May 25th, 1929 15 Cents

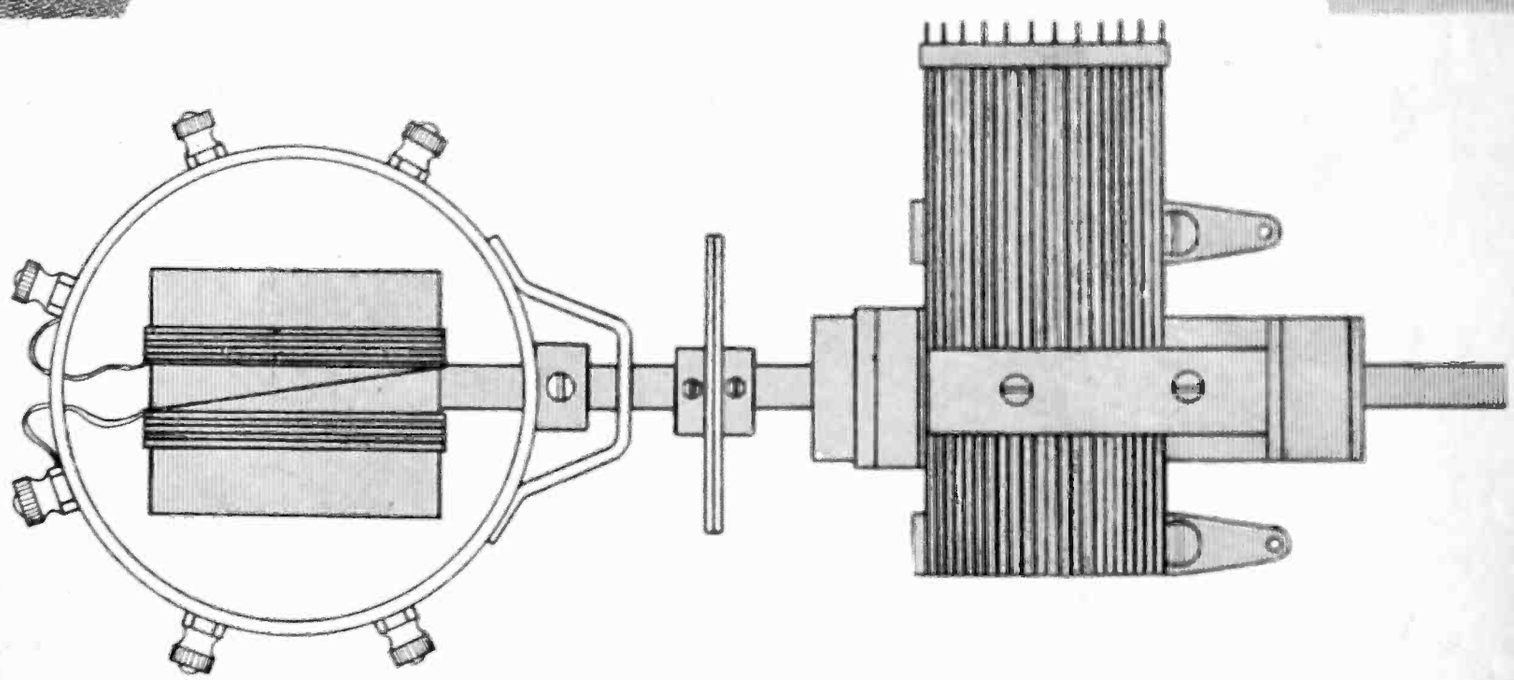
RADIO WORLD

REG. U.S. PAT. OFF.

WORLD

The First and Only National Radio Weekly

374th Consecutive Issue — Eighth Year



AUTOMATIC STABILIZER

(SEE PAGE 17)

RADIO WORLD, owned and published by Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y. Roland Burke Hennessy, President and Treasurer, 145 West 45th Street, New York, N. Y.; Herman Bernard, Secretary, 145 West 45th Street, New York, N. Y.

Herman Bernard's

AUTOMATIC RF STABILIZER

was made possible by the use of the Hammarlund Flexible Coupling and the Floating Rotor Shaft feature of

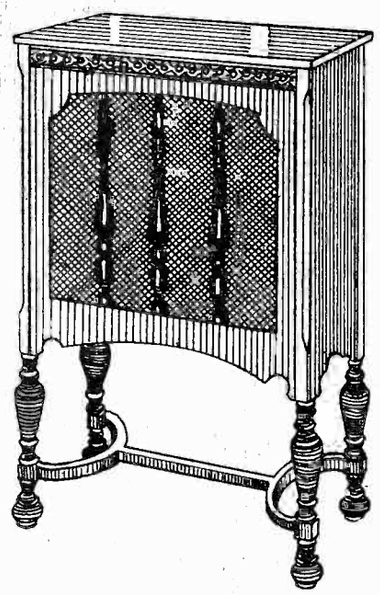
HAMMARLUND CONDENSERS

Your Dealer Sells Them

For Better Radio
Hammarlund PRECISION PRODUCTS

ARISTOCRAT FLOOR SPEAKER

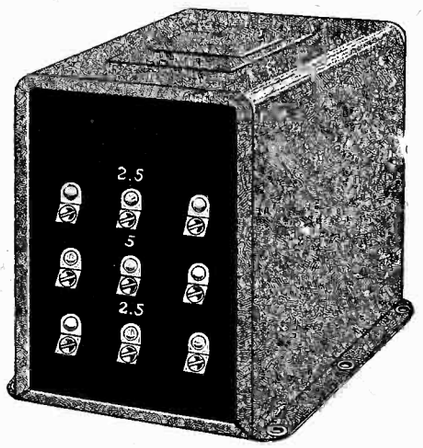
With Molded Wood Horn of 8 ft. tone travel (exponential type) with baffle and horn motor built in. Extraordinary bargain. **$20.00**



The speaker cabinet is walnut finish, 33" high, 24½". wide,. 17½". deep,. with. carved. legs. Golden cloth grille covers front opening. .Built inside is No. 595 molded wood horn with baffle and No. 203 driving motor unit that stands 250 volts without filtration. Horn and motor removable. Table alone is worth price asked. Remit with order and we pay cartage on Aristocrat Floor Speaker.

Acoustical Engineering Associates
143 WEST 45th STREET
NEW YORK CITY
(Just East of Broadway)

Filament Transformer



The heater type tube draws 1.75 ampere at 2.5 volts. If several such tubes are used a heavy-duty filament transformer is necessary. The top 2.5-volt winding of this filament transformer easily carries **NINE AMPERES**, or enough current for five heater type tubes. The bottom 2.5-volt winding stands four amperes, or enough current to heat **TWO MORE** such tubes, a total of **SEVEN TUBES!** The power tube, if of the 5-volt type, may be heated from the 5-volt central winding. 5-volt power tubes in push-pull may be heated from this winding.

All three windings are tapped at the exact electrical center. This precision location, made with the aid of an impedance bridge, accounts for absence of hum otherwise caused by the last tube when heated directly with AC. The heater type tubes are ***indirectly*** heated by AC, since the filament that glows is fed by AC but communicates heat to the cathode or electron emitter.

The heater type tube is represented by the 227, excellent as radio amplifier and audio amplifier, and the exclusive type of AC detector tube. Also the new AC screen grid tubes, with the same filament voltage and current, are of the heater type.

The transformer is beautifully finished in crackled glossy black, with bakelite front, and comes equipped with 52-inch AC cable with plug. Six riveted mounting holes for baseboard or subpanel. Size, 3¾ in. high, 2⅝ in. wide, 3 in. deep. Shipping weight, 6 lbs.

Cat. F226A, for 50-to-60 cycles, 105-to-120 volts AC, Net Price $6.00

Guaranty Radio Goods Co.
145 West 45th St.
N. Y. City

BLUEPRINT of the New, Highly Selective Screen Grid DIAMOND
(AC MODEL)
$1.00
RADIO WORLD
145 West 45th Street New York City
Few Doors East of Broadway

"Look for the Green Box"

The Only Tubes with 5-Day Money-Back Guarantee in Each Box

222 Screen Grid Tube **$3.50**

AFTER having tried many screen grid tubes, many specialists have made Kelly 222 their choice. Our 222 stands up! Filament is not critical, but 3.3 volts work best. Plate voltage may be from 90 to 180, but negative bias of 1.5 volts remains the same. The screen grid voltage, G post of socket, may be 22 to 45 volts, depending on how much amplification you want. A working amplification of 60 is easily obtainable (60 mu.).

The plate current is virtually independent of plate voltage in the recommended range, 90 to 180 volts. This aids stability.

The cap at top of the tube is for familiar grid connection.

This tube is for battery or A-eliminator operation.

240 High Mu Tube **$1.25**

Great for Detector or in audio channels where a resistor or impedance coil is in the plate circuit. Fil. 5 volts DC, plate 90 to 180 volts.

POWER TUBES

250	$6.00	210	$4.50
171A	1.50	112A	1.50

OTHER TYPES

280	$2.50	281	$3.50
227	2.25	226	1.25
201A	1.00	199	1.25

KELLY TUBE COMPANY
Walter J. McCord, Manager
57 DEY STREET, NEW YORK CITY
Suite 6 Tel. BARclay 8659

Quick Action Classified Ads

Radio World's Speedy Medium for Enterprise and Sales

10 cents a word — 10 words minimum — Cash with Order

RADIO INFORMATION
Reliable, prompt, accurate, in every-day language, 25c per question. Radio Information Bureau, 1426 South Clifton Park, Chicago.

HAVE AN EXPERT PUT YOUR SET IN SHAPE!
If your receiver or amplifier, no matter of what kind, is not giving proper results, send it to us, prepaid. We will test it FREE and let you know what's wrong, telling you cost of repairs. Our charges are very reasonable. Six years' experience. Loudspeakers and units repaired. Burnt-out coils replaced. Jaynxon Laboratories, 57 Dey Street, New York City.

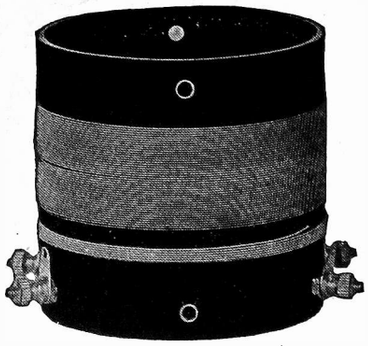
RADIO RECEIVING TUBES, by Moyer and Wostrel, first edition just off the press. No radio service man, experimenter or student of radio should be without this authoritative book on the principles and applications of vacuum tubes. It answers all your questions relating to receiving, amplifying and rectifying tubes. Price postpaid, $2.50 Radio World, 145 W. 45th St., New York

ARTISTS and Art Students are printing 250 signs or pictures an hour without machinery. Sample and particulars 10c. Straco, 1014 Mulberry, Springfield, Ohio.

DYNAMIC SPEAKER
Build your own with our castings. Set of machined castings, $8.00; not machined, $5.00. Full set blue prints and instructions included. Prices of complete parts on request.
IMPERIAL RADIO SPEAKER CO.
1453 East 174th St., Cleveland, Ohio

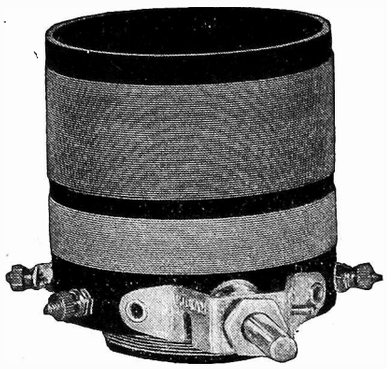
The Famous Tyrman '60' Super Kit, $42.89 postpaid. Willard Stahl, 225 Highland Street, Grand Rapids, Michigan.

DIAMOND Pair



AC5 . . . . $1.50

Highly selective antenna coil for any circuit, and interstage coil for AC circuits. Step-up ratio, 1-to-8. Tunes with .0005 mfd.
Model AC3, for .00035 mfd.....$1.75



SGT5 . . . . $2.75

Tuner to work out of a screen grid tube. The large primary is fixed and is connected in the plate circuit of the screen grid tube. Tunes with .0005 mfd.
Model SGT3, for .00035 mfd.....$3.00

UNIVERSAL Pair

TP5 . . . . $3.00

Interstage coupler to work out of a screen grid tube, where the primary in the plate circuit is tuned, the secondary, in the next grid circuit, untuned. Tunes with .0005.
Model TP3, for .00035 mfd.....$3.25

RF5 . . . . $1.50

Excellently selective antenna coil for any circuit, and interstage coil for any battery operated receiver, excepting output of screen grid tube. Tunes with .0005 mfd.
Model RF3, for .00035 mfd.....$1.75

A5 . . . . . $1.75

Conductively coupled antenna coil, for maximum pickup, where selectivity is not the main consideration. Continuous winding in two colors. Tunes with .0005 mfd.
Model A3, for .00035 mfd.....$2.00

Screen Grid Coil Co., 143 W. 45th St., N. Y. City

All Parts for MB-29

as described and specified by J. E. Anderson

Also for

H. B. Herman's

Resistance—Coupled Power Amplifier

GUARANTY RADIO GOODS CO.
145 West 45th Street
N. Y. City

COMPLETE PARTS
for the New, Highly Selective

SCREEN GRID DIAMOND

(Four-Tube Battery Model)

Exactly as Specified by Herman Bernard

$29.00 Net

Guaranty Radio Goods Co.
145 West 45th Street
New York City

Just East of Broadway

CONE ASSEMBLY WITH DOUBLE MAGNET UNIT

$6.00

An excellent magnetic type speaker for installation in any cabinet. The unit is a double-magnet Paratone, with two magnet coils, for utmost sensitivity. Each horseshoe magnet is ¾" thick. The magnet coils are forever protected against dust and other foreign, injurious substances, by special bakelite housings. The pin is reverse drive. The cone frame is metal. The 9" cone is specially treated buckram.

All assembled, with long cord, ready to play, Shipping weight 6 lbs. (Cat. CAS) Net **$6.00**

The unit alone (cord included). It will operate any type sounding surface, including paper, cloth, wood, etc. Shipping weight 4 lbs. (Cat. UA). Net **$3.50**

Guaranty Radio Goods Co.
145 West 45th St., New York City

HBH Unit

ALL acoustical and radio engineers agree that the balanced armature type of loudspeaker unit is the best, the most sensitive and the most faithful of all magnetic units. But it is only in the HBH unit that superior designing skill, scrupulous care in the selection of the best materials, and extreme accuracy of manufacture have been combined and co-ordinated so as to bring out all the possibilities of the principle of the balanced type unit.

Any magnetic speaker requires a strong permanent magnet for its operation. The strength of the HBH unit is assured by the use of a long magnet of large cross-section, made of specially selected, high coercive-force steel, forged under the lowest heat possible, scientifically tempered in oil and aged.

The making of a permanent magnet requires a highly specialized skill. It must be forged, cut and tempered with as few heatings as possible, and no heating must exceed a certain temperature if the magnet is to retain its strength and permanence. Another important feature of the magnet which enhances its strength and permanence is that NO HOLES ARE CUT IN IT. The magnet is one solid piece of steel and the pole pieces are clamped firmly to the steel by screws in the die cast harness holding the pole pieces and the armature.

