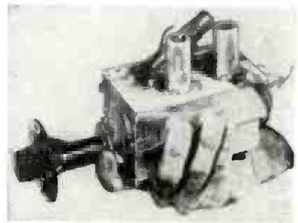
The oscilloscope is housed in an all steel cabinet finished in gray Hom-R-Tex with a leather carrying handle. Its size is 13 inches high, 10½ inches wide, and 15⅝ inches deep. Net weight is 26 pounds.

TV TUNER

Allen B. Du Mont Laboratories
East Paterson, N. J.

Designed to replace switch type TV tuners, the Series T3A Inputuner provides reception of FM as well as the TV channels. It uses the Mallory-Ware 3-section spiral Inductuner plus antenna tuning to provide good sensitivity and selectivity. The space required to mount it is identical with that of most of the leading switch-type tuners, and standard mounting holes are used to make the replacement easier.

This tuner works into the i.f. system of receivers having a separate sound i.f. and it is available with variations in the mixer plate network so that it can be installed without alteration into most separate sound TV receivers. The input impedance is 300 ohms. A sound trap included in the tuner is optional, and a choice of either 21.25-or 21.75-mc sound center i.f. is available. It comes

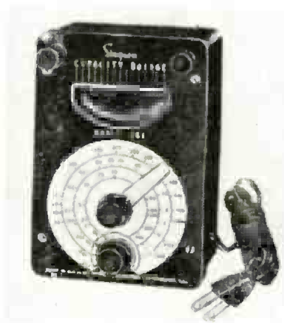


complete with tubes (6BC5 r.f. tube and 6J6 mixer-oscillator), TV-FM dial scales and mixer plate network and is ready for installation.

CAPACITANCE BRIDGE

Simpson Electric Co.
Chicago, Ill.

The model 381 bridge has three capacitance ranges—20 μμf to .005 μf, .005 μf to 2 μf, and 1 μf to 500 μf. The Bakelite-encased instrument measures 3⅝ x 5½ x 2⅜ inches and its weight is 1¾ pounds. Its small size makes it handy for all types of service work. The dial is made of etched aluminum and no multiplying factors or other calculations are needed for any of the three ranges.



LINE VOLTAGE REGULATOR

Standard Transformer Corp.
Chicago, Ill.

A new series of line adjusters has been added to the Stancor line of transformers. These four units permit operation of electrical devices at 115 volts when the supplied voltage is 65, 75, 90, 100, 115, 130 or 145. They meet power requirements up to 750 va, 50-60 cycles. The line adjuster input is correctable in seven steps by means of a selector switch and indicated by an output voltmeter. These units are also useful for altering a 115-volt line above or below that level. They are equipped with a line cord and plug to fit a

standard outlet and a plug-in receptacle to accommodate devices to be operated. The selector switch is mounted on the top of the transformer.

SERVICING TOOL KITS

JFD Mfg. Corp.
Brooklyn, N. Y.

The No. BR98 screw driver kit consists of five tools whose shanks fit one universal handle. The five screw driver blades are made in various sizes and

tip thicknesses to cover most TV and radio requirements. The steel blades are bright cadmium plated with fully polished ground tips. The universal handle is made of unbreakable, non-inflammable, shock-proof amber plastic.

The No. BR99 nut setter kit consists of five hex socket wrenches: 1/4 x 3 inch, 5/16 x 3 inch, 11/32 x 3 inch, 7/16 x 3 inch, 3/8 x 3 in. The sockets are electrically heat-treated for extra dura-

bility and hardness. A shock proof yellow plastic handle offers maximum safety and long life. The handle employing a positive spring action clutch, resists most acids and alkalies. Each of these kits is packed in a handy six-section leatherette case that fits into the pocket.

MICROPHONE

American Microphone Co.
Pasadena, Cal.

The American D 33 microphone has a 1-inch diameter head that provides full vision for artist and audience. Its

pickup is omnidirectional and no pre-amplifier is required. Weighing only 7 ounces, the D-33 is available in all popular impedances and is equipped with a Cannon Latch Lock plug and 25 feet of 2-conductor shielded microphone cable.

TAPE RECORDER

Amplifier Corporation of America
New York, N. Y.

The Magnemaster Consolette may be operated at 15 inches per second with a frequency response of 50 to 15 000 cycles; or at 7 1/2 inches per second with a response from 50 to 10,000 circles ± 2 db. After the reel has run through, the instrument automatically changes direction of tape travel and plays an equal length of time in the new direction. Thus continuous playing time of 30 minutes at 15 in. per sec. and 60 minutes at 7 1/2 in. per sec. is possible with the standard 7-inch diameter tape reels.

Separate sets of heads for record-erase and monitor permit monitoring off the tape while recording. The two-lever control tape mechanism has a non-slip non pinching drive and uses automatic compensating and self lubricating clutches. Synchronized brakes give instantaneous stop with no overshoot.

The 10-tube recording amplifier with supersonic bias oscillator and separate erase amplifier and 3.5 watt monitor playback amplifier has individual tone controls for bass and treble. Inputs are provided for radio phono and for high

or low impedence microphones. Input mixing circuits are optional. A 6E5 volume level indicator is built in and jacks are provided for connecting an external VU meter.

Output connections are provided for playback into a 500/600-ohm telephone line; external amplifier; external speaker; or through a self-contained 6 x 9 inch oval speaker.

The complete unit weighs 52 pounds and its dimensions are 17 inches wide, 17 1/2 inches high, and 17 inches deep.

BATTERY ELIMINATOR

Electronic Instrument Co.
Brooklyn, N. Y.

This 6 volt power supply kit, the model 1040 K, is designed for trouble shooting and demonstrating auto radios. It serves as both battery eliminator and battery booster and charger. Continuous rating is 10 amps at 5.8 volts, and intermittent rating is 20

amps. The output is variable from 0 to 15 volts d.c. A 10 000-μf capacitor provides the filtering. The rectifier has a full-wave bridge circuit using 4 heavy duty manganese copper-oxide rectifiers.

The meter on the panel measures both current and voltage, and for double protection the transformer primary is fused and its secondary has an automatic reset overload device. The kit is supplied complete with all parts and with comprehensive pictorial and schematic assembly instructions.

SOLDERING IRON

Palmer Manufacturing Co.
Woodside, N. Y. C.

The solderweld is a new instant-heat soldering device that operates on about 6 volts supplied by a battery or through a suitable transformer. The heat is generated between the two points of a split carbon electrode. Because it draws current only while actually soldering, the power consumption

of the iron is very low. The worn carbons may be replaced, and the tool needs no pre-heating, tinning, or filing. Its weight is 4 ounces.

LIGHTNING ARRESTER

La Pointe—Plascomold Co.
Unionville, Conn.

The VEE D-X 4 wire lightning arrester (RW-204) is now being constructed of high dielectric double phenolic. This

material, is for installation in accordance with the National Electric Code and is also approved by Underwriter's Laboratories (UL). The arrester is designed to accommodate 4-wire rotator line as well as regular 300 ohm transmission line.

ANTENNA MOUNTING

Insuline Corp. of America
Long Island City, N. Y.

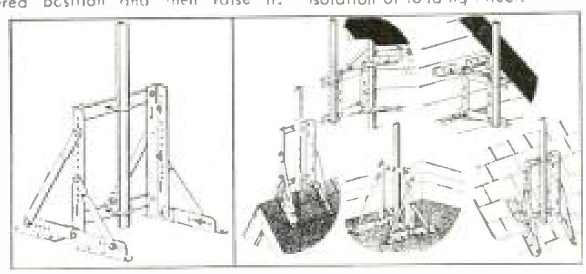
This new multi position TV antenna mounting adjusts to practically any position on a roof, parapet, side wall or corner of a building. It is constructed of cadmium plated, heavy gauge steel and is readily fastened in place with common leg bolts. Its pivoted design enables the antenna installer to insert the antenna in a lowered position and then raise it.

TV INPUT COUPLER

Brach Mfg. Corp.
Newark, N. J.

Designed to operate two TV receivers from one antenna this 2 set Coupler receives signals from either a 75 or

300 ohm antenna, filters out i.f. interference, and divides the signal to two receivers which may be either 75 or 300-ohm sets. The unit provides more than 20 db of isolation to local oscillator interference and complete isolation of loading effect.



Hi-Fi AM Tuner and Amplifier

PART I—A Variable Bandwidth AM Tuner

By D. V. R. DRENNER

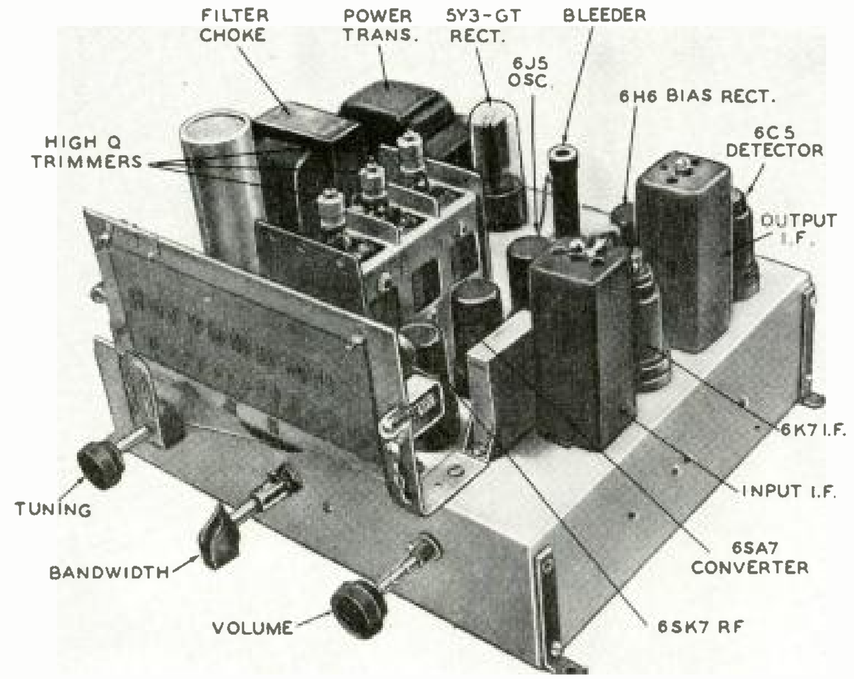


Photo of the AM tuner showing how the parts are laid out above the chassis.

MOST listeners still rely on standard AM broadcasts for the greater part of their radio entertainment. There is some pretty good fidelity in AM—if you have a tuner and an amplifier to reproduce it. Make the amplifier versatile by simply adding a selector switch and a bass control, and you can reproduce any hi-fi signal, whether AM, FM, or disc or tape recording.

This AM tuner doesn't depart from the conventional in too many respects. The superhet circuit, when it has variable-bandwidth i.f.'s, can pass all you'll get on the antenna, with little sideband cutting. Add a couple of other features and it will do a surprising job!

The schematic for this tuner (Fig. 1) shows some of these little additions which give it hi-fi at low cost—a feature most of us are interested in. For one thing, eliminating the conventional cathode bias on the r.f. and i.f. stages does away with numerous resistors and bypass capacitors. This makes a cleaner wiring job and reduces the over-all number of components. A bleeder voltage divider puts the correct voltage on plates and screens, confines the dissipated heat where it won't bother coils and impregnated parts, and adds to stability. To compensate for all the parts and money saved by this feature, separate decoupling networks are used in all plate and screen leads. But without them some serious common-impedance-coupling problems might arise, especially when the gain is rather high. The screens are run near their maximum voltage for just this reason—a compromise between high plate resistance and a high transconductance.

The diode detector was scrapped in favor of the infinite-impedance detector which is just as capable of handling large signals as the diode and which handles small signals with less distortion. The infinite-impedance detector is nothing but a cathode follower with a large cathode resistance to bias the tube almost to cutoff. This detector presents a very high impedance across the secondary of the last i.f. transformer so that there is no loss in Q as with a diode detector which has a relatively low impedance.

There we have the most important features of a good AM tuner. There are some others, like variable a.v.c., which we will mention.

The construction—whether it's on a new aluminum chassis, as the author's unit was, or on a well-baked cake pan—must be done carefully. The parts layout shown in the photos has short, direct leads, adequate separation of components and shielding, and gives stability in the r.f. and i.f. stages where it's really needed. And a hot r.f. stage can generate a lot of things beside a strictly class-A signal. The 6SK7 is used in the r.f. stage because it keeps the grid circuit where it belongs, down under the chassis with the antenna coil; and if the layout shown is followed, there should be no unwanted coupling between circuits. The 2,200-ohm resistors and the two 0.1-μf capacitors in plate and screen leads are decoupling units.

The converter uses a 6SA7. This tube has a higher gain at broadcast

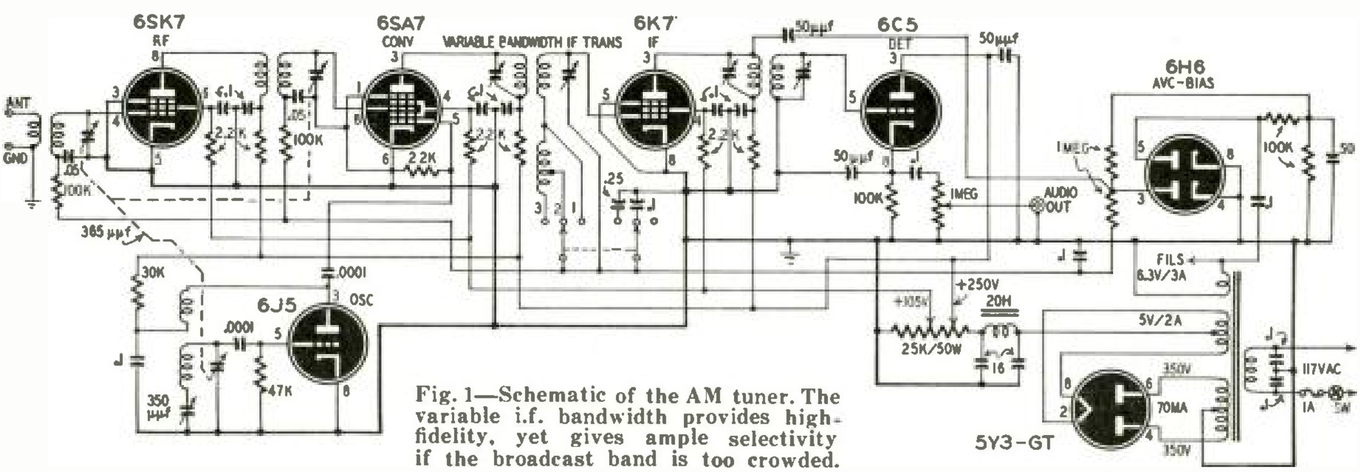


Fig. 1—Schematic of the AM tuner. The variable i.f. bandwidth provides high-fidelity, yet gives ample selectivity if the broadcast band is too crowded.

frequencies than similar converters because of a fairly high conversion transconductance and a high plate resistance. Because of its construction it is reasonably stable under a.v.c. conditions, and with a separate oscillator its operation can be further improved.

A separate oscillator tube (a 6J5 in this case) reduces the chances of frequency drift due to the a.v.c. action on the converter. At broadcast frequencies this may be splitting hairs, but the theory says it can happen even there. So as a refinement worthy of a good AM tuner, a separate oscillator it is! As in the r.f. stage, separate decoupling networks are used in the plate and screen leads.