The sensitivity and efficiency of the unit are enhanced by the use of laminated, properly tapered silicon steel pole pieces. Eddy current losses are thus reduced to a vanishing minimum and all the force is concentrated on the ends of the armature.

The armature itself is made of carefully annealed soft iron, thus eliminating any residual magnetization and reducing eddy currents and hysteresis losses to a very small percentage of the energy involved in the operation of the unit. The armature is made short and heavy to enhance its effectiveness in translating electro-magnetic energy into sound.

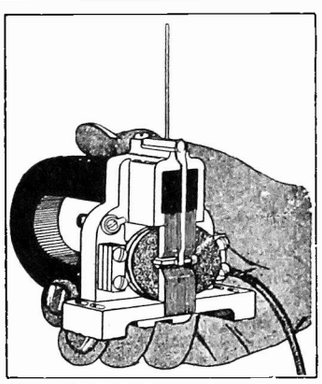
Nobody ever returned an HBH unit because of dissatisfaction with its performance! It stands up and delivers and continues to deliver. You can put 150 volts right through the magnet coils, steadily, without danger of the coil breaking. You don't need any extra power to operate this unit—as you do with dynamics—but get full efficiency at lowest cost and greatest economy.

Put this unit in your cone or cloth speaker in place of the unit now there and marvel at the difference! You will then recognize the technical superiority of this unit in terms of tone value and volume. It produces so much more volume than most other units that it makes distant stations sound like locals.

Order a unit today! Send **$4.00.** Try the unit ten days. If not overjoyed, return it for full refund. Otherwise take 90 days to pay the extra **$1.95.**

10-day money back guaranty!

90 days to pay in full!



The HBH Unit, representing the most skillful and sturdiest magnetic unit design. Mfgd. under BBL License.

Price $5.95
Moulded bracket (extra) 65c

Guaranty Radio Goods Co.,
145 West 45th St.,
N. Y. City (Just East of Broadway)

☐ Please ship one HBH Unit only on 10-day money-back guaranty; at $4.00 down, balance of $1.95 in 90 days, unless I return the unit in 10 days for full refund of $4.00.

☐ Please ship moulded bracket also at 65c.

Name .....

Address .....

City .....

State .....

RADIO WORLD, a weekly paper, published by Hennessy Radio Publications Corporation, from Publication Office, 145 West 45th Street, New York, N. Y. Phone: BRYant 0558 and 0559. 15c per copy, $6 per year. This issue is dated May 25th, 1929, and is Vol. XV, No. 10. Whole No. 374. Entered as second-class matter, March, 1922, at the post office at New York, N. Y., under Act of March, 1879.

"UNINTERRUPTED READER INTEREST"
EVERY WEEK — EVERY YEAR

RADIO WORLD

Vol. XV, No. 10 Whole No. 374
May 25th, 1929
15c per Copy, $6.000 per Year
[Entered as second-class matter, March, 1922, at the Post Office at New York, N. Y., under Act of March, 1879.]

Latest News and Circuits
Technical Accuracy Second to None

EIGHTH YEAR

A Weekly Paper published by Hennessy Radio Publications Corporation, from Publication Office, 145 West 45th Street, New York, N. Y.
Phone: BRYant 0558 and 0559
(Just East of Broadway)

BOARD BACKS PROGRAM SWAP WITH EUROPE

Washington.

Plans for international exchange of radio programs are being worked out rapidly by various broadcasting organizations both here and abroad. M. H. Aylesworth, president of the National Broadcasting Company, on his return from Europe recently, predicted that a regular exchange of programs with England would come about within a year. Only comparatively minor engineering problems, he said, prevent clear reception from overseas.

The Columbia Broadcasting System, according to Dr. Leon Levy of Philadelphia, president of WCAU in that city, and secretary-treasurer of CBS, has been negotiating with stations in Paris and Berlin for more than a year. William S. Paley, president of CBS, has been conducting these negotiations, Levy said, and tentative plans have already been made. At first the system will use short wave station, W-2XE, at New York, for rebroadcasting and pick-up of European programs.

Object of Exchange

The object of both the NBC and the CBS is to broadcast to Europe the choice American programs and to pick-up and rebroadcast in America the best and most interesting programs originating in Europe. Short waves will be the medium for connecting the American and the European stations, and the whole plan is dependent on the building of short wave stations in Europe and large enough to enable the American stations to pick up the programs. Suitable stations are already in operation in America.

Authority to rebroadcast programs experimentally to foreign countries by means of short waves has been granted by the Federal Radio Commission to stations WENR, Chicago, and WCAU, Philadelphia.

Coast Station Applies

The Pacific Western Broadcasting Federation, of Pasadena, Calif., has requested permission to construct a 1,500-watt station for trans-oceanic rebroadcasting and interchange of programs of educational, cultural and religious character. G. W. Alexander, executive manager of the federation, explained that the Commission already has granted a construction permit for a 50,000-watt regular broadcast station to operate on 1,490 kilocycles, and that the station is now under construction. The object of this station is to disseminate the same type of programs.

Tests to Be Made On 200,000 Watts

Washington.

The General Electric Company's experimental station, W2XAG, has been granted the right to use the highest broadcasting power ever authorized in the United States—200,000 watts. The station, located at Schenectady, N. Y., may use this power from midnight to dawn on the following channels: 550 kc. — 545.1m.; 660 kc. — 454.3m.; 790 kc. — 379.5m.; 1,150 kc. — 260.7m., and 1,500 kc. — 199.9 meters.

This frequency assortment enables determination of results in respect to frequency, as the five channels represent one per hundred meters in the broadcast band.

WEAF's frequency is 660 kc. and WGY's is 790 kc., so the tests will show what these stations could expect on 20 kw.

The Federal Radio Commission authorized the 200,000 watts and the frequencies. Chairman Robinson dissented. He is opposed to high power.

The tests are to determine the domestic service range of stations using power of this magnitude. The maximum otherwise authorized is 50,000 watts, consisting of 25,000 outright and 25,000 experimentally.

SPEED IS HARD FOR TELEVISION

Washington.

Dr. Alfred N. Goldsmith, a vice-president of the RCA and its chief broadcast engineer, told the convention of the Institute of Radio Engineers, of which he is past president, that technical difficulties are causing the slow progress in the commercial development of television. He said:

"Television, or the transmission of moving images, is by far the most difficult method of radio transmission.

"Compared to photo radio, or the transmission of still pictures by radio, the transmission speed requirements of television are approximately one hundred times greater.

"This fact alone makes television broadcasting subject to objectional effects, which would be of little or no hindrance in telephony or telegraphy."

J. W. Horton of the General Radio Company, Cambridge, Mass., said the scientific problems of pictures transmission were solved years ago, but that a solution of the economic problems is just beginning to appear possible.

Edgar H. Felix, radio consultant of the National Electrical Manufacturers' Association, New York City, spoke, too.

STATION LIMIT ADVOCATED AT I. R. E. SESSION

Washington.

Necessity for limiting the number of broadcasting stations was emphasized by Dr. J. H. Dellinger, chief of the radio laboratories of the Bureau of Standards, addressing the annual convention of the Institute of Radio Engineers. In fact, the necessity extends beyond broadcasting, he explained, as there are only 2,350 channels for world activities.

Discussing the rating of stations on the basis of "public interest, convenience and necessity, he said:

Applies Utility Test

"The interpretation and application of this phrase is a novel development in jurisprudence. The phrase is borrowed from legal terminology used in the regulation of public utilities, such as street-car lines and gas companies." Radio transmitting stations are not public utilities, and yet the test of a public utility must be applied to them for the two basic reasons already given, viz., the potential interference of each radio transmission with every other, and the fact the number of channels is sharply limited.

"The test of 'public interest,, convenience, or necessity' is being applied in broadcasting to mean that the rights of the listeners are superior to those of broadcasting stations. This means, that, as far as possible, interference must be avoided. It means that rural listeners, remote from any station, as well as city listeners, must be given service.

"It means that excessive duplication of programs by many stations cannot be permitted, and that high-power stations cannot be located in the midst of large populous areas.

Must Prevent Interference

"Perhaps the most important implication is that the total number of broadcasting stations must be limited to the number necessary to prevent undue interference. Each of these corrollaries of a purely legal principle requires extensive engineering data for its application.

"The fact that the number of channels is limited and the number of stations assignable to any one channel is again limited, imposes upon the Government the necessity of choice among applicants for the radio channels.

"This is the underlying reason why a Federal Radio Commission came to be created. To provide for choice among those who aspire to construct and use radio stations, Congress created not only the Commission."

EUROPE HALTED BY EARPHONES, SAYS NBC CHIEF

Enthusiastic over prospects of increased interchange of radio programs between Europe and America in the near future, M. H. Aylesworth, president of the National Broadcasting Company, returned from a month's intensive study of broadcasting in England and France.

"I found a universal friendliness beween radio interests," said Mr. Aylesworth, "which augurs well for world-wide understanding through common information. Particularly, the English-speaking world is destined to be much more firmly cemented in the immediate future through the instrumentality of radio broadcasting."

Financing of Stations

Mr. Aylesworth found the British Broadcasting Corporation authorities highly interested in the American method of financing broadcasts through sale of part of the time to commercial clients.

"There are several variations of the methods used in Europe to finance radio," said Mr. Aylesworth, "but I find that all are giving consideration to the American method. However, at present it seems that each country has met the problem in the best way possible under its present circumstances. The business methods abroad, including use of the sponsored program, are quite different from those here."

C. W. Horn, general engineer of the National Broadcasting Company, accompanied Mr. Aylesworth on his trip to Europe, and also visited Germany and Holland to study conditions there. He remained in England, where he is studying British methods with Capt. P. P. Eckersley, chief engineer of the British Broadcasting Corporation.

Compares Numbers of Sets

"England offers some peculiar problems in radio reception," Mr. Aylesworth stated. "There is a large number of small local companies furnishing electric current, with differing voltages, which makes introduction of the electric sets difficult. Both in England and France, a majority of listeners is still getting radio broadcasts by earphones. This is perhaps why there are about 2,500,000 receivers in England and only a few hundred thoussand in France, as against approximately 12,000,000 in the United States."

Mr. Aylesworth was impressed with the strides England's broadcasters are making with rural education by radio.

He intimated that the United States had much to learn from England in this direction.

Building to Resemble a Tube Is Planned

The CeCo Manufacturing Company, tube makers, Providence, R. I., has acquired property at 1312 South Michigan Boulevard, Chicago, which will be used as district headquarters.

The company is thinking of erecting in Chicago of a large office building to resemble the general contour of a radio tube.

Music Bursts from Theatre Wall Pipes

Broadcast speech and music were heard in the Vernon Theatre, Brooklyn, N. Y., although no receiver was consciously used. Albert Sussell, associate member of the Institute of Radio Engineers, happened to be one of the many listening in. It was not a performance for an audience, but rather a treat for those behind the stage, for the music came forth from pipes that ran in the wall.

Mr. Sussell remarked that dissimilar metals in the respective stretches of piping may have produced detection, after the fashion of metal rectifiers in A supplies and dynamic speakers. He reports feeling the pipes vibrate as a low-wave local station's programs were picked up, and hearing speaker volume with quality "not so bad," as the wall was quite a baffle. But most baffling of all was the freak reception.

RCA TELEVISION TESTS WIDENED

To allow a greater period for study of television reception at various locations, especially during the evening, the daily transmission schedule of the Radio Corporation of America experimental television station, W2XBS, has been extended to include the hours of 9 to 11 p. m., E. D. S. T.

Since early in March, when the operating schedule was announced, W2XBS has been transmitting daily from 7 to 9 p m. on a channel of from 2000-2100 kilocycles. Transmitted pictures consist of sixty horizontal lines, each divided into seventy-two elements laterally. Twenty pictures are scanned per second. The new daily schedule will permit experimenters to observe signs. photographs, and views of persons between the hours of 7 and 11 p. m.

Summer Business Large, Says Proskauer

According to Julien J. Proskauer, head of the Trutone Radio Sales Company, 114 Worth Street, New York City, the sale of AC receivers remains at a new high level for this season of the year. This is indicated by the high volume of Si-len-ser sales from all parts of the country, an analysis of these showing thousands purchased by dealers and service stations for installation with new sets sold. This is entirely aside from the sales of Si-len-sers to fans and set-builders. These installacoming in through the power line and save the dealer servicing, besides giving the customer satisfaction from the start. Hundreds of letters are received from service men by this concern, the trend showing that a new field of activity in curing line noises is opened to these men. From all indications, Mr. Proskauer figures that Summer business this year will run way ahead of previous years.

The demand for the Ce-lec-tor, recently perfected by this firm, is steadily growing, showing that a want is being filled by this new band-pass station separator. Circulars on these two products may be had. Address Mr. Proskauer. Mention RADIO WORLD.

BOARD ACTS ON PETITIONS FOR TRANSMISSION

Washington.

The following applications were granted by the Federal Radio Commission:

CeCo Manufacturing Co., Inc., Providence, R. I., WIXAC, experimental license.

Freed-Eisemann Radio Corp., Allwood, N. J., experimental visual broadcasting to operate 2,000 to 2,100 kilocycles and 4,850, to 2,950 kilocycles.

Radio Pictures, Inc., New York, N. Y., voluntary assignment from John V. L. Hogan to Radio Pictures, Inc.

Greeley Square Hotel Co., Hoboken, N. J., WMCA, renewal of license for 30 days.

The Commission made the following changes in station assignments:

KRLD, KRLD Radio Corp., near Dallas, Tex., from dividing time with WFAA to dividing time with KTHS.

KTHS on 1,040 K.C.

KTHS, Hot Springs Chamber of Commerce, Hot Springs, Ark., from 800 kilocycles to 1,040 kilocycles and from dividing time with WBAP to dividing time with KRLD.

WFAA, Dallas News and Dallas Journal, Dallas, Tex., from 1,040 kilocycles to 800 kilocycles and from dividing time with KRLD to dividing time with WBAP.

WBAP, Carter Publications, Inc., near Fort Worth, Tex., from dividing time with KTHS to dividing time with WFAA.

New Removal Rule

The Commission granted permission to the University of Florida, Gainesville, Fla., to discontinue the operation of its broadcasting station, WRUF, for the period beginning August 3, 1929, and ending September 2, 1929.

The Commission adopted the following rule:

"Hereafter applications for construction permit, modification of construction permits or station licenses involving removal of transmitting apparatus must be presented to the Commission at least thirty days before the contemplated removal."

Experimenter Group Occupies New Quarters

Announcement was made from the offices of the Mackinnon-Fly Publications, which recently purchased the Experimenter Group of publications for $500,000, that the combined publications have taken new quarters at 381 Fourth Avenue, New York City. The Mackinnon-Fly group consists of "Plain Talk," "Screen Book," "Complete Detective Novel," and "Wild West Stories and Complete Novel," while the Experimenter group embraces "Radio News," "Science and Invention," "Your Body Quarterly," "Amazing Stories," "Amazing Stories Quarterly" and "Aero Mechanics."