The i.f. stage has the older type 6K7. This puts the grid lead above the chassis and away from the plate lead, and reduces the chance of regeneration. Although the shielding of the single-ended type tubes is good the 6K7 is better for the variable i.f. transformer used, since the grid lead is on the top of the can. And here we have another chance at getting some fidelity. The secondary of the input i.f. has a tapped auxiliary winding which broadens the selectivity curve and lessens the sideband cutting which otherwise would be rather severe when the i.f. is peaked. Other methods of doing this same thing use variable coupling between the two windings, but the result is the same—the top of the i.f. curve is broadened, and the skirts fall less sharply.

Following the i.f. stage is the 6C5 infinite-impedance detector. Since we need some a.v.c. voltage, which this detector can't supply, a separate tube, a 6H6, is used. This also provides a diode for the d.c. bias on the grids of the r.f., converter, and i.f. stages. One half of the 6H6 is fed through a 50-μμf mica capacitor from the primary side of the i.f. transformer. This voltage will be higher than that delivered to the grid of the detector, and will give delayed a.v.c. This a.v.c. voltage is fed through the 1-megohm resistor in the a.v.c. line, and then to the grids through their isolation resistors.

The R-C constant of the a.v.c. bus is made variable, along with the variability of the i.f. transformer. On position 1 of the bandwidth switch, the R-C constant is fairly short (0.24 sec.), so that the a.v.c. will follow normal moderately rapid fading. But as the bandwidth is increased (positions 2 and 3), the a.v.c. time constant is progressively increased, giving 0.36 and 0.66 sec. at maximum. This is necessarily long to give good bass response; but since the hi-fi broad position is normally used on local or other strong stations, this long R-C constant does not impair the a.v.c. action, such strong signals being usually fairly constant in level.

On strong signals the gain is reduced, of course, and the long time constant takes appreciable time to return the gain to its normal high level. For this reason, tuning with the bandwidth switch in BROAD position will give an almost dead response if you tune from a strong signal across the band, until you hit another strong signal or until the a.v.c. voltage falls and increases the gain. It's a kind of unintentional quench circuit, but not bothersome since tuning is normally done in the SHARP position.

Along with the a.v.c. voltage a fixed bias of about 3 volts is supplied from the other half of the 6H6, through the 0.1-μf capacitor coupled to the 6.3 heater voltage. The two 100,000-ohm resistors and the 50-μf electrolytic form a filter and divider network for this bias voltage, which is fed through a 1-megohm resistor to the a.v.c. bus. Thus, the proper bias is provided without the conventional cathode resistors, and there is no chance for the cathode to go more negative than the grids when a strong signal hits the grids.

When the tuner is completely wired, plug in the a.c. and connect a pair of phones to the audio output. The detector will provide a healthy signal for tuning purposes via phones if you haven't an amplifier handy.

If you've got a scope and sweep generator handy, aligning the i.f.'s is easy, and they'll have about 20-kc bandwidth in the BROAD position, and 10 kc or less in the SHARP position. Tracking and other alignment procedures are conventional.

Materials for Tuner

Resistors: 6—2,200, 1—22,000, 1—30,000, 1—47,000, 5—100,000 ohm, ½ watt; 2—1 megohm, ½ watt; 1—25,000 ohm, 50 watt, wirewound adjustable; 1—1 megohm potentiometer.

Capacitors: 3—50 μμf, 2—.001 μf, mica; 2—.05, 4—0.1, 1—.25 μf, 200 volt, paper; 10—0.1 μf, 600 volt paper; 2—16 μf, 450 volt, 1—50μf, 50 volt, electrolytic; 1—350 μμf trimmer; 1—365 μμf, 3-gang tuning.

Transformers and coils: 1—antenna; 1—r.f. interstage; 1—456 kc i.f. input with variable bandwidth; 1—456 kc i.f. output; 1—oscillator coil; 1—20-h, 70-ma choke; 1—350-0-350 v.a.c., 70 ma, 5 v at 2 amp, 6.3 v at 3 amp power.

Miscellaneous: 1—2-gang 3-position switch; 1—s.p.s.t. switch; tubes, sockets, chassis, fuse, fuse holder, dial, hookup wire, and assorted hardware.

Modulation Check at Receiver

By ERNEST J. SCHULTZ

"How is my modulation OM?" is asked of the average phone operator almost as often as the time-worn "How strong is my signal?" Few stations can give an answer which is more than a guess, but a few simple additions and modifications to existing communications receivers enables them to measure modulation percentage of a received signal.

The oscilloscope circuit diagrammed in Fig. 1 is all that is needed to complement a receiver and permit the operator to see the other stations' audio. The circuit is no different from that used in modulation monitors. The input of the oscilloscope is connected by a short lead to the plate of the last i.f. stage. When the i.f. transformer is repeaked to allow for any detuning, the job is complete. A buffer stage could be inserted between the oscilloscope and the receiver to provide isolation, but this is usually not necessary.

With the oscilloscope connected and the horizontal internal 60-cycle sweep adjusted for finely focused baseline, the familiar r.f. envelope appears when a signal is tuned in. The amplitude of the envelope depends on the strength of the received signal and the setting of the r.f. gain control. The envelope changes shape as the observed signal is modulated and the percentage can be calculated. The oscilloscope may be fitted with a transparent screen with ruled lines to aid calculation.

This method of checking modulation is identical with that used for testing transmitters. Information available in many textbooks and handbooks is applicable and a study of it is most helpful.

Owners of panoramic analyzers can easily modify their instruments to read modulation directly, using the same system. The analyzer is useful for determining band conditions at a glance; but when it comes to evaluating a single signal, the scope image is not very enlightening. The received signal automatically has its r.f. component removed and only the audio component with a d.c. component is applied to the scope. This can be remedied without disturbing the instrument's normal functions.

The simplest modification is to remove the 6SQ7 detector-d.c. amplifier tube and insert the leads of a .005-μf capacitor into the socket pins which go to the detector diode plate and triode amplifier plate. The capacitor connects

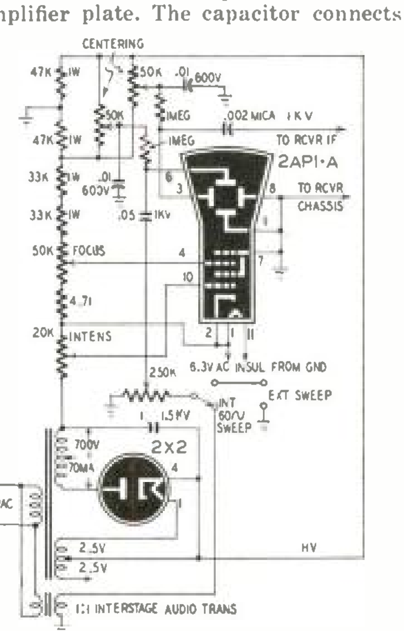
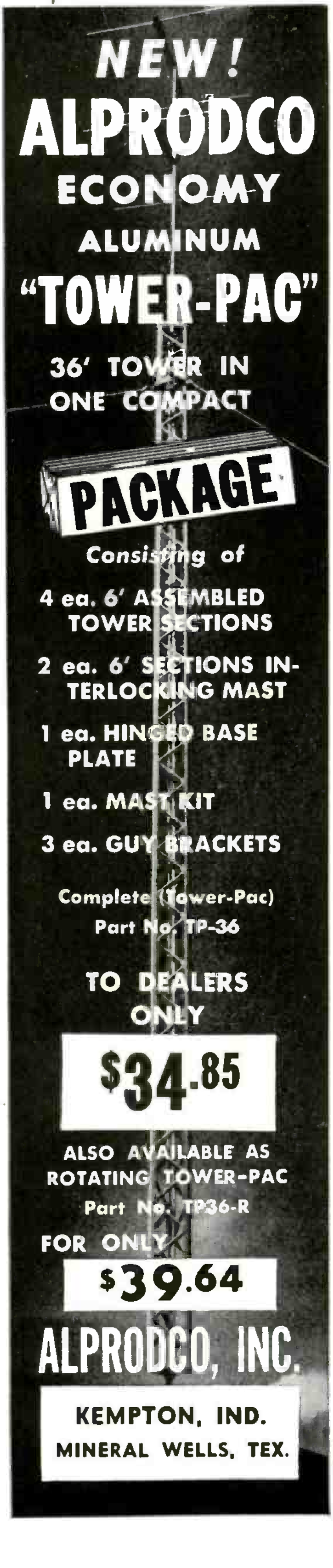


Fig. 1—Circuit of an oscilloscope for observing modulation at the receiver.



the i.f. signal directly to the oscilloscope tube, and the familiar wave envelope pattern is obtained. The analyzer's sweep control must be adjusted

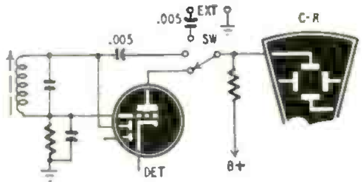
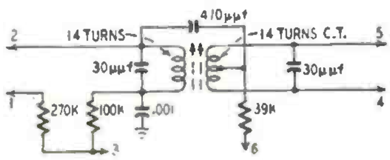


Fig. 2—The three-position switch and two .005 μf capacitors make the pan-adapter useful for modulation checks.

to zero and the frequency centering control adjusted for maximum envelope amplitude with a low setting of the sensitivity potentiometer.

FM RECEIVER ALTERATIONS

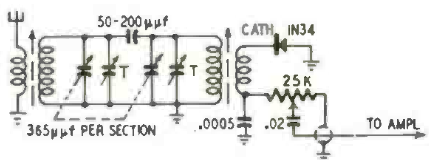
Mr. Robert C. Minnick reports that the performance of his FM receiver described in the March 1950 issue can be improved considerably by making a few changes in the discriminator cir-



cuit. Instead of using a capacitive center tap on the secondary of the transformer, he has center tapped the winding and has changed the coupling capacitor from 22 to 470 μμf.

ANOTHER CRYSTAL TUNER

This AM tuner performs well on the broadcast band when used with a high-fidelity amplifier and reproducing system. Because it has a crystal diode detector, and does not use vacuum-tube amplifiers, it does not require a power supply. The bandpass circuit consists of two slug-tuned, broadcast-band, an-



tenna coils connected back-to-back through a coupling capacitor which may be between 50 to 200 μμf. The secondary windings are tuned by a two-gang, 365-μμf tuning capacitor.

The tuner is aligned at the high end of the band with the 3-30-μμf trimmers and at the low end with the core slugs. The tracking is almost perfect with most coils. Some may require that a few turns be taken off one of the tuned windings.

Using the two antenna coils back-to-back gives this little tubeless tuner sufficient selectivity for use on the broadcast band, and the tuner output on local stations is enough to drive a high-gain audio amplifier.—*Leon Medler, W2YLB*

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resistor in the voice-coil circuit is 2/3 that developed at rated output. Connect a v.t.v.m. between the transformer center tap and ground and adjust the balance control for minimum voltage at the center tap. As a final check, measure the voltage on the grids of V1 and V2. Vary the balance control slightly to equalize the voltages on the two tubes.

If a v.t.v.m. is not available, connect high-impedance headphones between the center tap and ground and adjust the control for minimum signal.

The coupling transformer is not critical. The ratio of full primary to secondary should not be less than 1:1. The designer uses a step-up ratio of 1:3.

Use a high-grade output transformer for best performance. If it does not have a feedback winding, connect the feedback loop to one side of the voice coil winding and vary the value of the feedback resistor.

Some nonstandard resistor values are shown on the diagram; however, we see no reason why the nearest preferred values cannot be used successfully.

WIDEBAND AMPLIFIER EXTENDS VOLTMETER RANGE

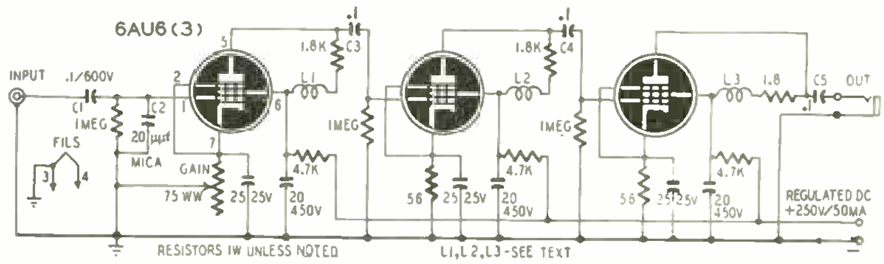
Designed to permit accurate reading on the low-range scale of a v.t.v.m., of a.c. or r.f. voltages of a few millivolts, this amplifier is described through the courtesy of Cornell-Dubilier Electric Corp.

The maximum gain of this instrument is 500 and its response is flat within 1½ db from 50 cycles to 4 mc. Its circuit is shown.

The instrument consists of three 6AU6's as video amplifiers. The input signal is applied to a coaxial connector, and the v.t.v.m. is connected to a phone jack at the output. Except for unusually small plate and cathode resistors and the peaking coils, there is little difference between this circuit and a resistance-coupled a.f. amplifier.

The peaking coils L1, L2, and L3 are somewhat critical in construction and physical placement in the circuit. Each consists of 52 turns of No. 31 enameled wire close-wound on a ½-inch Bakelite or polystyrene form. The inductance is approximately 24 microhenries. Mount the coils as far apart as possible and at right angles to each other to avoid magnetic coupling. C1 is a 0.1μf, non-inductive, 600-volt capacitor. C2 is a 20-μμf, silvered mica, compensating capacitor. C3, C4, and C5 are 400-volt, noninductive units.

No special shielding is required in the amplifier but it is advisable to have the power supply on a separate chassis. Place a heavy steel shield between them if both chassis are placed in the same cabinet. Twist the heater leads tightly and run them to the sockets by the most direct routes. Use miniature clamps to hold these leads close to the



chassis to prevent excessive radiation.

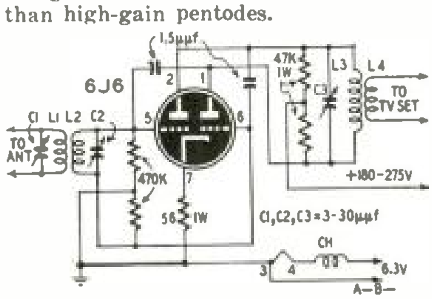
To adjust the amplifier, connect the v.t.v.m. to the output jack and set it to the 100-volt range. Connect to the input an accurately metered 0.1-volt a.c. signal of any frequency between 60 cycles and 4 mc. Adjust the gain control so the meter reads exactly 50 volts. Mark this setting of the gain control as ×500. With the same input signal, adjust the control so the v.t.v.m. reads 10 volts and 1 volt. Mark these points ×100 and ×10, respectively.

Set the v.t.v.m. to its lowest range—usually 0-1 or 0-3 volts—and apply an unknown voltage to the input terminals of the amplifier. Adjust the gain control to the calibrated setting which produces a readable indication on the meter. If the control is set at ×500, multiply the reading by .002. Multiply by .01 when it is set at ×100 and by 0.1 when at ×10. Thus when the meter reads 2.5 volts, the input voltage is 5, 25, or 250 millivolts when the control is set at ×500, ×100, or ×10, respectively.

Use shielded test leads at the input circuit and keep hands off them when making measurements. Use the shortest possible leads when measuring r.f. voltages.