The new home of the combined publications now occupies the entire sixteenth floor of the building, where each of the ten publications has separate editorial offices. The newly equipped laboratory, designed particularly for "Radio News" and "Science and Invention," is located in a corner of the floor in a sound-proof room.

CROSLEY FINDS AC SCREEN GRID TUBE TOO RISKY

Powel Crosley, Jr., president of the Crosley Radio Corporation, Cincinnati, air mailed a letter to dealers, with catalogue sheets telling about new models of Crosley sets.

"Crosley radio with screen grid tubes, of course!" was one announcement in the letter.

One attached sheet, announcing "Crosley 82" of the "1930 line," describes this AC console receiver in two models, "H" with 227 tubes and 245 output, and "S," with screen grid tubes for radio frequency amplification, with 227 and 245 for audio.

Footnote on Tubes

At the bottom of this sheet appears the following:

"Note to Crosley Dealers: The use of screen grid tubes in Crosley 82 is optional to meet the demand of those who desire to experiment and try out things. The screen grid tube and its use in radio sets and circuits has been a matter of constant laboratory experiment in the engineering department of the Crosley Radio Corporation for more than two years. A great many experimental models have been built. Sets utilizing the screen grid tube have been available for production for six months or more, but the Crosley Radio Corporation hesitates to recommend or promote the sale of anything until it has been completely proved.

Calls 224 Tubes Not Uniform

"The use of the screen grid tube by the public presents many problems. One of the most important of them is the question of the production of a sufficient quantity of tubes sufficiently uniform in their characteristics to render satisfactory service and have proper life outside the laboratory.

"The Crosley Radio Corporation is fortunate in having a license under the Hazeltine Neutrodyne patents which enables it to build highly selective, efficient and sensitive radio receivers, using standard tubes to get performance.

"Crosley 82-S with screen grid tubes presents the highest development of the screen-grid tube set to date. It is but little, if any, better in performance than the same set using the heater type tubes (227) with the genuine Neutrodyne circuit.

Mentions Possible Tube Shortage

"Being built in smaller quantities than some of the big-production Crosley models, it should not present a major problem in case of a shortage due to tube manufacturing difficulties in connection with the new type of tube."

The screen grid tubes, with stages properly shielded, require no neutralizing devices.

A second mention of the screen grid tube appears in connection with a model for battery operation.

OXFORD RADIO NEW NAME

The Joy-Kelsey Corporation announces a reorganization of this company and a change in name to the Oxford Radio Corporation. The organization remains unchanged. The new address is 3200 West Carroll Avenue, Chicago. All facilities well be devoted to building the Oxford dynamic speaker.

WBBM Heterodyned by JOHK, Japan

Chicago.

The Federal Radio Commission reckoned without the rest of the world when they made the reallocation of wavelengths last November, says an announcement from WBBM, which is on a cleared channel but finds itself heterodyned by a Japanese station on the same frequency of 770 kilocycles.

Very little of this is experienced in the Central and Eastern parts of the United States, but many foreign fans are having their WBBM signals heteroydned, the station adds.

A letter received by WBBM from a listener, K. L. Williams, Arcoona station, South Australia, says:

"The reception of distant stations is improving with the approach of our Winter and I heard you once again. Just as your station was coming in with good, loudspeaker strength, station JOHK in Japan came on the same wavelength, heterodyning, and making further reception impossible."

RIDER SERVICE MANUAL OUT

"The Mathematics of Radio," by John F. Rider; Volume 1 of "The Service Man's Manual," published by Radio Treatise Company, New York. $2.00.

This book is an explanation of the simple mathematics with which the service man comes in contact continually. The object is to supply the service man with the mathematics which he needs in working out his service problems, which depend on the computation of resistors, inductances, coils, voltages, power, currents, frequency and wavelength.

The author's wide experience with the exposition of service problems has qualified him eminently to write such a book.

The book is indexed so that the discussion appertaining to any problem can be found at a glance, and there is no problem likely to arise which has not been treated.

No advanced mathematics is necessary to understand the book. While a knowledge of algebra will be useful to the reader, it is not essential, for all the algebraic formulas used have been applied and illustrated with numerical values.

There is no doubt that this book will prove a boon to many service men as well as to many fans who wish to know why certain values of coils, condenser and resistors are used in any circuit, and that it will be accepted with enthusiasm.

The book contains 127 pages and 119 illustrations.

Clarostat Also Makes Wire-Wound Resistors

The Clarostat Manufacturing Company, 291 North Sixth Street, Brooklyn, N. Y., is making a full line of wire-wound resistances for every radio need. This is in addition to the well-known line of Clarostat variable resistances.

The new products may be had in very high resistances in flat wire fixed resistors and also in wire-wound volume controls. These are all made with precision and with the long-life factor in view. Full information as to types, resistance values and prices or information on special resistances for manufacturers' use may be had by addressing this concern. Mention RADIO WORLD.

LISTEN DURING SUMMER, SAYS DR. DELLINGER

The bugaboo of "Summer reception" need not bother the radio fan during the summer of 1929, according to Dr. J. H. Dellinger, chief of the radio section of the United States Bureau of Standards.

Improvement in radio transmitting equipment, the use of increased power, particularly by stations on cleared channels, and more efficient and selective receiving sets, Dr. Dellinger says, have combined to make Summer reception, in all essentials, as smooth and satisfactory as that experienced during cool or cold weather.

The burial of the bogy of Summer interference has resulted in more ambitious plans for radio programs during the coming months than have ever been attempted during the mid-year season.

Kent Series An Example

Typical of this is the announcement that the Atwater Kent Summer series, heretofore broadcast over a reduced network, will be carried through this year over the entire coast to coast chain of stations.

Discussing the reception ahead of radio listeners this year Dr. Dellinger says:

"There is every indication that we shall have a good radio summer. In the early days of broadcasting, people were inclined to think that it was hardly worth while to listen in Summer. That is very different now.

Big Improvement

"Tremendous improvement has been effected in transmitting equipment, particularly in the use of increased power. Receivers are more sensitive and selective than ever before. Programs are arranged with special consideration to summer habits.

"As a result, the public has as ample opportunity for radio enjoyment in the summer as in the Winter. Good programs are on the air—both locally and over the various networks. The idea that satisfactory radio reception could not be achieved in summer has been exploded by modern science, invention and progress."

CeCo Reports Assets In Excess of $600,000

CeCo Manufacturing Co., of Providence, R. I., makers of radio tubes, in a balance sheet issued as of March 31st, the end of its fiscal year, shows current assets in excess of $600,000. Cash on hand and in banks exceeds $500,000. The $100,000 extra is in call loans. The ratio of current assets to current liabilities is 6 to 1. Patents, processes and trademarks are carried at $1.

The company has completed plant improvements costing more than $500,000. Its new factory covering three and one-half acres will be occupied this month. It will have a capacity of 45,000 tubes daily. Ernest Kauer is president and directing head.

WEBER COMPANY MOVES

The Weber Distributing Company, formerly at 90 West Broadway, New York City, has moved to larger quarters at 200 Hudson Street.

Push-Pull All the Craze

Why The System Has Seized Public Fancy This Season

By Herman Bernard

Managing Editor

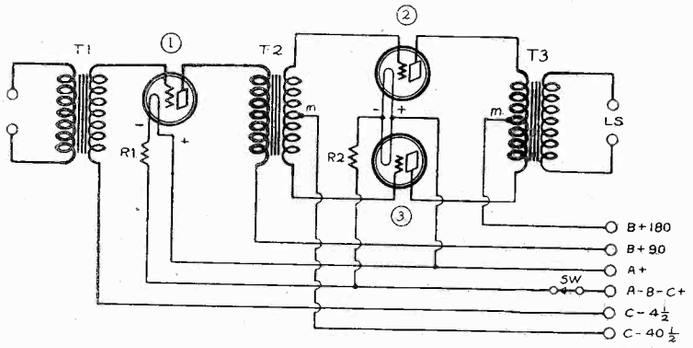


FIG. 1
A BATTERY-OPERATED TWO-STAGE AUDIO AMPLIFIER WITH THE FINAL OR OUTPUT STAGE PUSH-PULL. T1 IS A STANDARD AUDIO TRANSFORMER. T2 IS A SPECIAL ONE, KNOWN AS A PUSH-PULL INPUT TRANSFORMER, WITH SECONDARY MIDTAPPED AT M. THE OUTPUT TRANSFORMER T3 IS SPECIAL

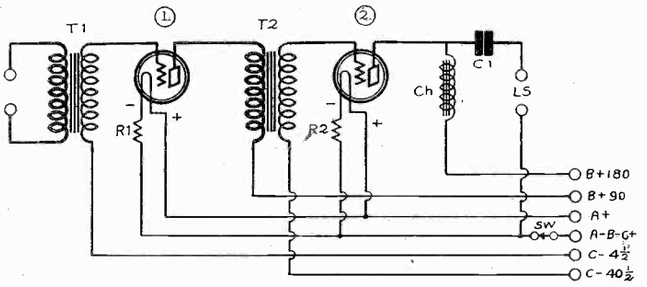


FIG. 2
A SINGLE-SIDED TWO-STAGE AUDIO AMPLIFIER FOR BATTERY OPERATION. T1 AND T2 ARE IDENTICAL OR SIMILAR TRANSFORMERS. TUBE (1) IS 201A OR 112A, WHILE THE POWER TUBE IS A 171 OR 171A. R1 IS A 1A AMPERITE. R2 IS A 1A AMPERITE FOR 171A OR A 112 AMPERITE FOR 171. CH IS AN AUDIO CHOKE COIL, 20 HENRYS OR MORE, WHILE C1 IS 2 MFD. NOTE THE LOUDSPEAKER RETURN TO THE FILAMENT CIRCUIT.

GREATER interest has been shown in push-pull audio frequency amplification this season than ever before. The chief advantages of push-pull are that greater undistorted power output is made possible and clearer tone. An extra tube is needed, also special transformers or other coupling devices. The object, however, is not to produce more volume, but to be able to handle greater volume without distortion. The amount of volume depends on the circuits that precede the push-pull stage, since this stage is almost universally the output or power tube stage.

Assuming transformer coupling, the input to the push-pull stage is through a center-tapped secondary, and the output through a center-tapped primary. This is shown in Fig. 1. An ordinary transformer may be used in an emergency as the input transformer if a high resistance potentiometer is placed across it, and the common grid return made to the movable arm. This arm is turned until the electrical-center is found. But the resistor method is not available for the output transformer, because direct current is flowing in this circuit, and the resistance would cut down too severely the voltage supplied to the plate, and constitute a poor load.

Case of Two "Taps"

The input transformer, therefore, consists of a standard primary with a midtapped secondary. M designates the midtap. Sometimes there are two "taps," indicating that the secondary is in two separate parts, instead of being a single winding center-tapped. If in two parts it requires a potentiometer, with extreme ends connected to the coil terminals and movable arm to C bias. The adjustment of the resistor balances out any unevenness that might be present due to transformer construction or circuit connection or tubes used.

The input is made to the push-pull stage by connecting the two grid terminals to the respective grids of the two tubes (2) and (3) in the diagram. Then the output is taken through a center-tapped primary. The secondary of this step-down or one-to-one ratio transformer is connected to the loudspeaker.

Special transformers for different types of speakers usually are recommended, that is, one type for magnetic speakers, another type for dynamic speakers. In the dynamic class some transformer manufacturers designate which of their transformer work best with particular makes of speaker.

Sometimes this secondary is tapped, so that you can use the tap that works best. The reason is that different speakers have different impedances, and there must be a definite relationship between speaker (load) impedance with the tube (sink) impedance.

Phases Opposite

The diagram shows a battery-operated two-stage audio amplifier, in which the first tube might be a 201A or a 112A, and the push-pull pair would be 171A or 171. The A battery voltage is 6 volts, dropped to 5 by a 1A Amperite (R1) and a 112 Amperite for R2, if 171A tubes are used for push-pull. If 171s are used here, put two 112 Amperites in parallel for R2.

A significant feature about push-pull is that the input to the last stage is thereby made at a phase difference between tubes (2) and (3) of 180 degrees. The voltages and currents are said to be equal but opposite at any given instant. That is, when tube (2) is 20 volts positive, tube (3) is 20 volts negative. This phenomenon balances out the even order of harmonics and tends to eliminate extraneous noises, such as line noises, hum and, to a lesser extent, motorboating.

The plate circuits of the push-pull stage are likewise 180 degrees different in phase. The tube in each instance turns the phase around 180 degrees, so that the output phase is exactly opposite to the input phase, but as this reversal applies equally to the two tubes, the relative angle is the same. Any difference in phase is representable by an angle because of the usual analysis of phase displacement by geometric means.

Voltage and current usually do not run abreast in electrical circuits, except where the circuits consist of pure resistance. In coil circuits of all kinds the current lags behind the voltage. In capacity circuits the voltage lags behind the current. Whatever displacement arises is relatively preserved by the push-pull stage, although absolutely turned around half way. If the current is 10 degrees behind the voltage at the input to the push-pull stage, then it is that way for one tube, while the other has a 190 degree angle. There are 360 degrees, the same as in the circle from which the phase angle representation derives its origin.

Object Is Quality

While for a single-sided circuit, like the one shown in Fig. 2, the general run of transformers may work fairly well, for a push-pull stage accurately wound and high-class transformers become a virtual necessity, particularly because of the balance that must be struck. This requires special pains in the winding and testing of the transformer.

Another reason for choosing high-grade transformers for push-pull is that the selection of push-pull is on a quality basis only, as the desire is to get the best and clearest tone. Cheap transformers would not produce this. Actuated by a desire for clear tone, the constructor who has bought first-grade push-pull input and output transformers would not want to saddle them on a circuit that had a distorting stage of audio ahead of the fine push-pull. Therefore the three transformers in a two-stage push-pull circuit should be as good as you can afford.

The push-pull design is not as familiar to most constructors as is the single-sided audio circuit, but no difficulty in the actual construction of the push-pull design need arise.

Some experimenters wonder whether a push-pull stage has its tubes in series or in parallel. The tubes are in series. Therefore the plate impedances add up. Two tubes in parallel have approximately half the impedance of a single similar tube, while tubes in series (e. g., push-pull) have approximately twice the impedance of one tube alone.

Needs Identical Tubes

Both push-pull tubes must be of the same type. In fact, even if of the same type, they should be as close to being identical as is possible. In manufacture of tubes, even of the same type, some

(*Continued on page* 18)

Public All Ears to Tone

Forces Solution of Problem of Pure AF Amplification

By Ludwig Arnson

A FEW years ago, when the potentialities of radio were just beginning to be understood and the future loomed like a hazy, half-formed picture, the energies of those connected with the radio industry were directed in one great channel.

That channel was the development of the art of receiving radio signals, and consisted mainly in developing new circuits, perfecting the vacuum tube, and trying to use more and more of these vacuum tubes in these circuits with a view to making radio available to everyone, regardless of locality or distance.

This goal was achieved. The receiving set of today is not greatly influenced by distance and now radio progress is branching out into another and larger stream that exceeds in scope that of its predecessor. This new trend is the development not of power in distance reception, but of power in the reproduction of the received signal.