LOW-BAND BOOSTER

I tried almost every TV booster in town in an effort to pull in WAGA-TV on channel 5 without snow. Most of them used 6AK5's which produced more snow while amplifying the signal. Unable to find a commercial booster that worked, I decided to construct one using triodes, which generate less noise than high-gain pentodes.



The push-pull booster described on page 64 of the March, 1949, issue looked like a good job. I decided to modify it for use on channels 4, 5, and 6. This circuit provides as much gain as two or three of the ordinary boosters and brings in WAGA-TV free of snow and with a good picture.

All coils are wound with No. 20 plastic-covered wire on ¼-inch forms. L1 and L4 are four turns each, interwound with the centers of L2 and L3, respectively. The latter coils have eight turns each. The heater choke consists of 12 turns of No. 20 insulated wire close-wound on a ¼-inch form.—*G. N. Manning*

TV BOOSTER COIL DATA

The channel 7 TV booster described on page 64 of the March, 1949, issue works better than any I have tried. It gives good performance on channels 2 through 7 when minor changes are made in the coils.

The inside diameters of the new coils are ¾ inch instead of ⅝ inch as in the original model. For channel 2, L1 and L4 have three turns and L2 and L3 have five. For channels 3 through 6, L1 and L4 have two turns and L2 and L3 three. Adjust the booster to the desired channel with the trimmers.

Physical size and placement of components are critical. It was necessary to add an extra turn to each coil on one channel 3 booster so that it would work properly.

Simple neutralizing capacitors for this booster can be made from the No. 18 plastic-covered wire used for the coils. Solder a 6-inch piece of the wire to pins 1, 2, 5, and 6 on the base of the tube. Twist wires 1 and 5 together to 3 or 4 inches, then twist leads 2 and 6 together for the same number of turns. Make sure that they are twisted so the two neutralizers resemble the letter X when looking down on the base of the tube.

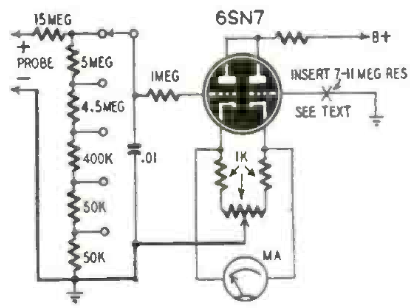
This booster is a little hard to tune until you get the hang of it. Afterward, you will be surprised at the results.—*Harold T. Hess*

CURING STICKY RELAYS

If a relay is noisy or will not break cleanly, place a small strip of masking tape between the armature and the pole piece. Scotch tape can be used as a substitute, but friction tape is not suitable because it is sticky on both sides.—*O. C. Vidden.*

STABILIZING THE V.T.V.M.

Many commercial and home-made vacuum-tube voltmeters show a shift in the zero point when the range is shifted. Particularly noticeable on the lowest range, this effect is caused by grid current flowing through the voltage divider which usually has a resistance of 10 megohms or more. Because the grid resistance is different for each range, the grid voltage will change accordingly and the zero will shift.



Some balanced vacuum-tube voltmeters are arranged to have the grid resistance constant. This is an improvement, but does not entirely eliminate the trouble because most circuits do not have a compensating resistor in the grid circuit of the balancing tube.

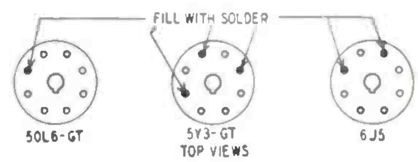
A typical unbalanced v.t.v.m. is shown in the diagram. Zero shift will be negligible if a suitable resistor is inserted at X in the grid return of the balancing tube. The value of this resistor will be approximately equal to the resistance between grid and ground of the active stage on the lowest range.

This resistance usually being moderately smaller than the 15-megohm probe resistance, the optimum value is likely to be slightly more than 7 megohms. This resistance is not critical, and 7 to 11 megohms should work nicely.—*Jacob Schacther.*

SALVAGING BROKEN TUBES

Constructors and experimenters often have on hand a few octal-based tubes which are practically useless because the key has broken off the base.

If the tubes have one or more pins missing from the base, fill the unused holes in the socket with solder. This permits the tubes to be seated correctly in the socket. The drawings show top views of sockets prepared for 50L6, 5Y3-GT, and 6J5 tubes.—*Dominic Angelo,* W9KGC.



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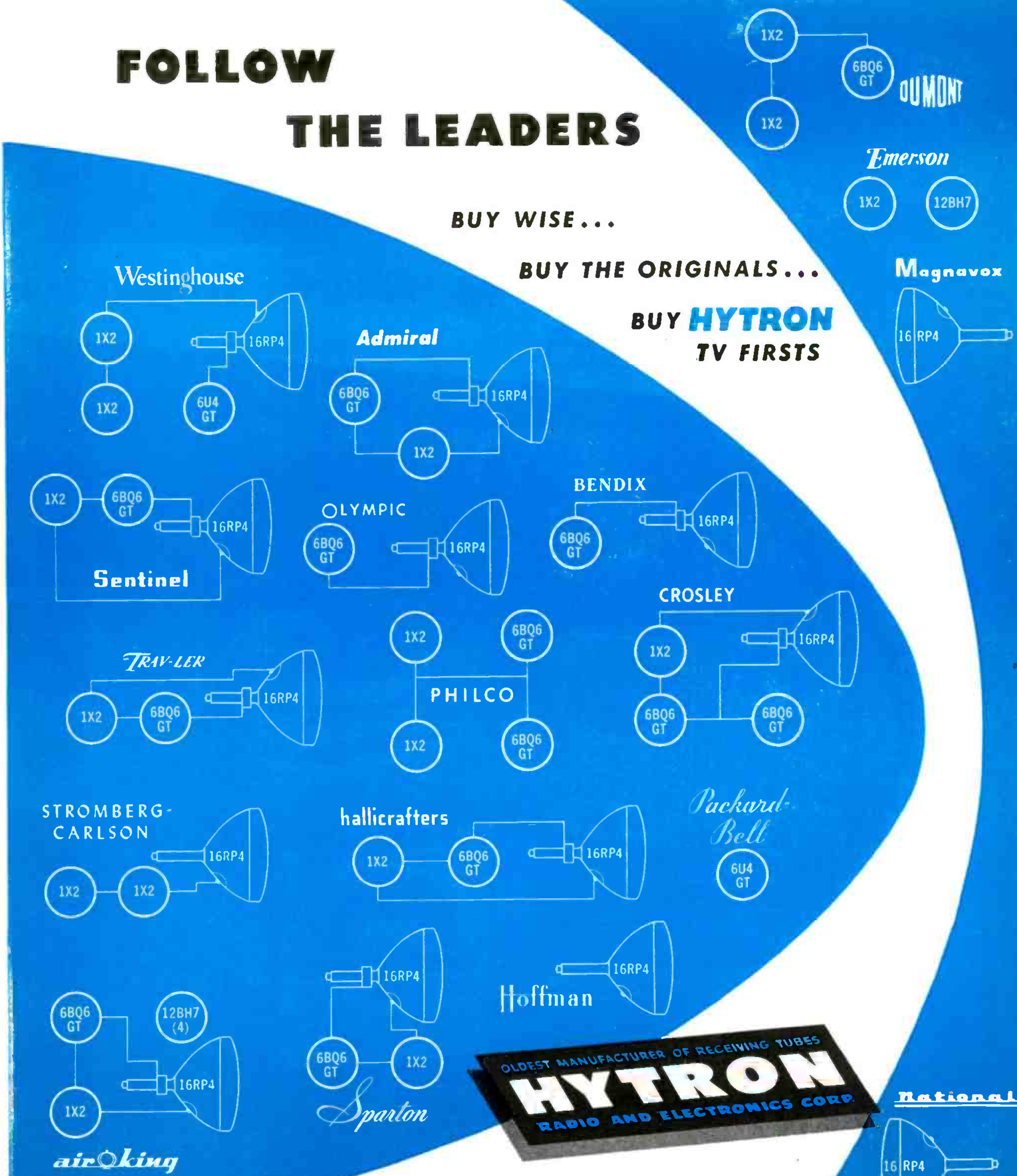

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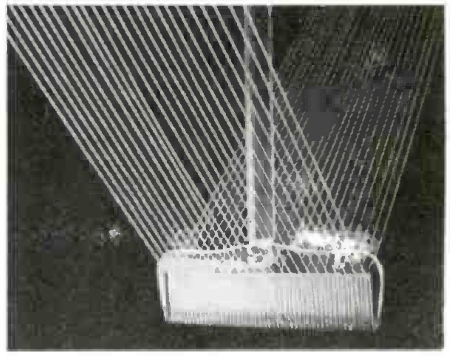
LOOP ANTENNA

The construction of a loop antenna can be simplified by fastening a 5-cent plastic comb to each end of each crossbar, as shown in the photo. These combs hold the wires securely and allow the turns to be spaced evenly, and the combs are good insulators. As shown, a hole can be drilled through the center of the handles of the combs so the combs can be secured to the ends of the crossbars with round-head machine screws, or the combs can be fitted into the slots cut into the ends of the



bars. The photo shows one corner of an all-plastic loop antenna using ½-inch diameter Lucite rods for the cross-members. If desired, the teeth can be shortened by clamping the combs in a vise and sawing through the row of teeth carefully.—*Arthur Trauffer*

SOLDERING IRON REGULATOR

A handy stand and automatic heat regulator for a soldering iron can be made from a small chassis, a flush-mounting duplex outlet, a small tin can, and a surplus Fenwall Thermoswitch.

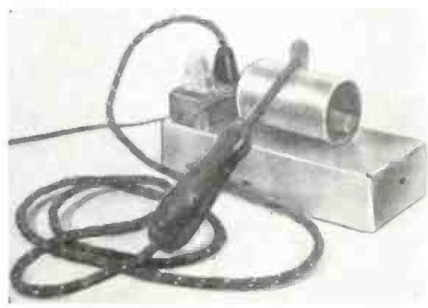
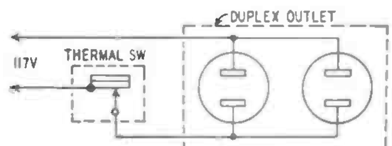


Photo of the soldering iron regulator.

The switch is tacked to the inside of the can with silver solder or a solder having a higher melting point than that normally used. The switch and outlets are wired as shown in the diagram. A neon-type night light is plugged in one side of the outlet as a tell-tale.



The automatic heat regulator circuit.

The switch has a wide range. It works best when set to cut off the current just below the melting point of radio solder. This adjustment is made with the iron *inside* the stand and next to the switch.—*Reid C. Simpson, Jr.*

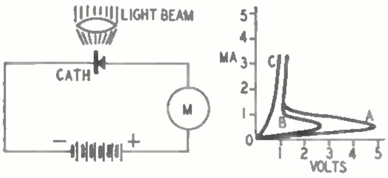
GERMANIUM PHOTOCELL

Patent No. 2,505,633

Randall M. Whaley, W. Lafayette, Ind.

(assigned to Purdue Research Foundation)

Under special processing, germanium can be made sensitive to light and heat. First the germanium is alloyed with nitrogen under pressure at high temperature to produce N-type semiconductivity; at certain points the alloy will conduct if it is *negative* with respect to a metal contact on it. If the alloy is further heat-treated in vacuum, P-type regions appear in addition to the N-type ones. At a P-type point the alloy conducts when it is *positive* with respect to a metal contact.



If a catwhisker contacts the alloy at a point between an N-type and a P-type region, the germanium becomes sensitive to light or heat. Typical characteristic curves are shown. If the alloy is kept in the dark at 25 C, curve A is obtained. At a temperature of about 50°C, B is typical. In both cases the voltage increases as current rises from zero. Then a "trigger peak" is reached and the curve shows an abrupt change to a negative resistance portion. Finally, the curve again shows a positive resistance, with current and voltage increasing together.

If the temperature is raised to about 100°C, curve C shows the operating conditions. In this case the trigger peak is not present.

Similar curves are obtained if the temperature is held substantially constant and various light beams are focused on the catwhisker contact. For example, curve A shows conditions in the dark at 25°C. When white light of about 0.5 lumen/sq. cm. falls on the catwhisker contact, curve B is obtained. C shows the result when about 2 lumens/sq. cm. falls on the contact.

To operate a heat- or light-sensitive germanium element, it is connected in a circuit in series with a relay and a battery. The alloy is biased so the operating point is close to the trigger peak. When light or heat is applied, this peak disappears and the circuit current increases. A current rise of 500 times has been obtained.

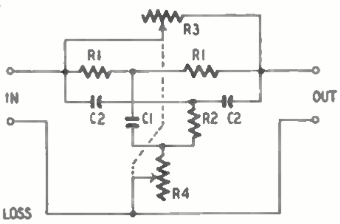
PARALLEL-T NETWORK WITH ADJUSTABLE LOSS

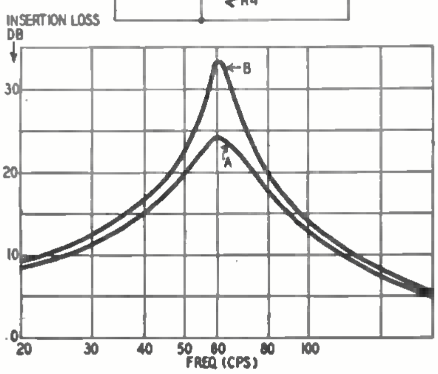
Patent No. 2,503,540

Herbert W. Augustadt, West New Brighton, N. Y.

(assigned to Bell Telephone Labs, Inc.)

Issued to the same inventor who designed and patented a parallel-T network in 1938, this patent is an improvement of that circuit. The original circuit had no control over attentuation (which was theoretically infinite at the resonant frequency). The newer circuit is more flexible, since it permits adjustment of the maximum loss.





The figure shows that the new invention is a conventional parallel-T (as disclosed in 1938) except for R3 and R4. In the original design R3 was infinite and R4 was zero. The components R1, R2, C1, and C2, were related as follows:

$$R1 \cdot C1 = 4 \cdot R2 \cdot C2$$

and the resonant frequency was

$$\frac{1}{\pi \cdot R1 \sqrt{2 \cdot C1 \cdot C2}}$$

If the product R3 x R4 is equal to

$$\frac{2 \cdot R1^2 \cdot R2}{R1 + 2 \cdot R2}$$

the resonant frequency is unchanged but the maximum loss is reduced. Curves A and B show how the attenuation varies. The value of R3 is smaller in A than it is in B. R3 and R4 may be ganged for adjustment but their product must remain constant to prevent change in resonant frequency.

The new circuit should be designed in two steps. First, a conventional network is built for the desired frequency. Then R3 and R4 are added to reduce the maximum loss.

ELECTRONIC ORGAN

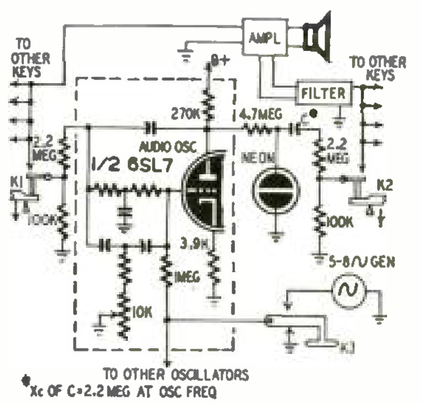
Patent No. 2,506,723

Merwin J. Larsen, Villa Park, Ill.