Audio Problems Solved

Organizations are now devoting their energies to the preservation of the perfection of the received signal. The main problems encountered in this field of audio-frequency reproduction, although they have been great, have been vanquished just as were the problems of radio-frequency reception before them. The modern home receiver not only brings in the signal, often from a great distance, but it reproduces it with a degree of power and a quality of tone that makes radio truly an "entertainment" in every sense of the word.

It is unfortunate though true that the average set builder and radio enthusiast have always taken the audio-frequency amplifier more or less for granted. It is looked upon merely as a matter of a couple of tubes, a couple of transformers, and the job is done. Such factors as biasing, tube characteristics, impedance, transformer response, etc., never assume the importance that was attached to the number of turns on the coils, the size of the condensers, the type of the hook-up wire, or other details of minor importance in the radio-frequency end.

More Interest in Audio

Now that the importance of undistorted power and purity of tone have become more fully recognized, the average set owner is taking a greater interest in this part of the receiver, and the intensely interesting facts previously known to the few are now being set as standards by the many.

Perhaps the most important feature in the designing of a good audio amplifier, just as it is in the radio-frequency end of radio reception, is that of adapting or matching each circuit to the preceding circuit. This is done by regulating the components of each circuit in such a manner that they compensate for the charactreistics of the components of the preceding circuit.

In a radio receiver, for instance, if the output of the detector, the amplifier, the power amplifier and the speaker all exhibit different characteristics at different frequencies, the final output of the loudspeaker will very likely be deficient in some ranges of the musical scale and over-emphasized in others.

There are, of course, artificial means of making the sound more pleasing, but these cures are never as satisfactory as a complete elimination of the trouble at its source.

Poor Disguises

In the case of a radio receiver equipped with inferior transformers, the result may be a poor response on the low notes. This result is often disguised by using a loud-speaker that will dull or mute the high notes, which undoubtedly makes the output more pleasing; yet a critical musical ear invariably detects the fact that the entire range is not being reproduced faithfully, but is simply disguised by the over-emphasized booming of the lower frequencies and the stunting of the high.

In a well designed assembly the input impedance of the amplifier is carefully matched to the source that feeds it, while requirements of the loud-speaker that is to be used. This is true not only with the input of a radio set, but with any source that may be operating the amplifier, be it microphone or phonographic pick-up.

Plenty of Leeway

A feature of flawless reproduction at great volume is the rating of an audio frequency amplifier. An amplifier, like any other instrument, must have plenty of "leeway." Just as a resistance manufacturer will rate a resistor at, for instance, 2 watts, when it will really stand up to 8 or 10 watts, so must the super-power amplifier be rated not at what it will do in sheer noise, but what it will give in "undistorted output."

To the average owner of the usual dynamic speaker, the need and uses of such tremendous power would seem extraordinary, and yet the field of utility is growing every day for installations such as these. The talking moving picture theatre demands an amplifier of great power, and, with the general acceptance of the "talkie," the need is becoming greater every day for amplifiers designed to meet this purpose. The ball park, the prize fight ring or the outdoor stadium all require amplifiers to carry the full volume of the sound to the farthermost corners.

Industrial uses increase also, as the value of this service becomes more appreciated. Hospitals, for instance, are using moderate power amplifiers to notify the personnel of the positions of doctors and internes at all times, just as large factories use their amplifiers to keep in touch with departments and personnel.

Even Neighbors May Like It

Although radio etiquette dicates "do not annoy the neighbors," there are many uses for tremendous power which, quite paradoxically, sometimes gives enjoyment to the neighbors, and to everyone else who may not be near enough to hear the amplifier, be it a powerizer or any other.

Literature Wanted

THE names and addresses of readers of RADIO WORLD who desire literature on parts and sets from radio manufacturers, jobbers, dealers and mail order houses are published in RADIO WORLD on request of the reader. The blank at bottom may be used, or a post card or letter will do instead.

RADIO WORLD,
145 West 45th St., N. Y. City.
I desire to receive radio literature.

Name .....

Address .....

City or town .....

State .....

H. Hindmarshm, 1735 2nd St., S. E., Canton, Ohio.
James Chapman, 2847 N. Marvine St., Philadelphia, Pa.
Geo. D. Marvil, Box 57, 126 Ridge Ave., Darby, Pa.
C. W. Hedge, Chenoa, Ill.
C. B. Houston, The Bank of Nova Scotia, Smiths Falls, Ont., Can.
Irwin Dlugatch, 835 DeKalb Ave., Brooklyn, N. Y.
O. D. Cartwright, 509 North G St., Muskogee, Okla.
G. T. Burch, 3710 Ridgecroft Rd., Gardenville, Baltimore, Md.
C. H. Weldy, 219 W. Broad St., Tamaqua, Pa.
Fred Stroehle, 2112 32nd St., Rock Island, Ill.
John More, 2533 W. Oxford St., Phila., Pa.
H. L. Thuot, 421 So. Main St., Fall River, Mass.
Grovers Radio Shop, Mr. Fred Grover, Mansfield, Mo.
W. H. Beaizley, Radio Service, St. George, Ont., Can.
E. J. Walsh, 147 Coal St., Wilkes-Barre, Pa.
Ralph Crays, 2205 N. Meridian St., Indianapolis, Ind.
LeRoy Scherer, 636 N. Illinois, Indianapolis, Ind.
A Trinkwald, 1881 Mannering Rd., Cleveland, Ohio.
M. McMorrow, Steelville, Mo.
Harry L. Rogers, 33 Laurel St., West Lynn, Mass.
E. F. Asbill, 908 No. 5th, Sayre, Okla.
Cecille Hennessy, 3 Wykagyl Terrace, New Rochelle, N. Y.
P. J. McCutcheon, care The Colorado Fuel & Iron Co., Pueblo, Colo.
Albert H. Neely, 2037 E. Fletcher St., Phila., Pa.
Clarence H. McKay, 50 Wakefield St., Rochester, N. Y.

H. M. Woods, 5246 Winthrop Ave., Chicago, Ill.
Chas. F. Loftus, 65 Sove St., Chicago, Ill.
Fred J. Dean, 114 Charlton St., Southbridge, Mass.
Chas. A. Schehl, 4200 Harford Ave., Baltimore, Md.
Wm. I. Black, 1409 Evans Street, McKeesport, Pa.
Daniel Crosley, 4304 Georgia Ave., Washington, D. C.
Arthur Marchand, Retail Radio Dept., The Aeolian Company, 689 Fifth Ave., New York City.

R. Wm. Tanner, 2016 Erie Ave., Springfield, Ohio.
Claude Bennett, Portland, N. Y.
Mrs. H. K. Warren, Kayenta, Ariz.
Sylvan Elencweig, 1342 Forbes St., Pittsburgh, Pa.
Harry Weir, 805 E. 13th St., Duluth, Minn.
D. T. Wiles, Box 618, Monroe, La.
Chas. J. Kelly, 923 12th Ave., S., Providence, R. I.
R. A. Willis, 128 Ely St., Alma, Mich.
Wm. Osberg, 155 Park St., Jamestown, N. Y.
B. G. Thompson, 4616 Prairie Ave., Chicago, Ill.
Otto Johnson, 627 P St., Fresno, Calif.
Stewart Macfarlane, Fundicion Union de Sagua, Apartado No. 43, Sagua La Grande, Cuba.
F. W. Jerrell, 217 E. Emerson St., Princeton, Ind.
A. H. Williams, P. O. Box 952, Fort Myers, Fla.
G. M. Mann, 26 Hemans St., Worcester, Mass.
Wm. A. Stead, 385 Madison Avenue, New York City.
Wm. E. Murphy, 241 Cambridge Ave., Buffalo, N. Y.
Manuel G. Pales, P. O. Box 1195, San Juan, P. R.
Wm. E. Hill, 18049 Moenart Ave., Detroit, Mich.
Nestor Tamminen, Box 32, West Paris, Me.
J. F. Weinman, 17 W. Fayette St., Baltimore, Md.
Geo. T. Dixon, Box 328, Saxton, Pa.
J. J. Buckalew, P. O. Box 95, Milford, Dela.
Harold C. Sohnlein, 104 Plymouth St., Buffalo, N. Y.
Prince Radio Shop, E. R. Prince, Logan Ave., N. Parkersburg, W. Va.
P. Sweeney, 353 Furman St., Brooklyn, N. Y.
E. F. Winans, Lake St. Croix Garage, Prescott, Wis.
A. Neal, Pando, Colo.

Automatic Volume Con

By Capt. Peter

Contributing

Tends to Reduce Fading Effects, Distortion Due to Tube Input to Control May Be Used—

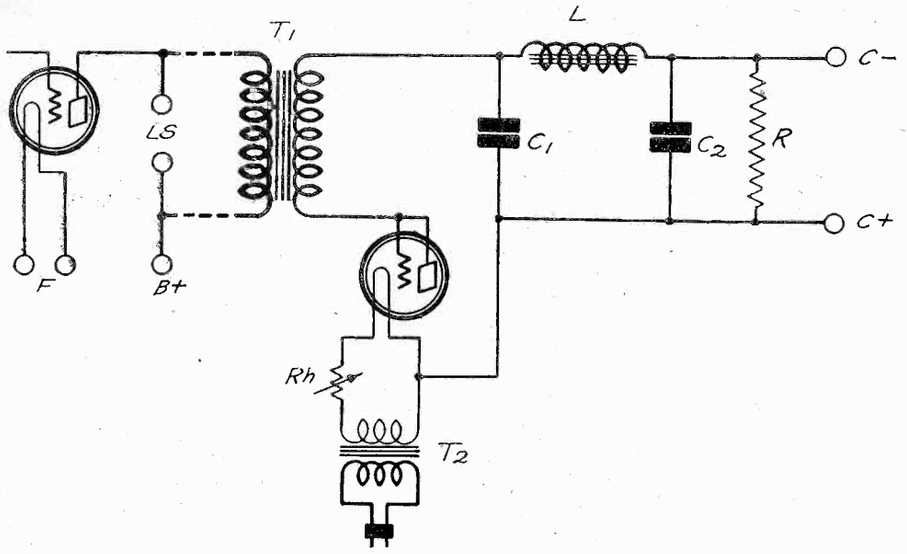


Fig. 1

A SIMPLE C BATTERY ELIMINATOR CONNECTED TO THE OUTPUT OF A RECEIVER BY MEANS OF WHICH THE VOLUME OF THE RECEIVER MAY BE CONTROLLED AUTOMATICALLY. THE FILAMENT OF THE RECTIFIER TUBE IS HEATED WITH AC.

THERE is much interest at this time in automatic volume controls for radio receivers. Two classes of listeners are especially interested, namely, those who have sensitive receivers capable of picking up distant stations and who are troubled by fading, and those who live in apartment houses where there are many antennas which contain tuned circuits. Most of the owners of radio receivers come in either or both of these classes, and hence the interest in automatic volume controls is general.

An automatic volume control, if designed and adjusted correctly, will hold the volume fairly constant for wide fluctuations of the signal strength at the antenna, at any intensity desired. With each automatic control there is usually a manual control for preliminary adjustment of the volume to the desired level. The automatic control maintains this level as the signal intensity varies.

Two Types of Control

There are two types of automatic volume control. In the first the radio frequency signal is put into the volume control tube to effect changes in the direct current in its plate circuit. This current, after suitable filtering, is then utilized to change the grid bias on the radio frequency tubes in the receiver.

The proper arrangement is effected when the signal increases the bias. This requires that the volume control tube be used either as a rectifier or as a plate bend detector.

When the signal increases, the plate current, and hence the grid bias which depends on the plate current, increases. Thus the greater the signal strength, the greater the bias and the less the amplification. A balance is effected between amplification and signal strength, the volume level depending on the previous adjustment of the volume control tube and circuit.

Audio Input

The second type of automatic volume control is essentially the same, except that audio frequency is put into the volume control tube.

While the two types of automatic control are essentially the same in principle, they are widely different in effect and in construction. The first type, or that which employs radio frequency on the control tube, is a true signal control which does not change the quality of the output. The second, on the other hand, does change the quality. In effect it does automatically the same as the monitor at the transmitting station who controls the degree of modulation. It lowers the intensity of the loud passages and at the same time permits the weak to come through with full strength. But it acts more quickly than any human monitor possibly could.

However, this levelling out of the intensity does not result in any appreciable impairment of the quality. Indeed, it may result in much improvement, for the limitation of the volume on loud passages prevents harmonic distortion due to overloading of tubes, which is the most serious form of distortion and the most readily noticeable.

Range of Volume

The volume range in orchestral music may have a range of 100,000 to one from fortissimo to pianissimo passages. A radio system, including the transmitter and the receiver, would be very costly if it were to handle such intensity variations. Therefore the range is reduced to about 1,000 to one, which is done by the monitor at the transmitter. The automatic volume control utilizing the audio signal would reduce this still further.

This great reduction in the intensity range is not noticeable, because the ear will not respond to it. If the automatic volume control, or the monitor, does not limit the range, the ear does it. When the limitation is left for the ear, the entire radio system may be overloaded on the strong passages, resulting in harmonic distortion. The ear does not eliminate this, but accepts it keenly, even if the sensation is unpleasant. Furthermore, when the ear is forced to limit the intensity, a great strain is imposed on the auditory mechanism. So the monitoring and the automatic volume control not only relieve the ear of much work but also of much unpleasant distortion.

Easy of Application

While the radio frequency operated volume control is more faithful, the audio frequency control is more easily applied. This is because more power is available in the audio frequency portion of the circuit, and a single rectifier tube suffices. Fig. 1 shows one possible circuit arrangement for a volume control using audio frequency.

The primary of transformer T1 is connected across the loudspeaker terminals of the receiver. Thus the primary voltage on T1 is the same as the signal voltage across the speaker. The type of transformer to be used is not of great importance. It would depend on the average signal voltage across the speaker and on the bias needed for the radio frequency tubes. A 1-to-1 transformer should suffice in most instances, and it may be an audio coupling or output transformer.

The volume control tube may be any amplifying tube whatever. The type of tube to choose would depend on what filament voltage is available for it. A —99 tube is as good as a 250. Indeed, a small tube is preferable to a large one.

The rheostat Rh in Fig. 1 is for adjusting the grid bias, and hence the volume. If much resistance is used, the voltage at the output will be low. Hence the bias will be low and the amplification high. When no resistance is used, the bias will be high and the amplification high.

Choice of Filter Constants

In a circuit of this type it is necessary to have a filter to take out the audio frequency fluctuations. The output voltage should respond only to the slow fluctuations in the intensity, that is, to the mean audio frequency amplitudes. Hence the filter must be chosen so that hum or sig-

Right or

(Answers on

1—The plate of a tube is positive with respect to B plus on the battery or eliminator.

2—The potential of the grid of a tube is alternately positive and negative while a signal is being impressed on it.

3—The percentage of modulation of a carrier wave remains constant while a person speaks into the microphone

4—Most of the sound from a stringed musical instrument is radiated from the strings.