(assigned to Stromberg-Carlson Co.)

The harmonic content of a sound determines its tone quality or timbre. For example, a flute generates almost pure sine waves while brass instruments generate mainly odd harmonics. Other tone effects are produced by instruments which inherently strengthen or weaken certain harmonics or the fundamental. An electronic organ can be designed to control harmonics of its output to give the desired tone quality.

This instrument shows a simple method for controlling tone quality. Each note is generated by a parallel-T oscillator which has nearly pure output. Audio voltage is fed through to an amplifier and speaker when key K1—shown at the left of the diagram—is depressed. Leads from other oscillators and their keys carry different musical notes to the amplifier.



The oscillator output also passes through a 4.7-megohm limiting resistor and a neon lamp. The B-supply voltage is insufficient to ignite the lamp, but when the audio wave polarity aids the d.c., the lamp breaks down. This heavily distorts the sine wave and introduces harmonics. Only alternate half-waves ignite the lamp since the others have a polarity which opposes the d.c. Therefore key K2 controls a tone which possesses *all* harmonics because the positive and negative halves of the output waves are different. An unsymmetrical wave must contain even as well as odd harmonics.

A very-low-frequency generator is controlled by K3 to modulate the audio oscillators and produce a vibrato effect when desired.

For tones containing odd harmonics only, the audio wave must be symmetrical. Therefore a second neon lamp must be used so that distortion is produced on both halves of the sine wave.

CAPACITOR TESTER

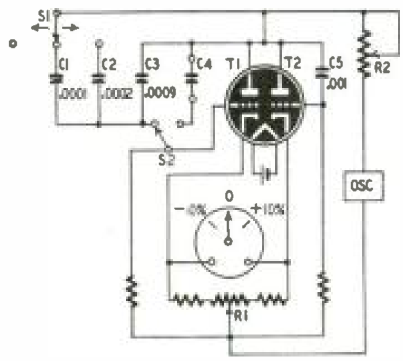
Patent No. 2, 507,324

Frank G. Taborsky, Maywood, Ill.

(assigned to Western Electric Co.)

Production tests of radio parts must be made quickly and accurately. The actual value is generally unimportant, but the component must be within specified tolerance. For example, a capacitor may have a tolerance up to 10%, of marked value.

The test set is simple. An oscillator supplies the plates of the double triode and conduction takes place during positive half-cycles. A capacitor, connected across grid and plate of each triode, and the grid leak form a voltage divider across the oscillator. The grid voltage is determined by the size of the capacitor. If the capacitance is increased, there is less reactance between grid and plate and these elements approach the same potential. A larger capacitance results in greater cathode current.



The figure illustrates a case where capacitors have a tolerance of 10%. The standard capacitance C5 has a value of .001 μf, equal to the nominal capacitance of the units to be tested. C3 is 10% less than C1. To calibrate the test set, S2 is thrown to the left and S1 is set to contact C1. Then the same capacitance (.001 μf) is connected in each triode circuit and, if other conditions are exactly the same, both cathode currents will be equal and the meter will indicate zero-center. If it does not, R1 is adjusted to equalize the circuits.

Now S1 is switched to the open tap, leaving only .0009 μf across T1. This is 10% less than the value across T2 so the meter will deflect in one direction. This point on the meter scale is marked −10%. Then S1 is thrown to contact C2. The meter will show a reverse deflection equivalent to +10% and the point may be so marked. The extent of these deflections depends upon the setting of R2, the sensitivity control.

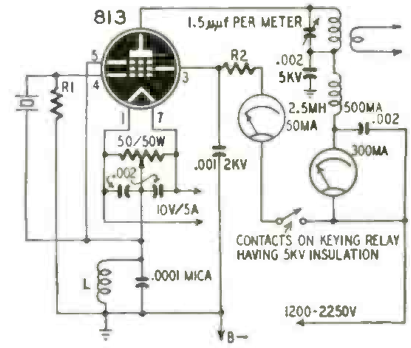
For production tests, S2 is thrown to the right. Each test unit C4 is connected in turn. If the meter needle stays within the marked limits, the capacitor is acceptable. It is good practice to check the test set calibrations periodically.

Improved radar, developed by the United States Navy, will reduce the threat of schnorkel-equipped submarines. The schnorkel is a small breathing tube which permits the submarine to stay submerged indefinitely. The top of the tube is so small that the old-type radar equipment had little chance of picking it up. The new radar, to be carried by Navy patrol planes, can detect the schnorkel with ease.

HIGH-POWERED OSCILLATOR

? *Years ago when the 813 was first introduced by manufacturers, you published a circuit of a crystal-controlled oscillator using this tube. Please reprint this circuit.—L. F. H., Pittsburgh, Penna.*

A. This circuit can be loaded to draw 485 watts and will deliver approximately 375 watts to the antenna when the plate voltage is 2,200 and plate current is 220 ma. It will deliver approximately 170 watts with 1,250 volts at 180 ma on the plate. Screen inputs are 400 volts at 40 ma and 300 volts at 35 ma for 375 and 170 watts output, respectively.



This circuit should *not* be used with harmonic-type crystals. Use a 500-watt, single-ended tank coil and select the tuning capacitor for the lowest frequency you plan to work. Its capacitance should be approximately 1.5 μμf per meter and its spacing sufficient to handle twice the plate voltage. The screen dropping resistor R2 will depend on the plate voltage. Screen currents are 35, 30, 45, and 40 ma for plate voltages of 1,250, 1,500, 2,000 and 2,250, respectively. The grid resistor R1 should be 6,000, 7,500, 12,000 and 10,000 ohms for the plate voltages as listed above. This resistor should be a 10-watt noninductive type.

Cathode coil L is wound on a 1½-inch form, the number of turns depending on the frequency of the crystal. Use 32 turns of No. 22 close-wound for 160 meters, 9 turns of No. 22 spaced to 1 inch for 75, and 6 turns spaced to ⅝ inch for 40 meters.

This circuit can be used for 814's, 4E27's, 4-250A's, HK257's, and similar husky pentodes and tetrodes if the grid and screen resistors are adjusted for proper operating conditions as given in tube manuals.

CONVERTER AND FM ADAPTER

? *Please print circuits of a crystal-controlled converter and an adapter for FM. I want to receive 31.34-mc emergency transmissions on my automobile radio.—R. G. W., Marion, Mass.*

A. The crystal-controlled converter is shown in Fig. 1 and the FM adapter in Fig. 2. A 30-mc antenna is coupled to the input of the 6K8 converter tube through a 30-mc antenna coil tuned by a standard single-section, 365-μμf capacitor or padder. The crystal frequency of 29.84 mc is selected so the 31.34-mc signal will be received when your receiver is tuned to 1500 kc. The crystal should be the overtone type manufactured for 10-meter transmitters. The oscillator tank coil L1 consists of approximately 12 turns of No. 22 enameled wire close-wound on a National XR-50 form or equivalent. C1 may be a 25-μμf fixed or variable

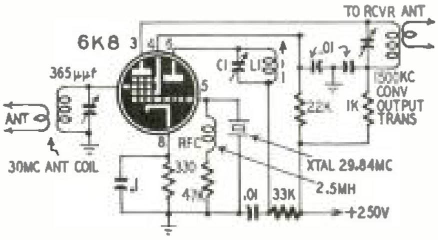


Fig. 1—Crystal controlled converter.

capacitor—the latter type is preferable. The output transformer is a Miller type 512-WT or equivalent. The output of this transformer feeds into the antenna of the receiver.

Tune the oscillator coil by adjusting its slug and the value of C1 for minimum plate current to the triode plate. Apply a modulated 31.34-mc signal to the input of the converter and tune the input and output circuits for maximum output from the receiver. Signals between 30.39 and 31.34 mc can be received by tuning the receiver between 550 and 1500 kc.

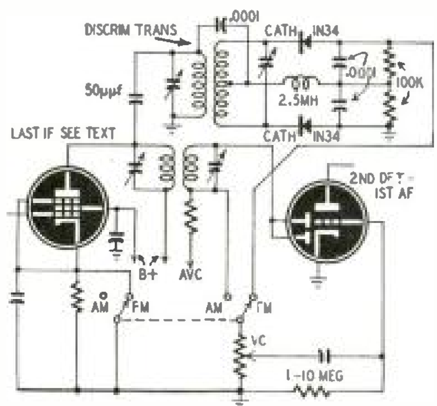


Fig. 2—The circuit of the FM adapter.

The FM adapter uses a 456-kc full-wave output transformer or a special discriminator transformer National type SA-4842 and 1N34's as the discriminator. Replace the last i.f. tube with its sharp-cutoff equivalent—a 6SJ7 if your set has a 6SK7. The FM-AM switch shorts the cathode resistor in the i.f. stage, thereby making the tube work as a limiter. For further information on this type of circuit, refer to the article "Narrow-Band FM for Ham Radios" in the July, 1947, issue of RADIO-CRAFT.

CROSSOVER NETWORKS

? *I have two 8-ohm speakers which I want to connect to a crossover network designed from data given on page 83 of the April issue. As I see it, the speakers will be in parallel so they should be connected to the 4-ohm tap on the output transformer. Am I right? I would also like to know why electrolytic capacitors should not be used in the networks.—H. K., Marion, Kan.*

A. The speakers are not in parallel because of the filter network between them. The network is designed to have an input impedance which is a constant or nearly constant resistance equal to the impedance of the speakers and the secondary of the output transformer. The product of the speaker impedances should equal the square of the transformer's secondary impedance.

Electrolytic capacitors have a high resistive component which will be effectively in series with the speaker voice coils, thus resulting in a power loss. They require a d.c. polarizing voltage if they are to maintain their rated capacitance. Also, tolerances in electrolytics are too great to permit their use in networks which require close tolerances for optimum operations.

ADDING A PUSH-PULL STAGE

? *I have a model T-64 RCA receiver which has a single-ended 6F6-G output stage. I would like to convert this stage to push-pull if the added drain is not too much for the power transformer. Please show a simple transformerless circuit for adding the push-pull stage.—F. G. M., Eagle Pass, Texas.*

A. The circuit of the audio section of the T-64 is shown in Fig. 1. Fig. 2 is

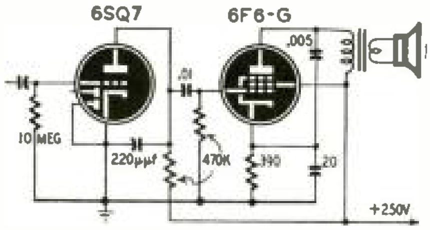


Fig. 1—The audio circuit of the T-64.

the corresponding circuit of an RCA model QU2C receiver. The 6AD7 is a triode and power amplifier pentode in a single envelope. The pentode section is equivalent to a 6F6. The triode section is designed as a phase inverter to drive the push-pull stage.

The maximum-signal cathode current for the 6F6 in Fig. 1 is approximately 44 ma. The maximum-signal cathode current of the push-pull stage in Fig. 2 is approximately 53 ma. If the power transformer in the set is not already operating at top capacity, the added drain should not cause overheating.

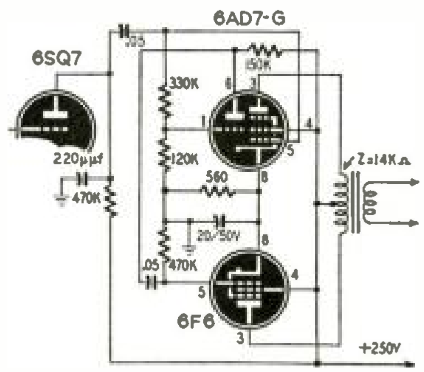


Fig. 2—Circuit of the push-pull stage.

Replace the output transformer with a 10-watt size having a 14,000-ohm, center-tapped primary.

PUSH-PULL FEEDBACK

? *I have several high-quality output transformers which have tertiary feedback windings. Please show how these windings are used to apply feedback to various types of circuits.—E.N.H., Brooklyn, N. Y.*

A. Figs. 1 and 2 show how feedback can be applied around a transformer-coupled power amplifier. T1 may be an input, driver, or interstage transformer; T2 is a push-pull output transformer with a tertiary feedback winding; and T3 is a filament transformer having a separate heater winding for each directly heated power-amplifier tube.

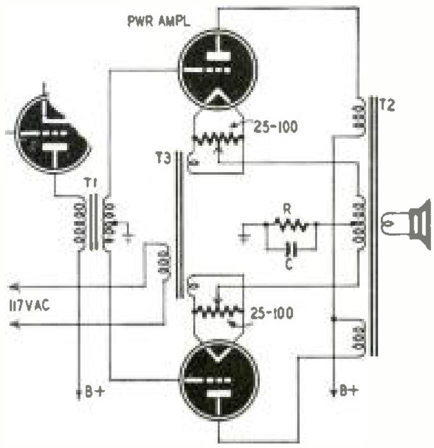


Fig. 1—Filament tube feedback circuit.

Fig. 1 is used with directly heated (filament-type) tubes. T1 may be replaced by conventional resistance-capacitance coupling if the power amplifier is operating class A and the speech-amplifier tubes deliver sufficient voltage. Low-resistance potentiometers are connected across each filament winding and to the outside leads of the feedback winding. These are adjusted for minimum hum. The cathode biasing resistor R and its bypass capacitor C are connected between ground and the centertap on the tertiary.

If you use a driver transformer having a split secondary, connect the feedback loop as shown in Fig. 2. In this

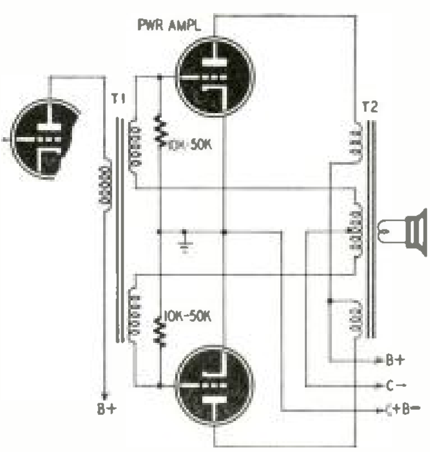


Fig. 2—Feedback applied to the grids.

type of circuit, a single heater winding can be used for both directly heated tubes. The centertap of the filament winding can be grounded and fixed bias applied through the centertap on the feedback winding.

Cathode-type tubes can also be used in the circuit in Fig. 2. The circuit is shown for fixed bias. Cathode bias can be used by grounding the cathodes through a biasing resistor and grounding the centertap on the tertiary.

Use the circuit in Fig. 3 if the feedback is to be applied around two push-pull stages. Resistance-capacitance coupling is shown but transformer coupling can be used. Feedback voltage is applied to the cathodes of the drivers through resistors R. The value of these resistors depends on the amount of feedback desired, the characteristics of the driver tubes, and the amount of feedback voltage supplied by the winding.

If the driver tubes have a common cathode or a common cathode resistor, feedback can be applied to the driver grids. The centertap of the tertiary should be grounded and capacitors of approximately .01 μf inserted between the series resistors and the outside leads to the tertiary. If feedback is to be applied to the power amplifier alone, connect the ends of the feedback loops directly to the power amplifier grids. Series capacitors should be inserted and the centertap grounded as when applying feedback to the grids of the driver tubes.