5—The maximum voltage amplification that can be obtained per stage of direct coupling is the amplification constant of the tube.

trol Prevents Ear Strain

V. O'Rourke

ditor

s Well As to Prevent Harmonic verloading—Either RF or AF ircuits for AC and Batteries

nal components as slow as 16 cycles will be eliminated from the output of the rectifier.

The choice of filter constants depends not only on the frequency of the voltage impressed on the rectifier tube but also on the current that is taken from the circuit, that is, on the value of resistance R. The larger this resistance is, the more easily can the rectified current be filtered.

Another Reason

There is another reason for making this resistance high. If it is low the volume control tube will take considerable energy from the loudspeaker, since the input transformer is connected in parallel with it. When the output terminals of the rectifier circuit are open virtually no energy is taken from the speaker.

A suitable value of R is .5 megohm. The resistance may be fixed in value or variable, such as a volume control Clarostat. Or it may be a high resistance potentiometer or a duplex Clarostat. In this case the C minus terminal should be connected to the midtap or the slider so that the bias may be varied. This furnishes an additional means of adjusting the circuit to the desired volume level.

When the value of R is as high as .5 megohm the capacity of each of C1 and C2 need not be more than .5 mfd., and the inductance coil L may be the secondary of an old audio transformer.

Battery Set Control

The volume control circuit is an experimental one. There are too many volume requirements, and too many different receivers to be controlled, to give exact specifications. But the circuit is simple and can be assembled out of parts which in most instances are already at hand. Who does not have a spare tube, a spare socket, a few extra condensers, and a couple of old audio transformers? The circuit can be hooked up and tried out in half an hour.

The automatic volume control discussed is not limited to AC sets. Its application to battery sets is even simpler. Fig. 2 shows the arrangement for a battery set. The rectifier tube is connected across the filament battery just as any of the other tubes. The rheostat or Amperite in the filament circuit of the tube is put in the positive leg, but otherwise the circuit is the same. It is not necessary to provide a terminal for C plus in this instance, because in any battery set A minus is the same as C plus, and this connection is made automatically in the wiring of the receiver proper.

It is understood that the voltage provided for by the volume control tube is to be used as bias on the radio frequency amplifiers, and not on any audio frequency amplifier. It is permissible in some instances to use the voltage to control the bias on a detector. When that is done it should not be used for bias on any radio frequency amplifier.

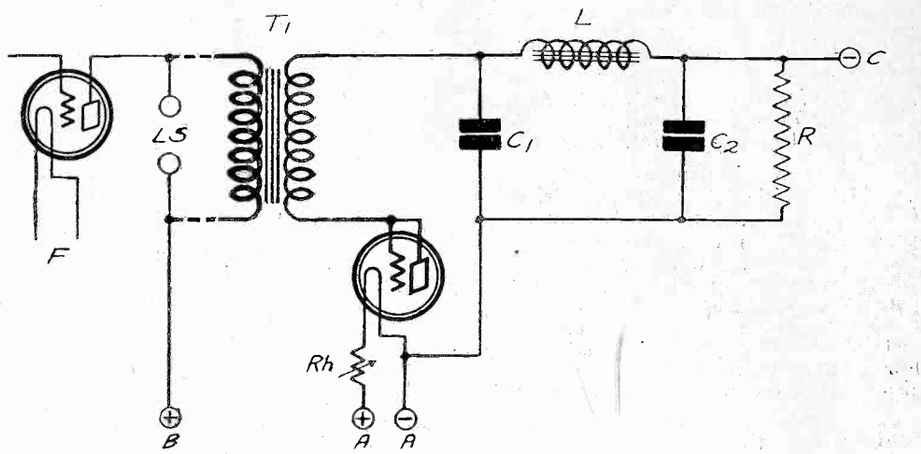


FIG. 2

THE SAME CIRCUIT AS A FIG. 1 ADAPTED TO BATTERY SETS IN WHICH THE RECTIFIER TUBE IS CONNECTED ACROSS THE FILAMENT BATTERY. NO TERMINAL NEED BE PROVIDED FOR THE C PLUS CONNECTION.

Wrong?

e 16.

6—The best material for a permanent magnet for loudspeakers is cobalt steel.

7—A voltmeter or ammeter designed for alternating current can be used for measuring direct voltages or currents.

8—The selectivity of a Super-Heterodyne is due to the sharpness of the oscillator.

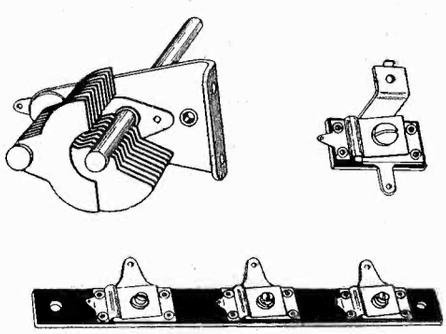
9—The repeat points in a Super-Heterodyne can be eliminated by tying the condensers together.

10—The length of a radio wave multiplied by the frequency is equal to the velocity with which the wave advances. This holds true for other types of wave motion, no matter where encountered.

3 New Parts Swell Hammarlund Group

The Hammarlund Manufacturing Company announces three new parts. One part is a new antenna tuning condenser with long shaft. The catalog number is MC-19-G.

A neutralizing condenser strip, catalog number is MC-19-G.



A neutralizing condenser strip, catalog number EC-35-KW3, but the second new part has maximum capacities of 35 to 80 mmfd., and 100 mmfd., but may be ordered in quantity for any number of condensers and in any capacities.

A bracketed neutralizing condenser, EC-35-KFB, the third part, may be used also for grid condenser on short waves, or for equalizing. Maximum capacities, 35 mmfd. and 100 mmfd.

Full information may be had from the Hammarlund Manufacturing Company, Inc., 424 West 33rd Street, New York City. Mention RADIO WORLD.—J. H. C.

Nation Will Hear Hoover on May 30

President Hoover's Memorial Day message will be broadcast to the entire nation as he speaks in Arlington Amphitheater beside the tomb of the Unknown Soldier of the World War.

The entire proceedings of the solemn memorial service by the Grand Army of the Republic in the historic Virginia bowl will be heard through the combined networks of the National Broadcasting Company from coast to coast, from 2:00 to 4:00 P. M., Eastern Daylight Time, May 30th.

KELLOGG APPOINTS LEIGHNER

The Kellogg Switchboard and Supply Company, manufacturers of Kellogg radio receivers, announced the appointment of Wm. J. Leighner as works manager.

For the past six years Mr. Leighner has held the position of works manager for Westinghouse plants located at South Bend, Ind., Milwaukee, Wis., St. Louis, Mo., and Valdosta, Georgia.

SCHOENBERG LEAVES FOR EUROPE

Leon Schoenberg of the radio advertising department of the New York "Herald Tribune" sailed on the S.S. Columbus, for Europe. His first objective is Austria where he goes to see his mother whom he has not seen for twenty-six years.

DeFOREST GETS MEDAL

Dr. Lee DeForest received the John Scott Medal from the Board of Directors of City Trusts, Philadelphia, at a meeting of The Franklin Institute. Dr. DeForest received the medal and $1,000 for his invention of the vacuum tube.

Amazingly Se
Takes Coun

Screen Grid AC Tuner Design

By J. E

Technical

[*Few circuits in the past several years have so quickly and fully been accepted by home constructors and custom set buildcrs as the MB29. Part I of the article on this screen grid AC circuit was published last week, issue of May 18th. The RF channel has four AC screen grid tubes. The detector is a 227, worked on plate bend rectification. A power amplifier is to be used in conjunction with this outstanding receiver.*

James Millen, general manager of National Company, an engineer of note, and Professor Glenn H. Browning are responsible for the design. They tuned in nine Pacific Coast stations from Malden, Mass., in one evening at speaker volume.

Any questions regarding the circuit or parts therefor should be addressed to J. E. Anderson, Technical Editor, Radio World, 145 West 45th street, New York City.—Editor.]

ALL the cathodes of the radio frequency amplifiers are connected to the midpoint of a 60 ohm resistor, R2, placed across the 2.5 volt heater winding, the object of which is to balance out hum. It will be noted that this resistor has been placed in the center tube so that it is placed symmetrically with respect to the other tubes. For reasons of symmetry R1 and C5 have also been placed near this tube.

Compact Assembly

Fig. 1 showed the radio frequency portion and the detector. This part is built into a compact unit, as will be seen in Fig. 3. In the center is the tuning control with the knob at the bottom and the dial window at the top. A handsome modernistic escutcheon lends an artistic touch to the assembly. The shaft at the left projecting from the metal base is the volume control. The shaft at the right is the AC switch control. The binding post on the base at the right end is for the antenna.

The tuning condensers come in two equal sections of two condensers each, placed symmetrically with respect to the drum dial. The cylindrical cans directly back of the condensers sections contain the tuning coils and the filters. The tubes are placed back of the coil containers. The coils, condensers and the tubes are placed so that the leads connecting them are only about an inch long where exposed.

The parts not accounted for in Fig. 3 are placed under the aluminum base-panel.

A good audio amplifier should be used with this tuning unit to complete the receiver. There are many compact power amplifiers which are suitable. In Fig. 3 is shown a neat assembly of the tuning unite with the National 245 push-pull amplifier and power supply, as well as a dynamic loudspeaker and an electric phonograph motor. The speaker is mounted directly over the tuning unit and the phonograph motor over the power supply. The box is the top part of a commercial radio high boy console.

The console assembly is exceptionally neat and compact considering that it contains both a complete radio receiver and an electric phonograph, with no leads to it except a small antenna and the power lines. It is worthy of imitation by those who wish their sets and phonographs disposed in an artistic manner.

The front of the console is large enough to afford a good baffle board effect for the dynamic loudspeaker, thus making it unnecessary to provide another baffle board. Box resonance can be avoided by leaving the back of the console open, or at least that part devoted to the speaker. It is also desirable to leave the other rear part open to provide ventilation for the power devices. By "leaving it open" is not meant that the parts should be entirely exposed, for ventilation will be good if the back is covered by a silk screen, and this will not add to the box resonance to any appreciable degree.

Other Arrangements

Some builders may prefer other arrange-

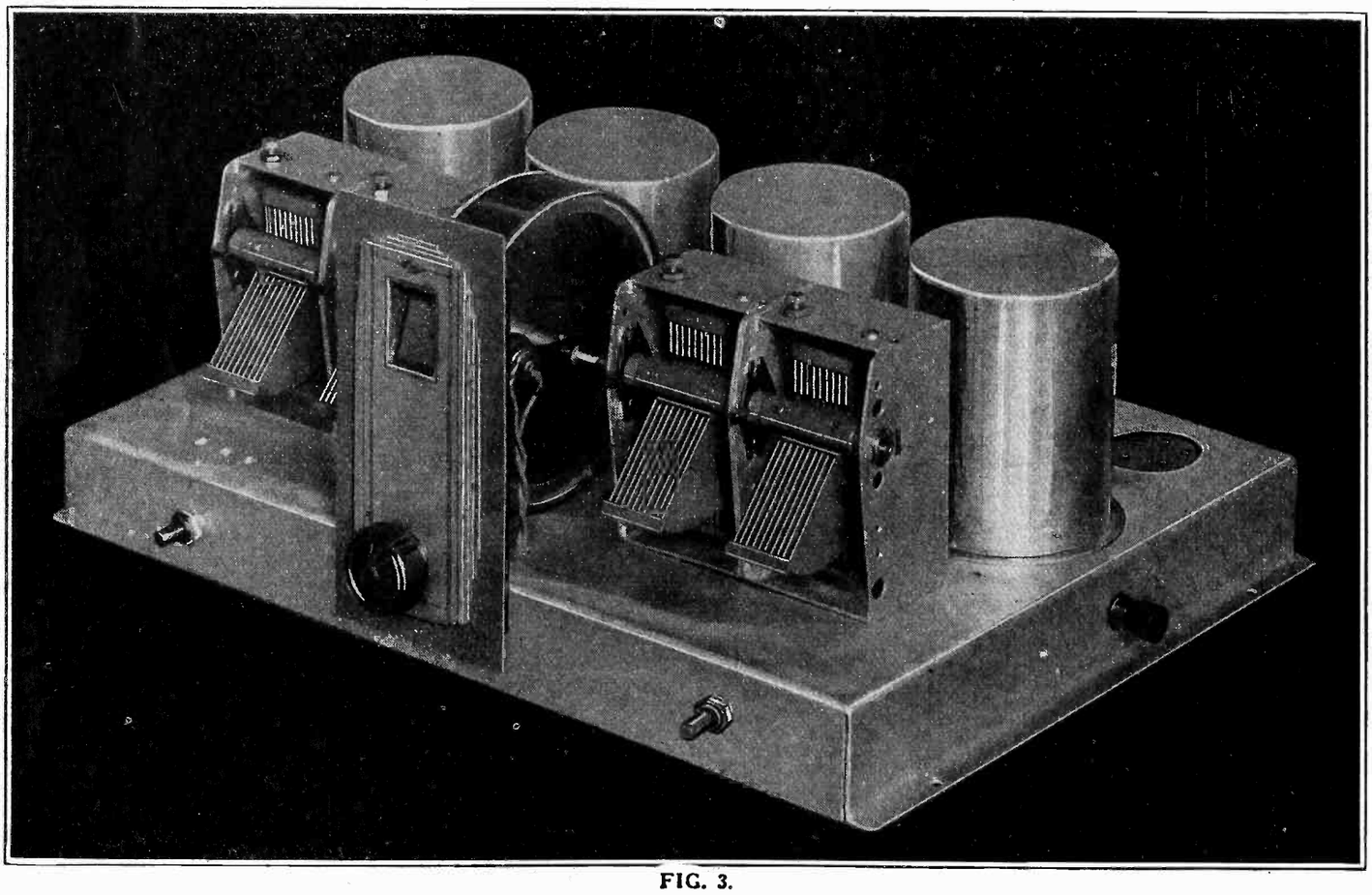


FIG. 3.

THE ASSEMBLY CONSISTS OF THE ALMUINUM SUBPANEL, WITH FIVE SOCKETS BUILT IN; THE FOUR SHIELDS WITH TUNING COILS AND OTHER PARTS INSIDE; A 4-CONDENSER GANG; A DRUM DIAL; A VOLUME CONTROL (LEFT) AND A SWITCH. THE ENTIRE OUTFIT IS NEW, INCLUDING CONDENSERS AND MODERNISTIC DIAL.

nsitive MB29

try by Storm

ed to Assure Out-Performance

Anderson

Editor

ments of the parts. For example, they may prefer to have the front panel arrangement more symmetrical, so that the tuning dial would be in the center of the set. Naturally, this will require more room, unless the various units are assembled in skyscraper fashion. The phonograph, for example, may be placed on top, the tuner next below, and the loudspeaker next and the power supply at the bottom. When one uses completed units, such as the tuner here described and the audio amplifier and power supply pictured, there is no danger of getting the wrong arrangement, since there is nothing that could be assembled in the wrong way. Any arrangement artistically satisfactory will be all right electrically. And there is little chance of getting it wrong acoustically, either, so long as the speaker is not boxed up completely.