In some cases it may be desirable to add feedback from a push-pull output to the single-ended input of an amplifier having three stages. To do this, ground one side of the feedback winding and connect the other side either to the grid circuit or the cathode circuit of the input stage through a suitable resistor. The size of the resistor depends on the amount of feedback desired.

Usually it is not advisable to carry the feedback around more than three stages because instability is likely to result at either the high or the low end of the amplifier response. In general, negative feedback adds to the stability of the circuit, but the coupling circuits of several stages may add enough phase shift that the feedback becomes positive at either the high or the low frequencies.

Reverse the connections to the feedback winding in all these circuits if the amplifier breaks into oscillation.

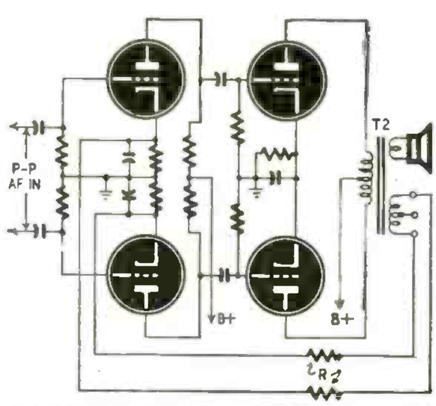


Fig. 3—Feedback applied to two stages.

TVI PROBLEM

? *My TV receiver is a G-E model 810. When it is tuned to channel 7, I have severe interference from channel 11 in the form of dark wavy lines which completely wipe out the picture. Reception on channel 7 is perfect when channel 11 is off the air. What causes this and how can it be cured? F. R., Pawtucket, R.I.*

A. Most likely one or more of your neighbors has a Motorola receiver using a TS-14, -18, -23, or -52 chassis. These sets have the local oscillator below the carrier frequency on channels 7 through 13. The oscillator is tuned to 176.15 mc for reception on channel 11. It radiates a signal which falls on channel 7 (174 to 180 mc) and produces interference which varies from a slight herringbone to a complete picture blankout.

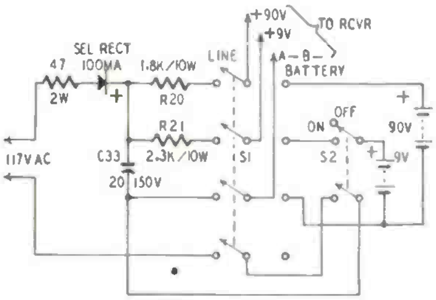
If you are able to locate the offending set or sets, the owner or owners should be advised to return the set to the distributor or Motorola service technician. The tuner will be modified to prevent this trouble at no cost to the set owner.

When these Motorola receivers are tuned to channels 13 or 12, they radiate signals which can cause interference on channels 9 and 8, respectively.

SELENIUM RECTIFIER CIRCUIT

? *I would like to use a selenium rectifier in place of the 117Z3 in the circuit of the portable three-way receiver in Fig. 15-2 in the RCA Receiving Tube Manual RC-15. Please show how this is done.—K. M., Bronx, N.Y.*

A. The circuit is shown. It may be necessary to increase the value of R21

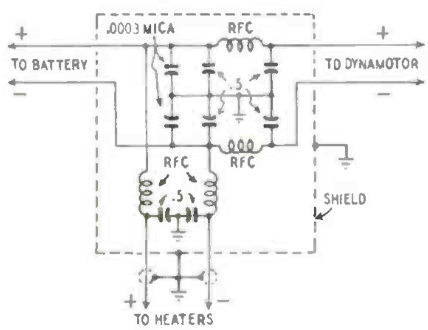


so the voltage applied to the filament string does not exceed 9 volts under load. We suggest using a 2,500-ohm, 10-watt resistor with slider in this position. Codes on the components correspond to those in the original circuit.

CURING DYNAMOTOR WHINE

? *I am using a surplus 6-volt dynamotor to supply 300 volts d.c. to a small receiver. When I use a common battery for the dynamotor and the heaters, I hear nothing but a very annoying whine. I do not have this trouble when I use separate batteries. What causes this condition? I've tried connecting a 10-henry choke and 10-µf filter capacitor to the positive and negative sides of the high-voltage line. Nothing helps. What is wrong and how can I eliminate the trouble?—L. V. L., Marseilles, Ill.*

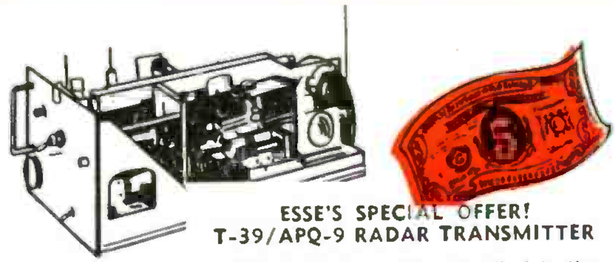
A. Most likely the dynamotor whine is entering the receiver circuits through the heater leads. The first step is to re-



duce the hash as much as possible by cleaning the brushes and commutator. Construct a small r.f. filter as shown in the diagram and install it close to the dynamotor. The r.f. chokes may be 20 turns of No. 12 insulated wire close-wound on a ¾-inch form. The filter should be installed in a small metal box or shield can. Try connecting it to a good ground. Use heavy leads in the 6-volt circuit to minimize voltage drop.

The copper of the commutator bars wears faster than the mica which separates them. If the copper is worn, carefully cut down the mica so that it does not stick up above the level of the copper. This will help to reduce noise.

MIX BUSINESS WITH PLEASURE



ESSE'S SPECIAL OFFER!
T-39/APQ-9 RADAR TRANSMITTER

This is the transmitter described in the February "CQ" for conversion for the 420-450 Mc. Amateur band and is now being subjected to approval by the F. C. C. for the 465 Mc Citizen's band. The oscillator has excellent frequency stability. Two-way communications for distances of 22 miles have been reported.

If conversion is not desired, the transmitter contains many excellent parts for the VHF experimenter such as a cavity oscillator using 2—RCA 8012 tubes rated at full output to 500 Mc. Tubes are forced air cooled by 24 V. DC motor which is easily converted for 110 V. AC operation. Other valuable parts such as switches, potentiometers, gears, revolution counter, etc., make this an offer not to be repeated.

(8012 tubes only, incl.)

PRICE **$5.00**

PP51/APQ-9 POWER UNIT .... $1.50 Ea.

Used for operation of above unit. Contains 2—4 Mfd. 1000 V. cond., 2—1 Mfd. 1500 V. cond. Transformers, power resistors, etc. A useful Item for parts or in conversion of above unit for amateur use. Unit complete except tubes.

$1.50

CO-AXIAL CABLE

RG- 8/U 52 Ohm .... $8.95 per 100'
RG-21/U 53 Ohm .... 5.95 per 100'
RG- 7/U 90-105 Ohm 5.95 per 100

BC-342 RECEIVER

Covers 1,500 to 18,000 Kc. Crystal filter. 110 V. 60 cycle operated. Complete with 9 tubes with 2 RF stages, mounting rack.

PRICE, NEW $125.00
USED 80.00

AIRCRAFT GYRO HORIZON, $4.50

Here is an expensive instrument used on aircraft, at a fraction of its value. These instruments just as removed from aircraft.

PRICE **$4.50**

AMPHENOL 16S-4 CONNECTOR

Both sections—chassis socket AN3100 and cable plug AN-3106 included. For two No. 16 wires. 35c

COMPLETE, NEW **35c**

RADIO KNOB ASSORTMENT

25 knobs, ALL NEW, $1.19

Consists of following knobs, all for 1/4" standard radio shafts. All are set screw type, some with double set screws.
5—Black Pointer knobs 1 3/8" in dia.
5—Gray Plain knobs 1 3/8" in dia.
5 Gray Pointer knobs 1 3/16" in dia.
5—Black Plain knobs 1" in dia.
5—Black Pointer knobs with the word audio 1 1/8" in dia.

Kit of 25 **$1.19**

F

BLEEDER RESISTOR

160,000 Ohms, 200 Watts. HV type for clip mounting. 1 1/8" dia., 11 1/2" long. 35c

$190.00 per Thousand

NEW **35c**

91-MC3M AMPHENOL MIKE PLUG

Has three male contacts chrome plated.
NEW .... 25c ea.
100 or more .... 19c ea.

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110 V. VENTILATING FAN ... $14.95

Ideal for kitchen ventilators, etc. Enclosed explosion-proof motor. Built for rugged, trouble-free requirements. Specifications: Maximum dimensions 12 1/4" dia. x 7 3/4". Input voltage 80-110 V. AC. Frequency 50-60 cycle single phase. Rmp. 1550 at 110 V. AC. Finish, 1 coat Navy gray Gyptal over 1 coat of zinc chromate primer. (New.)

PRICE **$14.95**

115 V. 60-CYCLE SELSYN INDICATOR UNIT

Type XV Selsyn contained in this unit, making an ideal beam position indicator. Mount into your control console by cutting 6 1/2" square hole and fastening by 4 corner screws through holes in panel. Scale is calibrated 0-360 degrees. By use f another Selsyn on the beam and a suitable relay connected to your beam motor, you have but to set the position desired on the calibration and the beam will stop when reaching the correct set position. Unit has self-contained 6.3 V. transformer for illumination of scale at desired brightness by rheostat adjustment provided on front panel. Size 6 3/4x6 3/4x8 3/8".

PRICE, While Small Stock Lasts **$9.50**

BC-312 RADIO RECEIVER

1,500 to 18,000 Kc. operation. 110 V. operation.

PRICE, USED $80.00

PNEUMATIC DRILL $8.95
Model D No. 301. Manufactured by Chicago Pneumatic Tool Co. Good used condition.

PRICE **$8.95**

We are especially interested in any factories, dealers or other outlets, giving us a list of surplus electronic equipment that is for sale in large quantities, so that we may submit our bid.

TERMS
Cash with order for quick shipment or 1/3 cash with order, balance C.O.D.

No order under $2.00 accepted due to these special price concessions.

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OUTPUT TRANSFORMER 39c

For 12,000 Ohm plate to B+ single ended 7B5 or equivalent at 10 Ma.

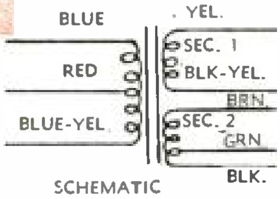
Sec. 200 Ohm headset at 50 Milliwatts level.

Dimensions: 1 5/16"x1 1/8"x1 13/16".

Vacuum impregnated with varnish.

Wire lead lengths 3½" to 9½" stripped and tinned.

9G1006 — BRAND NEW **39c**

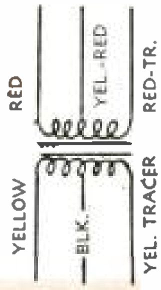


SCHEMATIC

VIBRATOR POWER TRANSFORMER

Manufactured for Harvey-Wells for use in aircraft transmitters. These are brand new quality merchandise. Dimensions 2⅝"x2½"x2 3/16". Secondary consists of 3320 turns No. 34 wire center tapped. Primary 6 V. consists of 54 turns No. 16 or larger center tapped. Pri. 12 V. consists of 126 turns No. 20 or larger center tapper. Core 1" stack with electrostatic shield between windings. Will deliver 300 V. 65 Ma. with 4.6 Amp. at 6 V. input, or 1.8 Amp. at 12 V. input.

C-8075—2 6 V. .... 85c ea.
E-8075—1 12 V. .... 49c ea.



MODULATION AND OUTPUT TRANSFORMER 50c

Transceiver transformer originally manufactured for Harvey-Wells aircraft transceivers.

Notes: Pri. 10,000 Ohms P-P, push-pull 7C5's or equiv. 79 Ma.

Freq. 300-3000 CPS.

Sec. 1—6000 Ohm 50 Ma. DC modulation wind.

Sec. 2—200 Ohm .5 Watt level tapped at 3.2 Ohm 3 Watt level. Used in 3 modes of operation:

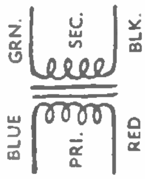
1. Pri. 2—7C5's Sec. 1 6000 Ohm lead Sec. 2 open.
2. Pri. 2—7C5's Sec. 1 open Sec. 2 3.2 Ohm load.
3. Pri. 2—7C5's Sec. 1 open Sec. 2 200 Ohm load.

Transformer vacuum impregnated with varnish.

Dimensions: 2 13/16"x1⅝"x1¾".

Wire leads approx. 4-6" long.

9D1003 — BRAND NEW **50c**



FAMOUS MAKE AC MOTOR STARTING CAPACITORS

Here's a chance to stock practically a full line of motor starting capacitors at very little money. Stock is clean and fresh, guaranteed quality merchandise.

Application: These capacitors are for use in starting AC capacitor type motors and replacement wherever motor capacitors are used.

ROUND TYPE:

Catalog No.	Mfd.	Volts AC	Size (Dia. x L.)
MSU121	26	110	1⅜x2¾"
MSU122	32	110	1⅜x2¾"

RECTANGULAR TYPE:

Catalog No.	Mfd.	V. AC	Size (W. x L. x H.)
MSG220	32	110	2 x3½x3½"
MSG221	53	110	2 x3½x3½"
MSF224	86	110	1¼x4½x4½"
MSF227	108	110	1¼x4½x4½"
MSF229	124	110	1¼x4½x4½"
MSG230	145	110	2 x3½x3½"
MSG231	161	110	2 x3½x3½"
MSF232	161	110	1½x4¼x4¼"
MSG250	26	220	2 x3½x3½"
MSG251	32	220	2 x3½x3½"
MSF252	32	220	1¼x4½x4½"
MSG253	43	220	2 x3½x3½"

PEC-181 RECTIFIER — BRAND NEW

The PEC-181 rectifier is a tube rectifier designed for float charging a lead-acid battery of 57 cells or may be used to supply current without connection to a battery. Conversion of AC supply line current to direct current is accomplished by means of two CE-306 grid controlled gas rectifiers. A constant voltage section is employed to maintain uniform filament voltage to rectifier tubes. Output voltage is controlled by means of a 6F6G Amp. tube and a 313C voltage regulator tube. The output current is limited to a selected max. value (7.5 Amps.) by means of a small gas filled thyratron tube, type 2050.

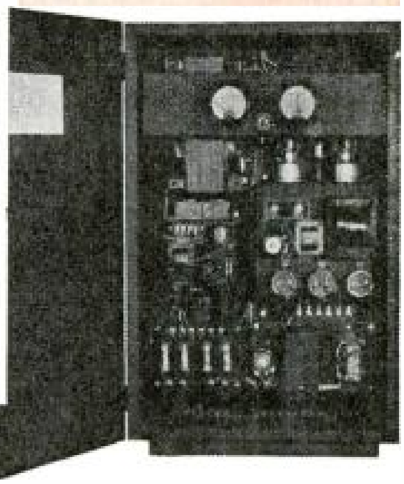
A time delay relay provides a period of 1¼ minutes before application of plate voltage to the CE-306 tubes. Input to rectifier: 105-125 V. or 210-250 V. 50-60 cycle AC. Output: 110 to 135 V. 0-7 Amps.

Unit measures 32½" high x 20½" wide x 14½" deep. Weight approx. 265 lbs. unpacked.

Provision for connections by rigid or flexible conduit.

Unit brand new, moisture-proof packed. Shipped complete with tubes and all spares.

PRICE $89.50



T-24 MICROPHONE $1.75

Carbon, for use with BC-222 and BC-322 Walkie-Talkies. Comes moisture-proofed packed.

PRICE **$1.75**

RECEIVER TUNING HEAD CRV-23253 .. 75c

Used with CRV-46151 Receiver for vernier tuning. Has beveled dial with hairline cursor. Bands are 200-560, 560-1600, 1600-4450, 4450-9050 Kcs. Each band spread over about 280 degrees of dial edge. Has provision for flexible tuning shaft or can be adapted for direct drive on any tuning shaft. Black crackle finish. Size 5"x3"x2" overall.

PRICE, Brand New .. 75c

BC-348 POWER SUPPLY $9.95

To convert the BC-348 receiver for 110 V. AC operation. Constructed especially for E. R. C. by a leading transformer company. Filament supply 24 V. Rectifier tube used: 6X5 (not included).

PRICE **$9.95**

TERMS:
CASH with ORDER or 25%
BALANCE C.O.D.
All Items Shipped Collect

813 TUBE SOCKET .... 50c ea.

Square low loss steatite socket. Heavy plated contacts for 813 or HK257 tubes. 2 5/8" square 1 7/8" mounting centers.

NEW **50c**

INDICATOR LIGHT ASSEMBLY .. 35c

Panel indicator light assembly. Mounts in 13/16" mounting hole in panels up to ¾" thick. For 110 V. Cand. base. ¼ Watt neon bulb. Clear eye.

PRICE **35c**

E N

CRYSTAL HOLDER BODIES .... 25 for

These crystal holder bodies ideal for 300 Ohm television plugs around your shop. Just solder 300 Ohm lead to pin terminals.

BRAND NEW .... 25 for 79c

O

6 V. DYNAMOTOR $6.75

Manufactured by Electrical Apparatus Corp., Chicago, for police radio. These units ideal for your mobile operation. Output is 200 Volts at .050 Amps. Input 6 Volts 4.5 Amps. Has filter self-contained in base. Wgt. 13 lbs. Size over all 8"x7"x4½".

PRICE **$6.75**

RADAR TRACKING CIRCUIT

A target is automatically tracked by this radar which continuously indicates range. It keeps an antenna or searchlights and anti-aircraft guns constantly on-target. The system was recently disclosed in patent 2,508,384, issued to Milton H. Gross of Berkeley, Calif. This particular radar was known during the last war and it still is basically important although many improvements have since been made. Most of these are, of course, classified as secret.

The automatic tracking equipment is shown in the upper part of the figure. An a.f. oscillator feeds the keyer which pulses the transmitter. The T-R box is

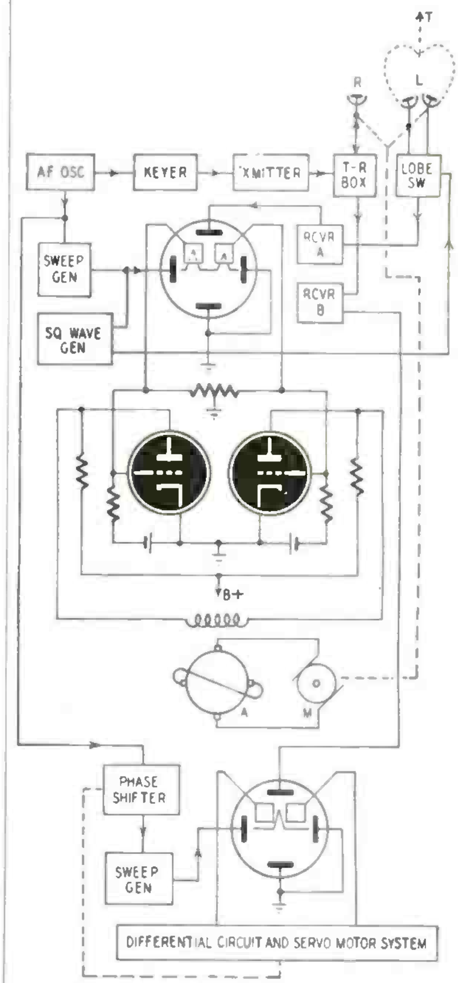


Diagram of the radar system. The size or position of the pips on the scope screens controls the two servo systems.

the usual type to protect a receiver B during transmission. Radar pulses radiate from antenna R.

The a.f. oscillator also controls a sweep generator and a square-wave generator. The first produces a linear horizontal sweep on the scope screen. The square wave alternately adds and subtracts from the sweep voltage. This displaces alternate sweeps. One sweep starts at the left of the screen, the next starts nearer to the center, and so on. The square wave also synchronizes the sweeps with a lobe switch. The antennas L move as a single unit, but they have individual lobe patterns as shown by dotted lines. During one sweep one of the antennas feeds receiver A. During the next sweep (which is displaced from the previous one) the other antenna feeds the receiver.

Because of the antenna switching, two pips are visible for each target. The pips have equal amplitude only when the target is located along line T. One of the pips will be larger (as shown here) when the target is not on T. In that case one antenna will pick up more echo signal than the other.

Two square metal plates are fixed to the outer surface of the oscilloscope as shown in the figure. Together with the glass envelope and the internal fluorescent coating, these plates form capacitors. Each capacitor is charged by the electron stream. Discharge takes place through the center-grounded resistor. If the pips are of unequal amplitude, a greater discharge takes place through the corresponding portion of the resistor.

The resistor voltage drops are amplified by a push-pull stage. This stage has no output when L is on target. In that event the pips have equal amplitude and the square capacitors are equally charged. When the antenna is off-target, the amplifier feeds a servo mechanism which corrects it. The servo system includes an amplidyne A and motor M, which are stationary until the target moves off line T. Then the antennas are moved to track correctly.

For continuous ranging the echo is picked up by R and fed to receiver B. The pulses are applied to an oscilloscope similar to the one described previously. A differential amplifier and servo system are also used. This is shown as a simple box since the setup is similar to the equipment already described (see lower portion of figure).

There is no alternate displacement of the scope sweep here, so only a single pip is visible for each target. At any instant its position depends upon the target distance. It can also be displaced by varying the phase shifter between the a.f. oscillator and the sweep generator. As a target approaches the radar station the pip tends to move to the left because the echo arrives earlier during each sweep. If the shifter is varied to increase its phase, the pip may be restored to its original position.

Normally the pip is adjusted to appear midway between the square capacitors. In this position neither capacitor is charged. The servo system must be at rest because the differential amplifier has no output. If the target distance varies, however, the pip is displaced. The servo is then set in motion to control the phase shifter. The phase is varied until the pip is again brought to the center of the screen and the servo comes to rest. For continuous ranging the phase shifter is calibrated in terms of target distance.

The servo motor systems are used to control not only the antenna, but also a searchlight or anti-aircraft gun. In the case of the gun, the system must not only track correctly, but also keep the range adjustments of the gun set properly. Many modern radar systems do this as well as correct for speed of target, windage, and other factors.

Radio Thirty-Five Years Ago

In Gernsback Publications

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Founder

Modern Electrics	1908
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Radio News	1919
Science & Invention	1920
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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.

ELECTRICAL EXPERIMENTER NOVEMBER, 1916

Wireless and Aeroplanes Aid European "Gun Spotters"
When Amateur Wireless Was Young, by H. de Scott
A 10 K. W. Poulsen Arc Radio Station
Court Declares Audion an Infringement on Fleming Valve
New Hy-Tone Radio Testing Buzzer
A New Magnetic Amplifier for Wireless Purposes
Construction of a Reinforced Wood Mast, by H. W. Offins
Experiments with a Radioson Detector, by Frank M. Kuss
Long Sparks and Quenching Tubes,
Radiation Current in Radio Antennae, by C. L. Whitney
A "Secret" Code Chart, by Raymond S. Sutcliffe
Simple Detector Shunt, by Warner N. Crosby
A Wireless "Hound" That Dogs Your Foot-Steps, by F. A. Steinbrook

USEFUL JEWELER'S TOOL

A small jeweler's eyeglass, known as a loupe, is useful for locating broken ends of a fine wire coil, examining a phonograph needle for wear, and many other fine jobs. A four-power glass with a 2-inch focal length is good, and its cost is not high.—*Jack Darr.*

Patent infringent suit has been started by the Standard Coil Products Company of Illinois against the Automatic Manufacturing Corporation of Newark, N. J. Standard Coil claims that the Automatic Manufacturing Corporation has so carefully copied Standard television tuner units that in some cases TV set manufacturers have returned units manufactured by Automatic to the Standard Company.

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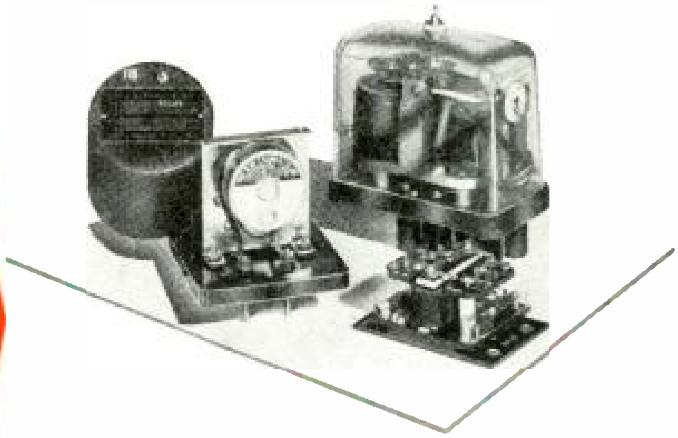
Whether you require large quantities of relays for production runs or single units for laboratory or amateur work, Wells can make immediate delivery and save you a substantial part of the cost.



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 Switch 2927B100-C2	.95
R-669	75 VAC.	400 CYC.	1B, 1A	Clare 400	.95
R-660	6 VDC.	...	¼" 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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ITALIAN RADIOS USE PERMEABILITY TUNING

Permeability tuning is used in many of the newer Italian radio receivers. One such receiver, a three-tube a.c.-d.c. regenerative job covering the broadcast band is shown in Fig. 1 and Photo A.

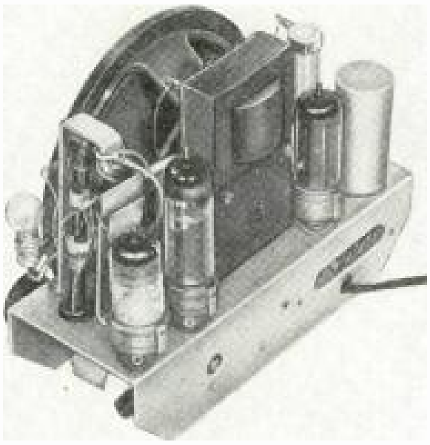

Photo A—A typical Italian midget set.

The American equivalents of the tubes in this diagram are 12BA6, 35B5, and 35W4. For the tuning coil, a standard permeability-tuned coil covering the broadcast band may be used for L1-L3. The feedback coils L2 and L4 should be wound on the same form with L3 and each should have about 25% of the number of turns on L3. A little experimenting with the number of turns on these coils and their spacing from L3 should produce good results. The capacitor C controls the regeneration.

Photo B is of a new Italian receiver which has differential permeability tuning. Three tapered iron cores directly in back of the tuning dial vary the inductance of the coils by varying the thickness of the core and not the length. These cores are not exactly conical because their shape determines the frequency spread on the dial and by tapering them correctly, the crowded end of the band can be spread out.

Besides covering the broadcast band, this set has two short-wave and one long-wave band plus a bandspread tuner which covers five additional short-wave bands of about 1 mc each. In Italy, as in all European countries, almost all the medium- and high-priced

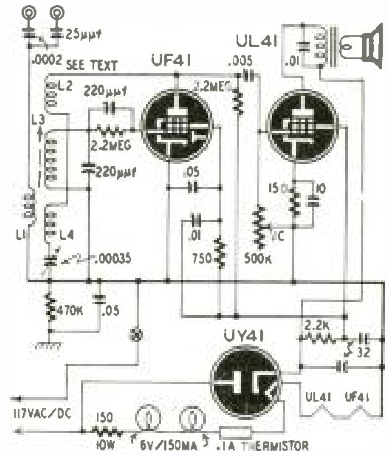

Fig. 1—Circuit of the Italian midget.

receivers have several short-wave bands and even the smaller a.c.-d.c. sets usually have one or more.—*D. E. Ravalico*

ITALY PLANS TV NETWORK

Italian TV, at present restricted chiefly to industrial use, will begin regular broadcasts on a three-city coaxial hookup sometime next year. Mr. John Geloso, head of one of Italy's largest radio manufacturing firms, stated that the network will include Milan, Turin and Rome and that construction on the cable is now under way.

Italy now has only one commercially-owned TV transmitter located in Turin, but it has no regular broadcast schedule and operates on an experimental basis. Few private individuals own TV receivers at present, but the Italian radio industry is now preparing to produce popularly-priced sets on a mass-production basis.

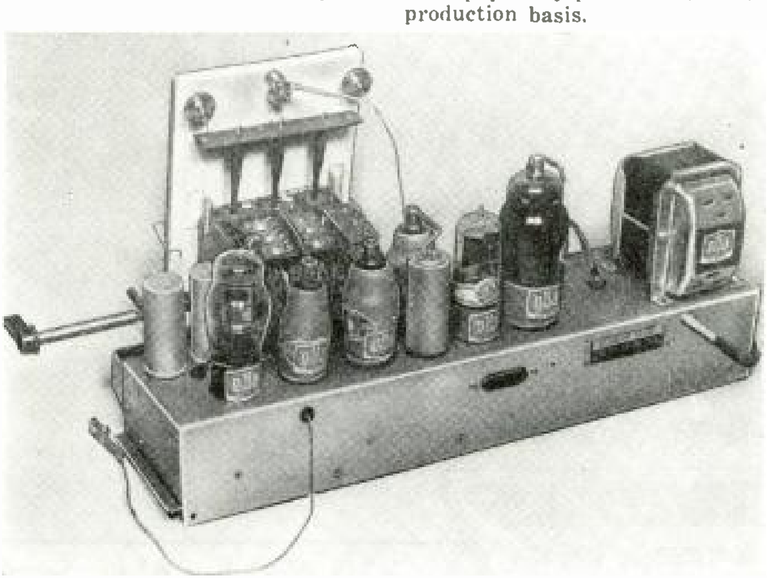

Photo B—One of the larger Italian receivers which has permeability tuning.

FREDDIE FUND BREAKS $3000.00 MARK

We are genuinely happy to announce that RADIO-ELECTRONICS' readers this month have passed the $3,000.00 mark in contributions to Freddie, the Arkansas radio technician's two-year-old son, born without arms or legs. This is most gratifying, but it is only the beginning.

Your Editor did a lot of research work recently to find out the frequency of such unfortunate births, but it became speedily apparent that totally armless and legless births are so rare that no medical authority ventured to give any opinion.

At the present time Freddie has been

George Van Photo

Freddie gets some help from a nurse

fitted with his first set of artificial legs which he works by twisting the lower part of his body which will make him walk in the future. So far he has only learned to balance himself. Walking will not be possible for some time to come.

Last month we had a visit from Freddie and his mother, accompanied by Dr. Henry H. Kessler of the West Orange, N. J., Kessler Institute for Rehabilitation. This Institute rehabilitates cases like Freddie's and war veterans' as well as accident cases where legs or arms have been lost.