Short Antenna Sufficient

One advantage of using a super-sensitive radio frequency amplifier, such as has been described, is that it can be used with a very short antenna. A few feet of wire running up along the wall, back of the set, will suffice for all local stations, and for most distant stations, too. It will not be necessary to string unsightly wires around the entire apartment, nor to get up on the roof to install an aerial, such as was necessary in the days of the crystal receiver. In fact, a wire around the console interior would provide sufficient pickup.

While it is desirable to provide a good ground to a cold water pipe, this is not necessary to obtain sensitivity. It is merely desirable for the purpose of adding stability. It is usually better to have a definite ground than to depend on the ground through the power leads. But so far as sensitivity goes, it is not necessary to provide a ground at all. It is no more necessary than it is to do so for a sensitive Super-Heterodyne which employs a loop pick-up. The present set is capable of greater sensitivity than many multi-tube Super-Heterodynes which have been lauded in strong superlatives.

Searching Tests

The receiver will be subjected to the most searching tests throughout the country as to sensitivity, selectivity, stability and it is confidently expected that it will "prove up" on all these points as satisfactorily as preliminary tests and design analysis indicate. The results of these tests will be reported in full as soon as they will have been made.

During the preliminary tests conducted by James Millen, an antenna of only a few feet of wire was used, and he succeeded in getting loudspeaker volume, at Malden, Mass., of nine Pacific Coast stations, some of which are rated as low power stations. This speaks well for the selectivity and sensitivity of the receiver, and lead us to believe that our own tests will yield favorable data.

Assembly a Pleasure

The radio frequency amplifier may be obtained both in kit form and ready wired. Most radio fans interested in an exceptional receiver will want to do their own assembly work. They will want to know whether or not the circuit is easy to assemble and to wire. Let them be assured that the work is extremely simple. The kit may be obtained even partly assembled.

The interstage transformers, being critical as to adjustment, must necessarily be assembled and adjusted in the factory, where all can be made exact duplicates of a standard. This work could not be done in the radio fan's laboratory. So the work of assembly and wiring is simply fitting pieces together and making a few soldered connections. Each component fits exactly into its place, and nowhere else, and each lead almost automatically points to the point to which it should be connected. It is a real pleasure to assemble and wire a job like that, especially when it promises to result in a receiver which will be the envy of the neighbors.

Features of Tuning Coils

A word might be said regarding the interior construction of the interstage coils. The radio frequency choke is placed near the bottom. Here also is placed the by-pass condenser. The tuning coil proper, consisting of a primary winding of 25 turns and a secondary suited to the condenser with which it is tuned, has been placed directly in the center, having been raised up by a specially constructed support. Thus the coil is as far as possible from the aluminum shielding, for a given size of the cans, the capacity between the coils and the shielding is the minimum. Further, the induced currents due the magnetic field are as small as can be. This placement has an important bearing on the efficiency of the coils. Another feature of prime importance is that the coils have been made exactly alike with machine precision.

[*This concludes the second instalment of J. E. Anderson's comprehensive article on the new MB29. It is such a noteworthy receiver, as he must have convinced you already, that many thousands of readers will look forward with eager interest to the third instalment, which will be published next week, issue of June 1st.—Editor.*]

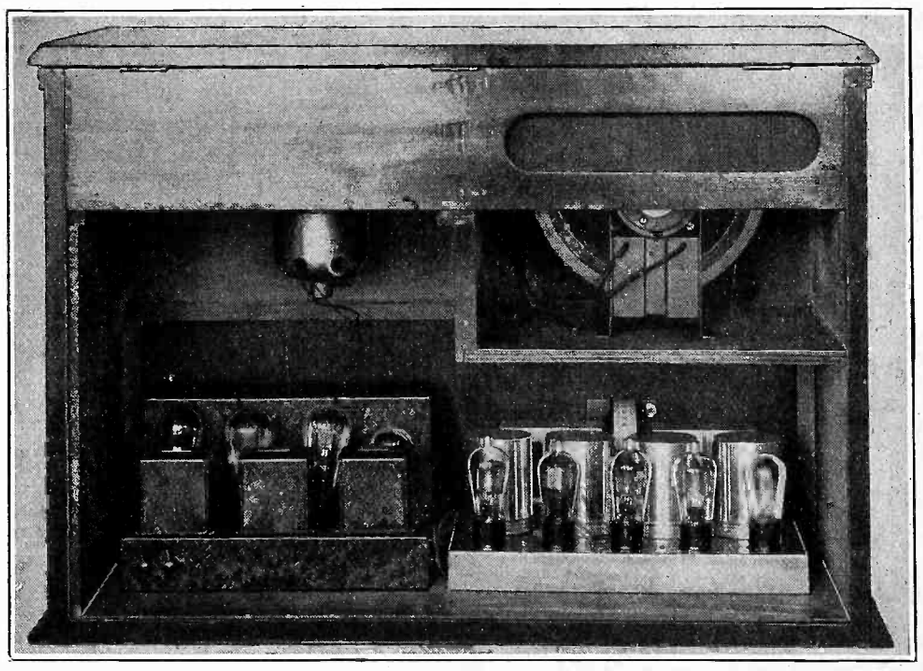


FIG. 4.

THE REAR OF A CONSOLE WITH BACK REMOVED. A COMPLETE INSTALLATION IS DEPICTED: THE MB29 AT RIGHT, ABOVE IT A DYNAMIC SPEAKER; A PUSH-PULL POWER AMPLIFIER AT LEFT, ABOVE IT AN ELECTRIC PHONOGRAPH MOTOR.

An Assuredly Stable Power A

By H. B.

[*This is the third of a series of articles by H. B. Herman, acoustical expert and radio engineer, on power amplifiers. The assurance of complete stability in a direct coupled AC audio circuit is welcome indeed to many readers. This power amplifier will work well from any radio frequency circuit that has at least two stages of TRF and detector. It will work the new National M-B29 very well, for instance. The B plus 67 lead to MB29 would go to a 100,000 ohm resistor in the receiver to provide screen grid voltage.—Editor*]

A RESISTANCE coupled power amplifier of assured stability should be welcome to those who prefer resistance coupled audio frequency amplification if only some assurances against motorboating could be obtained.

This circuit is stable for the following principal reasons:

(1)—Adequate capacity of filter condensers in the filter section of the rectifier tube's output.

(2)—Common applied plate voltage on all three amplifier tubes and on the detector as well.

(3)—Use of amplifier tubes of average amplification factor.

(4)—Inclusion of low-resistance choke coils in the B supply.

(5)—Stages restricted to three.

Use Grid Bias Detection

For proper use of this circuit the detector tube, not shown, because it is in the independent receiver, should be a 227, as it will likely be. Instead of using the leaky-condenser method of detection, it is better for the present purpose of quality to use grid bias detection. A resistor of about 50,000 ohms is connected from cathode of the detector to B minus, and across it is connected a bypass condenser of .5 mfd. or larger capacity. Grid return goes to B minus. Good detection then will result whether R1 is .1 meg. to 1 meg. It is well to use .1 meg., to keep the plate current higher, to avoid distortion on loud passages.

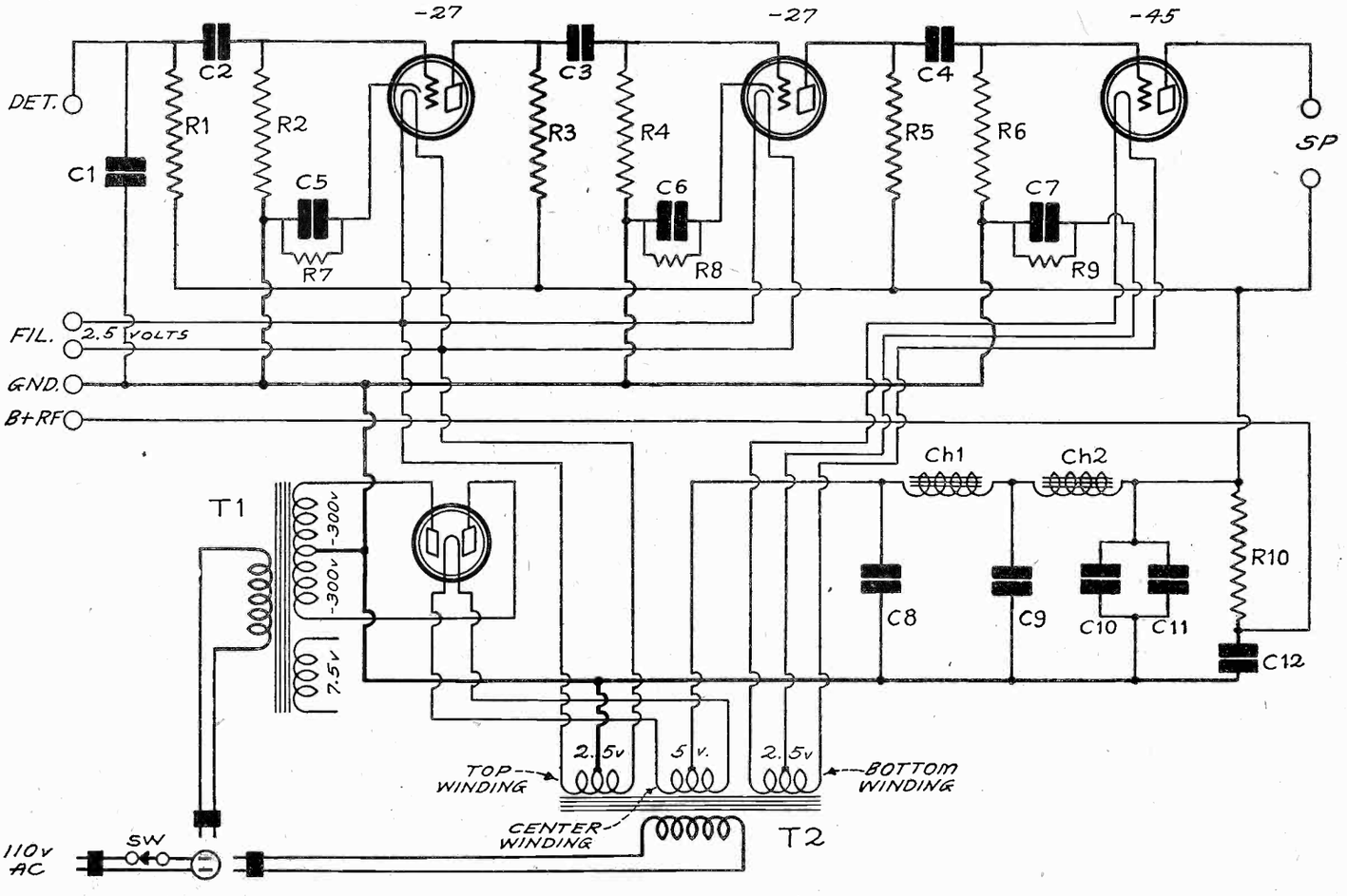
Discussing the five bases of stability, first there is the capacity of the filter condensers C8, C9, C10 and C11. These four are in one copper can and are of the electrolytic type. Merhson 9-9-18-18 is used (total, 54 mfd.). This has four separate capacities of the stated numbers, the binding posts being positive and the can itself common negative. C8 and C9 are 9 mfd. each. C10 and C11 are 18 mfd. each and are connected in parallel to constitute 36 mfd. The 18 mfd. posts are nearer the edge.

Value of Large Capacity

Not only does this enormous capacity across the total output make for stability but it enriches reproductions on low notes or any other passages that drain the plate current heavily, for the 36 mfd. constitutes an ample reservoir of capacity on which the signal may draw heavily when necessary. The electricity then comes largely from the quantity stored in the 36 mfd. rather than directly from the eliminator itself, although the eliminator originally supplied the electricity. The large condensers dispense with resistance-capacity filters otherwise advisable.

The common connection to maximum B voltage of all the plate circuits, of which there are three in the amplifier, enables all audio tubes to derive the advantage of this large output capacity, and, indeed, the detector is connected just as advantageously to the same voltage. This also simplifies the construction and connections.

All the plates, however, do not get the same net voltage. The dynamic speaker has an output transformer built in that has a low resistance primary and nearly 300 volts are applied actually at the plate. The biasing voltage need not be considered, although it reduces the plate voltage. The



A THREE-STAGE RESISTANCE COUPLED POWER AMPLIFIER FOR OPERATION FROM THE 105-120 VOLT 60 CYCLE AC LINE. THE FILAMENT VOLTAGE FOR HEATER TYPE TUBES OF AN INDEPENDENT RECEIVER IS SUPPLIED, ALSO B VOLTAGE FOR THE RECEIVER. COMPLETE STABILITY IS ASSURED. QUALITY IS EXCELLENT, VOLUME HIGH. NO MOTORBOATING.

Self-Overloading Eliminated in Qu

Resistance Coupled mplifier

Herman

LIST OF PARTS

T1—One power transformer, Silver-Marshall Cat. No. 330.

T2—One filament transformer, three windings: 2.5 volts for power tubes; 2.5 volts for heater tubes and 5 volts for 280 rectifier. (Guaranty Radio Goods Co., Cat. No. F226A.)

Ch1, Ch2—Two chokes in one housing, Silver-Marshall Unichoke Cat. No. 331.

C8, C9, C10, C11—Four Mershon electrolytic condensers, 9, 9, 18, and 18 mfd. respectively, in one copper can.

C7, C12—Two Aerovox 4 mfd. condensers, 200 volt DC test.

R1, R3, R6—Three Ferranti 100,000 ohms (.1 meg.) wire-wound resistors, with three mountings.

R10—One Ferranti wire-wound resistor with mounting, value of resistance depending on plate current of RF tubes. (50,000 ohms suggested if there are four tubes in the RF receiver, 75,000 ohms if there are five.)

R7, R8—Two Ferranti 10,000 ohm wire-wound resistors, with mountings.

R9—One Aerovox 1,500 ohm Pyrohm resistor.

R2, R4, R6—Three Lynch 5 meg. metallized grid leaks.

C1—One Aerovox .00025 mfd. fixed condenser, mica dielectric.

CZ, C3, C4—Three Aerovox .02 mfd. condensers, mica dielectric.

C5, C6—Two Aerovox .5 mfd. bypass condensers.

One DeJur-Amsco seven-binding-post terminal strip.

Two five-spring sockets and two four-spring sockets.

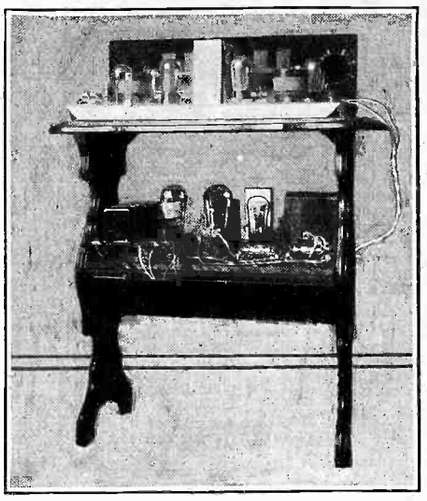
One convenience outlet with AC twisted cable and wall plug. (Note: switch SW is supposed to be in the receiver.)

One 9x18-inch baseboard.

One roll of Corwico Braidite.

Two 227 tubes, one 245 tube and one 280 rectifier tube.

One two-way socket plug.



The power amplifier used in conjunction with a receiver. It is advisable for space reasons to have receiver and amplifier separate. In this instance the baseboard of the amplifier is the size of a book rack. A grille cloth at front would obscure the amplifier.

maximum obtainable voltage is almost 50 volts in excess, to take care of the bias.

The other tubes shown have 100,000 ohm resistors in the plate circuit and biasing resistors of much higher resistance than R9.

Gain Per Stage Reasonable

Amplification factors are deceiving, as one might assume that it is advantageous to obtain as high as gain per stage as is possible. But practical limitations prevent this. For one thing, maximum mu tubes, like screen grid tubes, call for restricted biases and are in danger of easy overload. Also, instability arises from high gain per stage. With 227 tubes hum is kept very low, gain in is plentiful because of the three stages, and finer all-around performance results.

The low resistance choke coils reduce the tendency to common coupling.

Confinement of the total number of stages to three maintains the amplification within steady, reliable limits, easily kept in check by the B supply's filter system, with its proper chokes and high capacity condensers

Four stages of resistance coupled audio are impractical, as there is no known method of economical attainment of stability. A separate B supply for at least one of the stages would be necessary.

While it is a fact any amplifier can be made stable, the cost might easily be prohibitive, whereas the present circuit is not costly and it does possess stability.

The only extraneous sounds heard are a drumming that accompanies the turning on of the juice.

Stops Before Reception Begins

This is due to the incipient flow of electrons as the heaters get warm, but before the operating temperature is attained, which is prior to audibility of signals, the drumming completely disappears. You then operate an amplifier that is stable, loud, clear and altogether delightful.

With such a power amplifier it is well to use a receiver that has at least two stages of tuned radio frequency amplification, with a tuned detector input, or any other RF channel of equal amplification. If you have an existing AC tuner, of course change it over to grid bias detection if it uses the leaky-condenser method. Not only will quality be improved but selectivity as well, as the negative bias increases the input impedance, and this impedance should always be as high as possible. In an RF circuit that is tuned, if no grid current flows, and none does in a grid bias detector, the impedance at resonance is rated as infinite. The value of infinity is greater than any definite value that can be assigned.

Filament Transformer

It is assumed that 227 or 224 (AC screen grid) tubes will be used in the RF and detector circuits, so output posts are provided for this heater voltage of 2.5 volts. The filament transformer incorporated in the power amplifier has two 2.5 volt windings. One is located at top of the output bank of the transformer and feeds the two 227 tubes and the receiver tubes (up to five more, a total of seven tubes heated from the same winding). The other 2.5 volt winding heats the 245 output tube alone. It is well to have separate windings, even though the filament voltages are the same, for otherwise the negative bias of about 50 volts on the output tube (245) would be a positive bias on the heaters of the other tubes. For the 227 tubes in the power amplifier this would not be excessive, but for 224 AC screen grid tubes, if used in the radio receiver, 50 volts would be entirely too high. Not more than 9 or possibly 10 volts are recommended for heater bias of the 224.

Remember, of course, that heater bias has nothing directly to do with grid bias, but constitutes the application of a voltage different from the filament heater voltage. The heater bias does not supply current to the heater, as no plate current flows through the heater. The plate current flows from plate to cathode, through the biasing resistor, to B minus, the heater merely raising the temperature of the cathode to make the electrons flow.

The separate filament transformer is recommended, as it will not heat up. Hot transformers produce hum.

The diagram shows the heater midtap connected to B minus, so that the heater is negative by the amount of the voltage drop in the biasing resistors. An option is to connect this midtap to any cathode.

A Pointer About Grounding

A ground binding post is shown. This is B minus in any instance, and it may be connected to an external ground in most instances, not in all, however. Some AC circuits, whether receivers or power amplifiers, work better, or only, without any connection to ground, due to a potential difference between respective grounds causing a current flow. Connect an AC meter from the ground post of the power amplifier to external ground and see if there is a voltage reading. Sometimes as high as 15 volts show up. Then omit any ground connection, or connect ground only to the end of the antenna coil of the receiver, and disconnect the ground side of this coil from the rest of the receiver and amplifier. What is marked "ground" on the power amplifier then is only B minus, and while at ground potential, is not connected to any external ground. The power amplifier and even the receiver itself then may be considered as self-grounding.

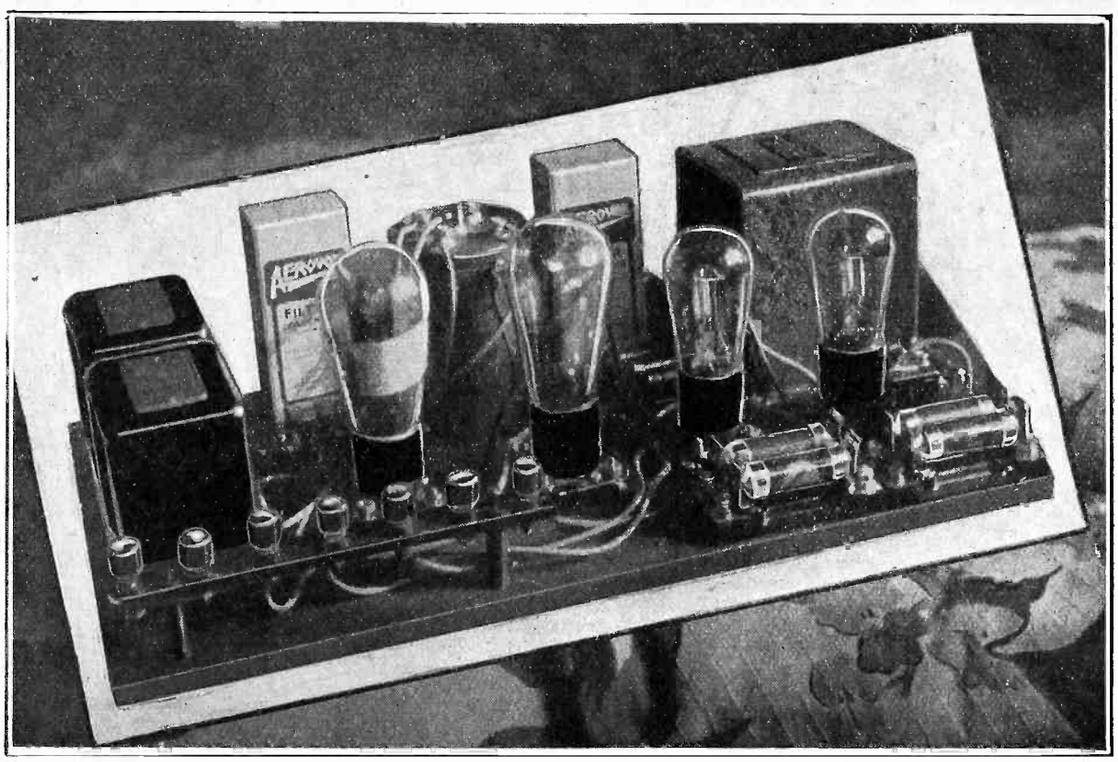
Safety in Resistors

The design of the resistance coupled amplifier is standard. The values of constants should be followed closely, except that R1 permits a wide choice. You can use .1 to 1 meg. or even more. Good results were obtained even with 5 meg., although the plate current was lower than one would prefer. Another reason for preferring a lower value, say .1 meg., is that resistors of more than average current-carrying capacity are more readily attainable, including wire-wound types accurate to 5%. The plate current is lower in the detector tube than in any other, but a starting voltage on the plate, due to arcing of the resistor, may be too high for the tube, hence a wire-wound resistor of .1 meg. was used in the laboratory model.

R3 and R5 also are .1 meg. each, and also of the wire-wound type. Resistors of this sort that are conservatively rated at 5 milliamperes are easily obtainable. Di-

(*Continued on next page*)

lity Circuit for AC Operation



View of the laboratory model of the power amplifier. The baseboard is 9x18". A dynamic speaker is to be used, hence output transformer is omitted. For magnetic speakers include such a transformer.

(*From page* 15)

rect current flows through these plate resistors, hence the precaution.

But in the grid circuits no direct current flows, and the usual types of leaks are very satisfactory, although high values of resistance are favored for this quality amplifier.

The resistors R2, R4 and R6 are 5 meg. each, or larger resistance may be used. The plate-to-grid condensers C2, C3 and C4 are .02 mfd. each, of mica dielectric, and this is a large enough capacity to make grid resistance of a higher order than 5 meg. not imperative. The proper proportioning of the condenser and grid leak affects the time constant and the low-note response.

The first and second audio stages may have the same bias, which is a little less than 20 volts when the resistors R7 and R8 are 10,000 ohms each. Thus it is impossible to overload the audio amplifier except as the vice is introduced from the detector. As all volume controls should be ahead of the detector, for best quality, overloading is at once traceable to the receiver, and the volume control should be adjusted to stop it.

The power tube, for instance, would have to be exceeded by 100 per cent. of its maximum undistorted power output before the second audio tube would be overloaded, while the first audio tube would have to be overloaded by 700 per cent. before it would overload the second audio tube.

Power amplifiers are much easier to build than receivers. The present design will prove comfortable in execution. The only doubtful point would be how to mount the Mershon copper can containing the four capacities.

There is a grooved ring near the top. Take some heavy wire, say No. 18, and bend it back on itself at a bared portion about 10 inches from the end. Then with pliers twist the loop end until about ½ inch protrudes. Then seat the wire into the groove of the can and twist together the two remaining ends, which are bared also, until the wire is very tight against the can. Then solder the joint most recently twisted.

Now solder two strong wire leads, preferably flexible, one to each twisted end of the occupant of the groove. Measure the depth of the can with this wire and turn a loop that fails to reach the bottom at extreme end by about ½ inch. Do the same thing to the other pendant wire. Now mark off where the condenser can is to be placed. Screw down two ¾" or ½" right angle brackets at diametrically opposite points, with base angles pointing away from the can, but the brackets so placed tightly against the can that the can has to be pushed down to pass them. "Inch-in" on one bracket to do this.

Whenever you are ready to mount the can finally, all you need do is to see that the can, when pushed into the space between brackets, has the pendants 90 degrees away from the brackets. Put a snipped lug over the loops on the pendants and tighten down the pendants with ¾" wood screws. The can won't budge.

[*Another Herman article next week, June 1st.*]

RIGHT AND WRONG?

(Questions on page 11)

1—Wrong. The plate is negative with respect to the B plus of the battery or eliminator because the current flows in the direction of the plate. Current always flows from positive to negative.

2—Wrong. The potential is only fluctuating. It always remains negative. If it goes positive the tube is not functioning properly.

3—Wrong. The modulation varies from zero up to the maximum which the intensity of the signal requires.

4—Wrong. Very little sound is radiated from the strings. Most of it is radiated from the sounding board or the body of the instrument.

5—Right. This is a theoretical maximum, but can never be actually attained, only closely approximated.

6—Right. Cobalt steel having a certain percentage of iron and cobalt has the greatest permanence, or coercive force.

7—Right. Any meter which will measure alternating currents or voltages or currents will also measure direct. The converse is not true.

8—Wrong. The oscillator has nothing to do with the selectivity of the circuit. The tuners in the intermediate amplifier and the tuners in the radio frequency portion of the circuit determine selectivity.

9—Wrong. The repeat points cannot be eliminated by any mechanical means.

10—Right. This is true for any wave motion.

Radio University

QUESTION and Answer Department conducted by RADIO WORLD, by its staff of experts, for University members only.

When writing for information give your Radio University subscription number.

IN ONE OF my power tubes there is a bluish glow whenever I reduce the grid bias. What causes this phenomenon?

(2)—I have noticed that the glow varies with the signal intensity, that is, it is more brilliant when the volume is loud and almost disappears when the volume is weak. What is the cause of this effect and what does it signify?

(3)—Does the glow indicate a defect in the tube and is it harmful?

MARTIN KELLY,
Cincinnati, Ohio.

(1)—The blue glow is due to ionization of the residual gases in the tube. It occurs when the plate voltage is too high, or when the plate current is excessive.

(2)—As the signal varies in intensity the plate current varies, and hence the ionization varies. It signifies overloading.

(3)—The glow indicates the tube has not been exhausted sufficiently. It is not harmful to the tube but it may cause some distortion of the signal. Such tubes usually do not last so long as well-exhausted tubes.

* * *

I AM INTERESTED in acoustics as applied to auditoriums. Can you suggest any method of studying the acoustic properties of such places with the object of improving them?

(1)—What kind of instruments are necessary to study the reverberation?

(3)—What can be done to improve the properties of the room?

WILLIAM SIMMONS,
Seattle, Wash.

(1)—One of the best methods of studying the acoustic properties of an auditorium is to set up a vacuum tube oscillograph and observe the various echoes which are set up by a sound, such as the report of the gun fired in the place.

(2)—You will need a vacuum tube oscillograph with all the accessories.

(3)—From the observations taken with the oscillograph determine what surfaces in the auditorium cause the reflections, and then cover the surfaces with sound-absorbing materials such as Celotex, Masonite, or draperies.

* * *

IS IT POSSIBLE to operate a detector tube with such high input that the first audio frequency amplifier may be omitted and still have enough signal voltage on the power tube to load it up to the practical limit?

(2)—If so, what detector tube do you

New RF Stabilization

Method May Be Adopted in Present Sets that Squeal

The automatic system of stabilization at radio frequencies was presented for the first time anywhere in the May 11th issue of RADIO WORLD. *Further details were printed in the May 18th issue. Herewith is the final installment, so written that those who did not read the other installments will understand the principle and operation.*—Editor.

* * *

AN automatic system of stabilization at radio frequencies was discussed in previous issues and is available to any who have a receiver with shaft extending from the end of the first condenser and room to affix a coil next to this shaft. The front cover illustration this week shows such a coil attached to a Hammarlund Midline tuning condenser.

Any present coil may be pressed into service by adding the tickler, or a three circuit tuner may be used. However, the number of turns on the tickler would have to be less for present purposes than for regenerative receivers. Usually eight turns for the tickler will be sufficient. Remove excess turns from any present tickler, half the required number from each side of the separation in the winding. This separation usually exists, because the shaft penetrates the rotor, and the winding is so put on as to avoid the shaft.

For Drum or Flat Dials

The system as depicted on the front cover suggests a drum control, with condenser to the left, as it would naturally be for the first stage, but if the illustration is turned around 90 degrees to the right you will have the picture as suiting a condenser that is mounted at right angles to the front panel instead of, as with drum control, parallel with the front.

The simplest way to use this device is to connect the primary and secondary as usual, and to connect the tickler in the plate circuit of the first radio frequency amplifier. The tickler connection necessitates removing the coil terminal now connected to the plate of the first tube, and joining this removed terminal to the otherwise unused end of the new tickler coil. The three circuit tuner, of course, would replace any two-winding RF transformer in the input circuit to the first tube (antenna coupler).