Freddie himself at his visit seemed to take his fitted legs, strapped to his body, philosophically enough, although one could sense that he did not like the idea particularly. It will be a long road of torture and persistence before he can walk. Much later will come the fitting of arms.

Several times a year Freddie must come up North with his mother and stay at the Kessler Institute for treatment and fittings and each trip costs over $500.00. These trips will go on for many years and the incidental expenses come very high. For this reason we urge our readers once more to send in generous contributions. Freddie, being a radioman's son, we feel that all of our readers have a stake in his future. Sooner or later Freddie too will be in radio—of this we feel certain. So keep up the good work by sending in your contributions—even the smallest is highly welcome.

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

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

Balance as of August 22	$2725.51
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Abery Radio—Hartford, Conn.	2.00
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Herbert Riband, Philco Corp.—Philadelphia, Pa.	10.00
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Turnstile Maintainers of B.M.T. Surface Subway, Shop 849, Nostrand Ave.—Brooklyn, N. Y.	10.00
W6DXA & Son—San Anselmo, Calif.	2.00
TOTAL TO SEPTEMBER 22	$3134.21

WESTINGHOUSE H-196, -208, AND -217

To prolong the life of the low-voltage rectifier tube in early chassis in the H-196, replace the 5Z4 with a 5V4-G which has a higher current rating. No circuit or wiring alterations are required.

The ¼-amp fuse in the horizontal output circuit should *never* be replaced with a jumper. If the 6BG6-G becomes defective, the transformer is apt to be damaged. A blown fuse in this circuit usually indicates a gassy 6BG6-G. The tube should be replaced if the trouble is not located elsewhere in the receiver circuit.

There has been confusion as to the correct method of adjusting the sensitivity control on these models. If the set is on the service bench, set the control for 0.6 volt on the a.g.c. line. If it is in a customer's home, turn the channel selector to a dead channel, set the contrast to *maximum*, then turn the sensitivity control fully counterclockwise for maximum sensitivity. The raster will then be filled with snow. Turn the control clockwise until the amount of snow just begins to decrease. The screen will still be saturated with snow. Lock the control in this position. Its slot will be approximately horizontal.

If the control is set below the correct point, the set will not be sensitive enough in weak-signal areas. If the control is too high, the set will overload on strong signals.—*Westinghouse Service Hints*

HALLICRAFTERS T-54 AND 505

Noise was visible on the raster and could be heard from the speaker but no station could be tuned in. All tubes checking good on the checker, we tried substituting tubes. The set was restored to normal operation as soon as the 6C4 high-frequency oscillator tube was replaced with a new tube known to be good.—*Ray Dirba*

EMERSON TV MODEL 600 AND 639

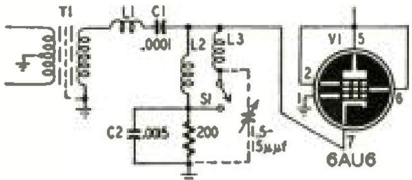
If the picture size decreases to well below normal and cannot be adjusted to fill the mask, check the B-supply at capacitors C34 and C35. If the voltage is low, it is possible that these capacitors are too low. We have found some which measured as low as 0.1 μf when their correct values should be 120 and 150 μf at 150 volts for proper operation.—*William Porter*

LOCATING MICROPHONIC CIRCUITS

Poor connections and microphonic tubes and components are sometimes difficult to localize in a receiver. To simplify the problem, connect a signal generator to antenna and ground on the receiver. Tune receiver and generator to a quiet spot on the band, remove modulation from the generator and turn the volume up on the receiver. The set being hypersensitive to noisy connections and components and microphonic tubes when receiving a strong r.f. signal, it is much easier to locate the faulty component by gently tapping each one in turn while listening for microphonics.—*V. Woychoski*

TVI CURE FOR G-E RECEIVERS

High-channel interference, such as channel 8 being received on channel 5 and channel 10 on 6, may occur on G-E models 810, 811, 214, 820, 830, 835, and 840. This trouble can be reduced considerably or eliminated entirely by connecting a 1.5-15-μμf trimmer (stock No. RCY-002) between the low side of L3 and ground as shown in the drawing. S1, a part of the channel selector switch, is open on the low channels. Thus L3 and the trimmer constitute a series-tuned circuit which can be adjusted to remove the interference. On the high band, the trimmer is switched in parallel with C2 (1,500 μμf) making the trap circuit inoperative so it cannot affect high-band operation.



Tune the receiver to the low channel which has high-band interference. Rotate the trimmer from *maximum* to *minimum* capacitance. Two minimum-interference points will be observed. The first minimum occurs when the trap is tuned to the high-channel fundamental and the second when it is tuned to the second harmonic of the local oscillator. The best adjustment is the *second* minimum. Tune for the minimum interference at the *lowest* setting of the trimmer. This attenuates the interference by approximately 83 db.—*G-E Radio Service Bulletin.*

CHEVROLET 985793

Intermittents are common sources of trouble in these auto receivers. In some instances the signal distorts and the volume drops to a low level, then clears up for hours at a time. This trouble has been traced to the spark plate used as a bypass at the plate of the 6SQ7. The spark plate develops an intermittent high resistance to ground, thus affecting the operation of the a.f. stage. Replacement spark plates being almost impossible to obtain, simply sever the connection between it and the plate of the 6SQ7. The circuit is in no way affected by the removal of this part.

If the set goes dead and starts to operate as soon as a voltmeter is applied to any part of the circuit, look for a defective sensitivity control. Replace this with a good 2,000-ohm unit.
—*C. A. Phillips*

MAGNETIZED METAL C-R TUBES

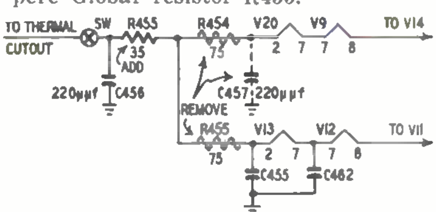
If the metal cone of a 16AP4 or similar type C-R tube becomes magnetized, it is likely to cause objectionable distortion in the form of a kink in the edge of the raster. The magnetism, caused by close contact with a strong magnetic field like that around the frame of a PM speaker, is usually localized and can be located with a pocket compass. Magnetism is most disturbing when it occurs in the middle or small end of the cone.

Demagnetize the cone with an a.c. electro-magnet made by winding approximately 1,250 turns of No. 24 insulated wire on a 7-inch form. Connect the coil to a 117-volt a.c. line and move its flat side over the magnetized areas. Do not remove the power from the coil until after it has been moved away from the tube.

The coil draws approximately 1 ampere and will overheat if used continuously.—*Westinghouse Service Hints*

G-E MODELS 12T3, 12T4, 12C107

Late production runs of these and similar models have a single 0.6-ampere Globar resistor in the heater circuit to give the same current regulation during warm-up as the two 0.3 ampere, 75-ohm Globar resistors used in earlier sets. The heater bypass capacitor C457 has also been omitted from late circuits. The diagram shows the changes in the circuit. The new resistor is stocked as RRW-054, 35-ohm, 0.6-ampere Globar resistor R455.

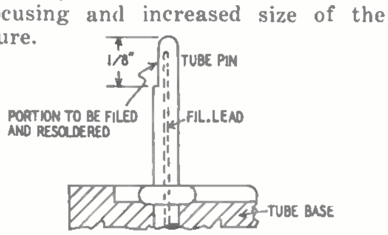


Early production receivers of these models have a 41.25-mc trap coupled to the second video i.f. coil. This caused an audio buzz when the set was tuned for best picture at a low contrast setting or when operating on a weak signal. This trouble was reduced in some sets by shunting the trap and its tuning capacitor C281 with a 5,100-ohm, ½-watt resistor. If this resistor is added in the field, the video i.f. need not be realigned.

The trap is not included in later production runs. Replacement second video i.f. coils *with* trap are no longer available. Replace the coil by part No. RL1-096.—*G-E Service Bulletin*

INTERMITTENT H-V SUPPLIES

Failure of a 1B3-GT high-voltage rectifier in half-wave circuits will result in a dim picture or no picture at all. Failure of a rectifier tube in voltage-multiplier circuits will result in defocusing and increased size of the picture.

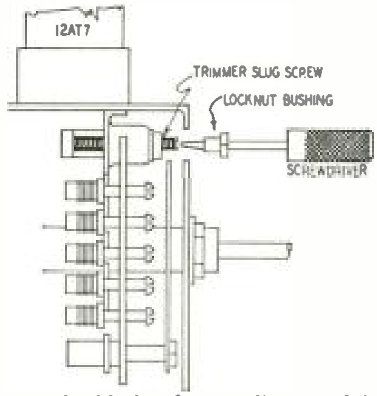


Failure of the 1B3-GT rectifiers can often be traced to poorly soldered connections between the filament leads and the tube base pins. These tubes can be repaired and returned to service by filing pins 2 and 7 as shown in the drawing and resoldering them with noncorrosive solder which is allowed to flow freely to insure good connection. —*Philco Television Service Bulletin*

SENTINEL 400 SERIES

Tearing and picture noise may be encountered when early models 400, 401, 402, 405, 406, and 411 are jarred. The trouble is caused by a loose slug screw in the oscillator padder C-11. This loose screw does not provide a good ground contact and will produce noise in the picture.

Install a lock-nut bushing (part No. PST 500) on the slug screw as shown in the drawing. Slide the lock-nut bush-



ing on the blade of a small screwdriver with the nut end toward the handle. Insert the blade of the screwdriver into the trimmer screw slot, then slide the bushing down to the screw and turn it on *by hand* until the nut end is firm against the front of the tuner chassis. Do not screw the lock-nut down too tight for this may damage the threads or the trimmer. Solder the nut to the tuner frame. Check each local oscillator trimmer for correct adjustment after the nut is installed.—*Sentinel Service Bulletin*

HALLICRAFTERS T-54, 505 AND 506

When the width control does not prove effective in adjusting the width of the raster, check the 47,000-ohm, 2-watt resistors in the plate circuit of the 12SN7-GT horizontal amplifier before looking elsewhere for the trouble. These resistors open up at the slightest provocation and are a constant source of trouble in these receivers. —*M. J. Kolo*

GILFILLAN MODEL 16G

This set had a burned out 50L6 the first time it came in for repairs. Within a few weeks, it was back again with the same tube burned out. By checking the heater voltages of each tube, I found the voltage on the 12SK7 to be approximately 8. By replacing the 12SK7 with a new one, the heater voltage went up to the normal 12.6. No further trouble was had with burned-out 50L6's. The old 12SK7 checked good in a tube tester.—*Manuel E. Silva, Jr.*

7-INCH TV SETS

Most of these sets use electrostatic-type C-R tubes. If the picture jumps, changes intensity, is generally unstable, and snaps and pops come from the speaker, clean the socket and base of the picture tube. The high voltage attracts dust and moisture which cause leakage and arc-overs.—*Gray Trembly*

ANOTHER THINKER

Dear Editor:

After reading your various articles on television, I would like to congratulate you on the job you are doing to help me and others like me get a thorough understanding of television and radio in general. I also heartily agree with Mr. Peter Saveskie on everything he said about RADIO-ELECTRONICS being a thinker's magazine.

I would like to make it clear to all the readers that the television station here at Iowa State College, WOI-TV, does put on programs other than a lady showing you how to bake a cake, or a man demonstrating the right way to find corn borers.

JACK ANDERSON

Ames, Iowa

CORRECTIONS

The parts list for the midget signal tracer on page 33 of the August issue calls for a .01-µf capacitor. Delete this value from the list and use two .05-µf units. If you have already purchased capacitors according to the parts list, use the .01-µf unit between B-minus and the case. We thank Mr. Dick Goings, of Seattle, Wash., for this correction.

The "High-Sensitivity Voltmeter", on page 62 of the August issue, is described as an a.c. instrument. This instrument is for d.c. measurements only. Do not use it on a.c.

We thank Mr. Carl T. Peterson, of Seattle, Wash., and others, for this correction.

Matthias Little was elected president of the QUAM-NICHOLS CO. He succeeds James P. Quam who became chairman of the board. Mr. Little joined Quam-Nichols in 1930 and has been vice president of the firm since 1946.

Fred Kooiman, who had been general sales manager of THOMAS ELECTRONICS, INC., since that company's inception, died on August 23.

Rear Admiral Roy M. W. Graham, USN (Ret.) was appointed as special assistant to the manager of the Equipment Sales Division of RAYTHEON MANUFACTURING CO. His work will be in connection with harbor radar systems. Admiral Graham saw important naval action in World War II for which he received the Legion of Merit with gold star as well as other decorations and campaign medals.

Ross Nichols, former secretary and treasurer of the WESTON ELECTRICAL INSTRUMENT CORP., was elected executive vice president. Weston also announced the appointment of **Philip Barnes** as general sales manager and **Charles B. Denton** as advertising manager.

Anthony J. Albano, chief engineer of the TEL-O-TUBE CORP. OF AMERICA has been elected secretary of the corporation. Prior to joining Tel-O-Tube two years ago, Mr. Albano production engineer for Allen B. Du Mont Laboratories.

Ray O. Hill was appointed comptroller of the CANNON ELECTRIC DEVELOPMENT CO., and **John K. Trotter** was named production manager.

Ray Rice, public relations counselor, died of a heart ailment at the age of 49 in New York Hospital. Mr. Rice handled publicity for the RAYTHEON MANUFACTURING CO. A former colonel on the staff of General Omar Bradley, Mr. Rice was buried in Arlington National Cemetery with full military honors.

L. E. Pettit, manager of the advertising division of the electronics department of GENERAL ELECTRIC, succeeded **Stanley H. Manson** of STROMBERG-CARLSON as chairman of the RTMA Advertising Committee. Other RTMA Committee appointments include: membership committee, **J. J. Kahn**, STANDARD TRANSFORMER CORP., chairman; export committee, **V. S. Mameyeff**, RAYTHEON MFG. CO., chairman; industry statistics committee, **Frank W. Mansfield**, SYLVANIA ELECTRIC PRODUCTS, chairman; cathode-ray safety committee, **R. E. Carlson**, TUNG-SOL

Lamp Works, Inc., chairman; legislative committee, John W. Van Allen, Crosley Div. Avco Mfg. Corp., chairman; traffic committee, Richard C. Colton, RCA Victor Division, chairman; general standards committee, Dorman D. Israel, Emerson Radio & Phonograph Corp., chairman. RTMA also announced the appointment of John K. Koepf an assistant to James D. Secrest, secretary and general manager. Rockwell M. Gray, of the Rauland-Borg Corp., was elected chairman of the Association of Electronic Parts and Equipment Manufacturers. John H. Cashman, of Radio-Craftsman, Inc., was named vice chairman; Helen Staniland of Quam-Nichols Co., treasurer for her fifteenth annual term. Kenneth C. Prince was re-elected executive secretary and legal counsel.

Personnel Notes

. . . Brig. Gen. David Sarnoff, chairman of the board of RCA, speaking before the Fifty-first Encampment of the Veterans of Foreign Wars proposed a program of positive action against Communist aggression. He foresaw international television within 5 years as a powerful medium for democratic propaganda.

. . . Curtis K. Wall, former assistant quality control engineer at Sylvania, joined the distributor sales department, Radio Tube Division, as manager.

. . . Roy Augustine was appointed to the engineering staff of the Muter Co.

. . . John K. Herbert joined the National Broadcasting Company as assistant to the president.

. . . George M. Hakim joined Allen B. Du Mont Labs., receiver sales division as assistant advertising manager in charge of cooperative advertising. Du Mont also announced the promotion of George D. Hulst to manager of the Special Projects Laboratory of the electronic parts division.

. . . G. E. Burns was appointed field sales manager and W. C. Walsh as Western regional sales manager of General Electric's replacement tube sales organization. G-E also named John Klenke as Atlanta district manager of the electronics department and F. W. Tietsworth as commercial engineer for the Eastern sales region of the tube divisions.

. . . John Gray joined the Simpson Electric Co. of Chicago as head of the industrial sales correspondence department.

. . . Al Moeller, general manager of General Electronics Inc. since 1944, died in Ridgewood, N. J.

. . . Emil Maginot joined the American Television & Radio Corp., St. Paul, Minn., as sales manager of the distributor sales division. Mr. Maginot was formerly sales manager of the renewal division of the National Union Radio Corp.

. . . Harry P. Weston was elected executive vice president of Reeves Soundcraft Corp.

. . . A. W. Rhinow, recently retired advertising and sales director of the Federal Telephone & Radio Corp., became the business manager of the Protestant Radio Commission.

. . . Henry Jaslik, of AIRBORNE INSTRUMENTS LABORATORY, was named a delegate-at-large to the ninth general assembly of the International Scientific Radio Union representing the National Research Council in Zurich, Switzerland.

. . . C. E. Willis was named assistant sales manager of the electromechanical division of LEAR, INC., and A. N. Lawrence was made manager of the Eastern office at Teterboro, N. J.

. . . J. Grayson Jones, chief engineer at CONRAC, INC., was elected vice president.

. . . Raymond W. Ayers elected vice president of FREDERICK HART & CO., INC., Poughkeepsie, N. Y., manufacturer of sound recorders.

. . . Frank Dillbahner, treasurer of WELLS GARDNER & CO., died in St. Luke's Hospital, Chicago, at the age of 75.

. . . Harry E. Austin was named vice president in charge of the Pacific Coast district for RCA COMMUNICATIONS, INC.

. . . Walter F. Kram has joined the engineering staff of the BALLANTINE LABORATORIES, INC., as senior engineer.

. . . J. William Costello joined CAPEHART-FARNSWORTH as sales promotion manager. Capehart also announced the appointment of Lewis W. Reynolds as manager of the Atlanta region and William H. Rinkenbach as sales research manager.

. . . Leonard A. Johnson named sales manager for maintenance and contracting trades in the electrical sound recording tape division of MINNESOTA MINING & MFG. CO. M. D. Benson succeeds him as West Coast sales head of the division. A. D. Steele was appointed sales supervisor of the St. Paul region.

. . . Walter Ostman succeeded T. W. Kirby as Pacific Mountain territory manager of the PHILCO CORP. Mr. Kirby was transferred to the Allegheny division.

. . . Scott W. Donaldson, deputy assistant secretary of the U.S. Air Force, appointed vice president of TELE-KING CORP. and Edwin Weisl Jr. joined the company as advertising manager.

. . . Fred S. McCarthy was made sales promotion manager of the WESTINGHOUSE TELEVISION AND RADIO DIV.

. . . L. M. Sandwick was named vice president and general sales manager of SCOTT RADIO LABORATORIES and sales manager of JOHN MECK INDUSTRIES, INC.

. . . Joseph Kattan was named distribution manager of EMERSON RADIO & PHONOGRAPH CORP.

. . . Larry Offenbecker was named director of advertising at SCOTT RADIO LABORATORIES.

. . . T. R. Mathews was appointed distributor manager of the radio-television division of the STROMBERG-CARLSON CO.

. . . Sol Predeger was elected vice president of MAJESTIC RADIO & TELEVISION, INC. The company also announced the appointment of Warren Frebel as purchasing agent.

FATHER OF RADIO, The Autobiography of Lee de Forest. Published by Wilcox and Follett Company, Chicago. 6½ x 9½ inches, 502 pages. Price $5.00.

The life history of the Father of Radio could never have been written by anyone, however well briefed, but the Grand Old Man himself. Dr. de Forest is a writer of consummate skill, with an ability to use the resources of the English language beyond that of most of our leading authors. He delineates facts with the exactness of one accustomed to drawing up patent claims; his expression is poetic, breaking into versification in more than one place and appearing in sustained passages which the author himself has called "prose poems." For de Forest is a poet, and a number of his poems—in addition to those scattered through the text—appear in a special Appendix.

The surprising thing is that the biography of such a variegated and eventful life could be contained between the covers of a single book. Fifty-one necessarily short chapters were needed to describe this life.

The bulk of the narrative is of course concerned with de Forest wireless, and especially the adventures—technical and legal—with the Audion. The author's other fields of interest are not neglected, and we can see throughout the book how his love of music constantly spurred him toward that end which today he views with mixed feelings—broadcasting! Indeed, in 1910 he made the first broadcast of entertainment (earlier broadcasts were chiefly for test purposes) and in 1916 put a transmitter on the air with regular programs. We hear of the "radio knife," not known to the majority of radiomen as a de Forest invention. His development of talking pictures is also given prominence, though little is said about his "vibration transducer" or phonograph pickup, or about a number of other inventions which he himself did not follow up, and which have become universal. The personal angle is not neglected; and we see in de Forest the romantic, to be expected from his poetic rather than reasoning brain which might be inferred from his technical inductions and deductions.

Three appendices include selections from de Forest's poetry, a paper "Evolution of the Audion" and a list of de Forest patents, which number over 200. The second appendix should forever put an end to all reference to the Audion's invention as "putting an additional electrode in the vacuum tube" and similar statements. Together with Chapter 19 of the text, this shows clearly that the Audion is an independent development, related more closely in important respects to the coherer (or more properly de Forest's anti-coherer) than to the Fleming "valve" with which it has been confused. And since de Forest considered each of the embryo stages of the Audion important, he put the discussion out of the range of controversy by leaving a historical trail of patents beginning in 1903.

To say that this book belongs on every radioman's bookshelf would be trite. To report that de Forest's artistic skill has made the reading of the "must" book a pleasure is to make an almost unique statement about literature fathered by an engineer.

RALPH 124C 41+, by Hugo Gernsback. (Forewords by Dr. Lee de Forest and Fletcher Pratt.) Published by Frederick Fell, Inc., New York, N. Y. 5½ x 8½ inches, 207 pages. Price $2.50.

Ralph 124C 41+ is a novel written around a young scientist of the year 2660 and the world he lives in—a world where radar, television, artificial plant culture, microfilm, and ray sterilization are commonplace. Indeed—they are today, but this novel appeared first in 1911, as a serial in the author's magazine *Modern Electrics*, when most official scientists would have pronounced them impossible.

Whether one thinks of Hugo Gernsback as the Father of Science Fiction or leans toward the idea (as Gernsback apparently did in 1926) that the title may belong to Jules Verne, the book is a classic—possibly the classic—of scientifiction. It established the principle that a story of future inventions must be scientifically correct; and it contains more justified predictions than any other dozen books ever published. Ironically enough, those which have not materialized are precisely those which seemed nearest at the time. For example, wireless transmission of power had already "almost" been brought about by Nikola Tesla, and the electric automobile was making progress against its gasoline-powered competitor in 1911. (Battery improvements and fuel depletion may yet leave the *electromobile* in full control of the roads long before 2660.)

(*Continued on page* 111)

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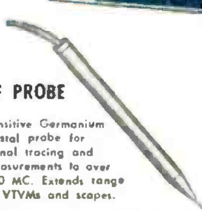

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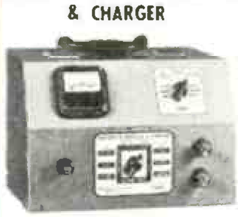

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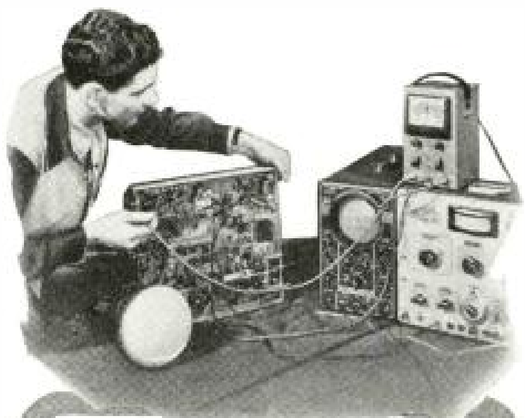

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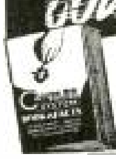

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BOOK REVIEWS

(Continued from page 108)

The reader is likely to overlook some of the predictions because of the matter-of-fact way they are treated. Magnesium masts are commonplace enough today that the reviewer can forget that in 1911 magnesium was merely a constituent of flashlight powder. Night baseball is another of today's commonplaces which would have been considered impossible by most engineers at the time the book was written. On the other hand, the *Bacillatorium* is so described that few readers would recognize a chamber lined with germicidal lamps.

Gernsback's near misses are almost as interesting as his hits. He describes hydroponics minutely—without the hydroponic tanks. His wire spirals miss modern luminescent-tube lighting by an impressively narrow margin. And his *steelonium* seems to have many—but not enough—of the qualities of titanium.

Many of the predictions are neither hits nor misses—simply unfulfilled. The reviewer of the 2050 edition will no doubt have an interesting task.

ADVERTISING INDEX

RADIO SCHOOL DIRECTORY

BETTER TV RECEPTION in Fringe and Low Signal Areas, by Woodrow Smith and R. L. Dawley. Published by Editors and Engineers, Santa Barbara, Calif. 6¼ x 9¼ inches, 141 pages. Price $2.50.

The authors of this little book get right down to business and talk about their subject, their whole subject, and nothing but their subject. Starting with an introductory chapter which discusses the action of the TV signal in fringe areas, it devotes chapters to methods of obtaining satisfactory signals; TV receiving antennas; transmission lines and distribution systems; antenna, mast, and feed line installations; and interference in weak-signal areas. In each subject there is an almost startling concentration on fringe-area conditions and a welcome lack of discussion of general television problems.

PRACTICAL TELEVISION ENGINEERING, by Scott Helt. Published by Murray Hill Books, Inc., New York. 6½ x 9½ inches, 708 pages. Price $7.50.

By covering both technical and practical aspects of television while using mathematical examples and problems which can be handled by persons with a working knowledge of algebra, the author has prepared a book which will prove useful to service technicians, students, engineers, and any other persons interested in almost any phase of the industry.

Beginning with a lucid and carefully planned discussion of light and optics and their relationship to the fundamentals of TV transmission, the author describes the C-R tube and oscilloscope in detail. Following this, he discusses image pickup tubes, the TV sync generator with its shaping, timing and deflection circuits, camera chains, video amplifiers, voltage-regulated power supplies; TV receivers, transmitters, and antennas; as well as television broadcasting techniques.—*RFS*

TV INSTALLATION TECHNIQUES, by Samuel L. Marshall. Published by John F. Rider, Publisher, Inc., New York, N.Y. 5½ x 8½ inches, 330 pages. Price $3.60.

The television installer often determines whether a set will give good results or work poorly. This book is written for the TV installer so that he can get the most out of a set in any given location, whether it be in the city or in fringe areas. While the first three chapters discuss television, radio propagation and antennas in general terms, the rest of the book is filled with practical advice and instruction on making the best installation, even to the number of sacks of cement to use for a mast foundation.

One chapter deals with high mast and tower installations—how to design and construct them and how to get them in position. The final chapter gives a summary of the municipal regulations governing TV installations of the larger cities. The useful appendix has many charts and tables that the installer will find useful.—*MW*

OCEAN ELECTRONIC NAVIGATIONAL AIDS, prepared by the United States Coast Guard. Published by the Government Printing Office, Washington 25, D.C. 6 x 9¼ inches, 73 pages. Price 50 cents.

Intended for the seriously interested but nontechnical reader, this booklet nevertheless contains many facts of interest to the radioman. The aids discussed include Loran, the marine radiobeacon system, microwave beacons, and other radio aids, and radar. Appendices give advisory minimum specifications for marine radar and for marine Loran receiver-indicator equipment.

The booklet has many photographs of the various types of navigational aids and photos of oscilloscope patterns as they appear on radar receivers. Many diagrams are used to illustrate the operation of the various types of equipment and a number of maps show the location of navigational routes.

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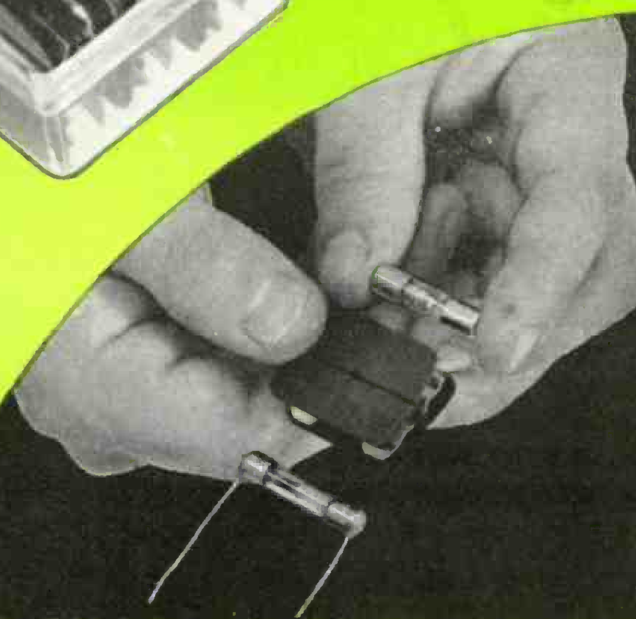

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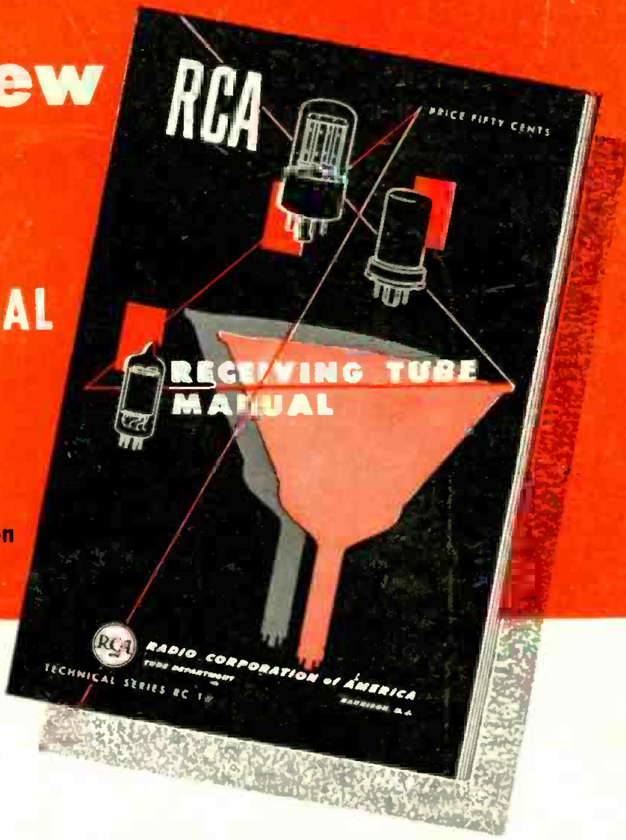

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