The theory of stabilization is that, as the tickler is joined to the condenser shaft by a flexible coupler, the condenser and the tickler turn together, and if the coil is arranged to provide maximum negative feedback at the lowest capacity setting, the resistance thus introduced will be maximum where it is needed most, and will gradually be reduced to zero at the arithmetic center of the dial scale, and feedback will turn positive at the higher wave-lengths. Thus where no resistance is needed, none is present, and where the aid of regeneration (reduction of resistance) is helpful, it is present.

An exception exists in the case of receivers that are fiercely oscillatory, where a slight amendment to the method outlined above may be used to excellent advantage. The details of this departure from the simpler form, as well as of the methods in which to connect the coils for positive and negative feedback variations, were described in the May 11th and 18th issues.

Often when one builds a receiver, even one where neutralization is suggested, by introducing small capacities to balance out truant currents and voltages, or by inserting grid suppressors, the neutralization does not work out entirely satisfactorily. The set sometimes is rendered quiet only by introducing high losses, present all through the frequency scale, and which almost kill off the signals. Therefore a method that proves gainful in amplification in a desired region—that of the higher wavelengths—and which provides extra resistance due to negative feedback, to stabilize the lower wavelengths, is a welcome one. It is presented in the pages of RADIO WORLD for the first time anywhere.

Widely Applicable

The method is suggested for use in the first tuned circuit because this one has greatest tendency toward oscillation. However, the same system may be used for any number of stages, provided the physical means of employing it is provided. This requires separately tuned stages or separate condensers ganged by flexible couplers, with the coil arrangement sandwiched between two condensers.

It is possible, of course, to place the coils at electrical right angles to each other, in two stages, to avoid stray inductive feedback-coupling.

The front cover illustration shows the coil mounted upright. To secure the coil to the subpanel, simply use brass angles of suitable size. The make of coil illustrated (a three-circuit tuner of the Screen Grid Coil Company) just fits against the subpanel when the National drum dial is centered on the 7 inch height of a front panel, and the base panel is 1 inch high. In any event, suitable size brackets, two for each coil, will solve any mounting difficulty.

In many instances it will be possible to turn the secondary coil toward you, so that it is at right angles to the front panel, and the coil form will rest against the front panel. Then fasten a long machine screw through the subpanel and through the secondary's form, fastening the screw from the inside of the secondary, and from the bottom of the subpanel. Extra nuts at the opposite positions (outside the coil form and on top the subpanel) will serve as lock nuts.

A trimming condenser, accessible from the front panel, should be used in circuits to which this system of self-stabilization is applied, for utmost sensitivity.—H. B.

---

recommend and what grid and plate voltages?

(3)—What maximum audio frequency voltage could be obtained without overloading the detector tube?

CHARLES MOODY,
Albany, New York.

(1)—It is quite feasible, and it has been done commercially.

(2)—The 227 or 327 heater tube is recommended, with 180 volts on the plate and 25 volts on the grid.

(3)—The voltage obtainable depends on the ratio of the audio transformer that couples the detector and the power tube. A peak voltage of 38 volts could be obtained, which is very nearly the maximum that should be applied to a tube like the—71A power amplifier.

* * *

I HAVE an output transformer which has four binding posts on the secondary side. What are all these for? The transformer is supposed to be used in conjunction with a push-pull amplifier and a dynamic loudspeaker.

(2)—Please show a circuit diagram how to use this with a single output tube and a dynamic speaker.

(3)—Please explain the object of the many taps on the secondary winding.

RALPH MELVIN,
Newark, N. J.

(1)—The object of the many taps is to provide a variable ratio of turns. There are six possible combinations of ratios.

(2)—The diagram is given in Fig. 752.

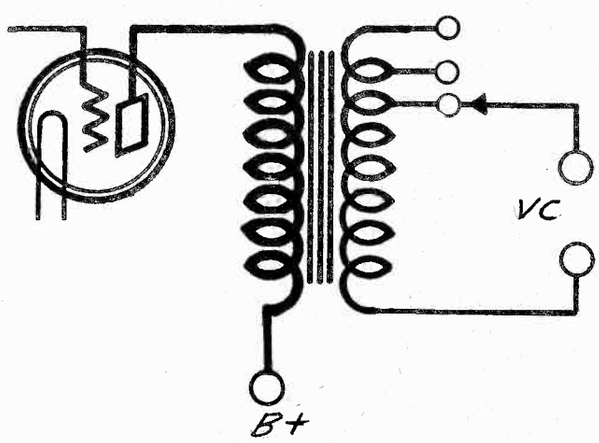


FIG. 752

Better results may often be obtained from a dynamic speaker by removing the built-in transformer and replacing it with a transformer of variable ratio as shown here. Requested by Ralph Melvin.

You can use either the whole primary winding in the plate circuit of the power tube or only one-half.

(3)—The object of the taps is to provide a means for matching the impedance of the dynamic speaker to the impedance of the tube. Use the combination of taps which gives the best response with the dynamic speaker you have. Connect the various taps across the voice coil in the speaker and not across the regular input terminals. You can identify the voice coil terminals by the fact that they are connected to the cone and lead to the springs supporting the center of the cone.

* * *

CAN static electricity make a noise in a radio receiver? Are lightning crashes due to oscillating current?

MILTON FEATHERSTON,
Omaha, Neb.

Static electricity simply means a charge. Lightning crashes or any other noise cannot be produced by anything but moving electricity.

Off to a N

Why Heater Type Tubes May

By James

Contributing

"Why does my set make such a funny sound when it starts?"

This question is often asked, now that AC receivers with the heater type tubes, 227 and 224, are being used in larger and larger numbers. Some peculiarities besides "funny sounds" are present, and the article herewith is a technical discussion of the main problem, with associated features.

In general it is assumed that the noises present during the tubes' warming-up process are not really objectionable, since they disappear when the set gets going. This is usually several seconds before the program is well audible.

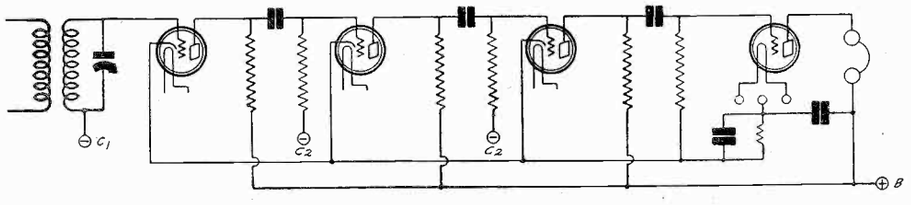


FIG. 1
A CIRCUIT OF THIS TYPE MAY BE INITIALLY UNSTABLE WHILE THE CATHODES ARE HEATING UP. OSCILLATION FOR A FEW SECONDS WILL RESULT.

The mere existence of the situation invites a discussion of it, and the author proceeds to analyze the situation in good style.

Perhaps the day will come when receivers will have relays in them that keep the plate voltage off until the electron emitters in the tubes are functioning fully, then throws on the plate voltage, so that nothing will be heard preliminary to the pure signal. Then the relay may reverse itself and turn the plate voltage off first, the filament voltage off last, when the listening period has drawn to a close. —EDITOR.

IT has been observed by many that certain receivers motorboat for a few moments just after the power has been turned on before they settle down to steady operation. What causes this momentary instability? What changes take place in the circuit which account for this behavior?

The opposite sequence of events has also been observed. That is, certain receivers are stable for a few moments and then settle down to a steady motorboating. Can this behaviour be explained in the same way as the opposite, or are there two distinct causes for the two different modes of behavior?

There is evidence which indicates that either type of action can be explained by the same phenomenon, and there is also evidence which tends to show that either type may be due to more causes than one.

Stable and Unstable Sets

The general cause for motorboating in any receiver is the audio feedback that occurs through the common elements in the circuit, such as grid and plate voltage supplies. Some sets are more subject to motorboating than others. For example, a resistance coupled amplifier having four plate circuits on the same voltage source is essentially unstable in the low frequency band.

Initial instability and subsequent stability, or initial stability and subsequent instability, can be explained on the supposition that the circuit changes its type during its warming-up period. That certain types of circuits change character during this period is obvious, but why this change occurs, if it does, in certain other receivers is not so obvious.

Changing Character

Consider, for example, a resistance coupled amplifier having four plate circuits on the same voltage source and a heater type detector, the rest of the tubes being of the filament type. When the power is turned on the filaments heat up in about one second and thus quickly attain their full amplification efficiency. The heater tube requires about one minute before it is in full operation. As long as the cathode of this tube is not hot enough to emit any electrons it is effectively out of the circuit. It contributes nothing either to render the circuit stable or unstable. Hence before this tube is heated up the rest of the circuit is either stable or unstable according to its character.

From this it must not be supposed that the circuit changes completely from an even to an odd circuit, that is, from one having four plate circuits to one having three. The first plate resistor functions, as far as feedback is concerned, even if the first tube is dead or is out of the circuit entirely. But there is a difference in the degree of feedback when the tube is dead and when it is alive.

Infinite Impedance

When the detector tube is dead its plate to filament resistance is infinite and hence does not produce any short-circuiting effect on the first plate resistor. As it gradually comes to life, the tube resistance lowers and begins to act as a short-circuit to the plate resistor, as far as the feedback is concerned. If the resistance is low enough it may be sufficient to prevent feedback through the resistor and stop motorboating.

When the detector tube is fully alive the receiver is a true four-plate circuit and hence stable, except for certain conditions mentioned above. That the first resistor is effective both for feedback when the detector is dead or out of the circuit can be proved by simply removing the resistor. If the circuit is motorboating with it in, it is almost certain to stop oscillating when it is removed.

It is seen, therefore, that a circuit which is essentially stable when in full operation may be unstable while the detector tube is warming up, and that explains why a circuit may be initially unstable.

Opposite Equally True

The opposite sequence may be explained in the same way. The circuit may be normally unstable but remains stable as long as the detector tube is not functioning.

While a resistance coupled amplifier was used as the basis of discussion above, transformer or impedance coupled circuits are not exempt from this behavior. They behave in exactly the same way, but it is more difficult to predict the probable behavior of such circuits. This is especially true of transformer coupled circuits, because the windings may be connected so that a given circuit is stable for one connection and unstable for another.

When the feedback is feeble in any given circuit, initial stability may be apparent only. It always takes a certain time for any oscillation to build up to appreciable intensity, and the initial apparent stability may be due simply to an extremely slow building-up of the oscillation. When the feedback is strong the oscillation builds up in an inappreciably short time.

Theory Breaks Down

In many instances the theory of the change of character of the circuit during the warming-up period seems to break down. Consider, for example, the circuit depicted in Fig. 1. In this the detector and the first two audio tubes are of the heater type. It takes the heater tubes used as audio amplifiers just as long to come to life as it does the detector. Yet this circuit may be initially unstable. The power tube which alone heats up quickly cannot give rise to oscillation, for it can feed back into its own grid circuit only. This feedback is in such phase as to dampen out any oscillation.

We must look for another explanation for the transient effect, or for a modification of the first. Just because the first three tubes are of the heater type, we can not assume that they reach operating temperature at the same time. If the third heater tube heats up a little faster than the second, we have the proper condition for initial instability. That this is a true explanation in some instances is attested by the fact that interchanging the two audio heater tubes will eliminate the initial ocillation.

Not Satisfying

But this explanation does not satisfy in all instances. There must be some other

---

Virtues of

(*Concluded from page* 8)

differences may creep in, which account for the mystery of some so-called "identical" tubes not matching up well for push-pull. The necessity for identity of constants in the tube, which is established by the geometrical structure of the tube itself, is that unbalance otherwise might cause distortion.

The plate current drawn by two tubes in a push-pull stage is approximately twice as much as that which a single tube of the same type would draw under the same voltage and load conditions. Therefore it is not always feasible to introduce push-pull without incurring other changes.

For instance, if an AC type of B supply is worked in a single-sided circuit almost to its capacity, adding another 20 mil drain would reduce the plate voltages on all tubes and possibly overtax the power transformer and the filter chokes. This would show up by the transformer getting hot and the chokes getting warm after an hour's use or more. But in a battery-operated push-pull circuit the use of heavy-duty batteries, at less than maximum rated instantaneous drain, as set forth by the battery manufacturer,

oisy Start

Howl or Motorboat at First

H. Carroll

Editor

factor which changes the circuit, or its adjustment, during the warming-up period.

Much of the peculiar behavior of circuits is caused by the value of the plate to filament, or plate to cathode, resistance, as was pointed out above. Emission is not the only factor which changes the value of this resistance. The plate and the grid voltages also are determining factors. If the plate voltage is low, or if the grid voltage is high, the resistance will be high. Neither of these voltages attains normal value the instant the power switch is turned on.

The plate voltage, for instance, cannot reach its full value until the condenser across the corresponding tap on the eliminator has been charged. If this condenser is large, and if the resistance through which the charging current must flow is high, an appreciable time elapses before the voltage attains its full value. During this time the amplifier may be unstable.

In direct coupled amplifiers the grid voltage does not attain its normal value instantly. The stopping condenser must first be charged to a steady voltage equal to the sum of the plate and grid voltages. The charging current must flow through two very high resistors and therefore the charging time is appreciable. This is particularly true when a large stopping condenser is used. During the charging time the amplifier may be unstable.

Large Stopping Condensers

This is not an argument for using a small stopping condenser. It does not matter what occurs during the first few seconds provided that the amplifier settles down to steady operation.

It has been asserted that the stopping condenser must charge and discharge for every cycle during operation, and that in order to amplify the high notes the stopping condenser should be small. This is a fallacy. It must be large to amplify the low notes, and if it is large enough for them it is small enough for the highest frequency. The time constant of the stopping condenser and the resistors in series with it are of interest only in connection with the original charging.

It must be remembered that all condensers in a receiver discharge while they are disconnected or while the power is off. Even if the condenser is open there is enough leakage through the insulation to discharge it completely, usually in a short time. Hence whenever the power is turned on the condensers must charge before the circuit begins to function. Most of condensers charge up to full voltage in an inappreciably short time, but some of them require a time long enough to account for the initial instability.

Simplified Circuit

Fig. 2 shows a simplified circuit of a resistance coupled amplifier having a common plate voltage supply the impedance of which is represented by Z. All the grid bias resistors are connected to the filament or cathode because it is assumed that there is no common grid circuit impedance, and also because the grid bias does not change the AC circuit.

The first has an emf E1, which is independent of any other signal voltage in the circuit. E2 depends on the signal voltage drop in R2 and on the amplification constant of the second tube. E3 depends on the voltage drop in R4 and on the amplification constant in the third tube, and E4 depends on the drop in R6 and on the amplification constant in the last tube. Thus all the voltages and currents in the circuit depend on the original E1 and on the impedances and amplifications constants in the circuit.

Live Tube Kills

Note what happens when the first tube is dead, or when it is out. Nothing is connected across R1 and Z. All the feedback is forced up through R1, the condenser and R2. If the feedback is positive the current in R2 increases. Hence E2 increases, since it is directly proportional to the drop in R2. All the subsequent Es increase and therefore the currents increase. The sum of all the currents through Z increases and more current flows through R2. Oscillation builds up.

Now suppose the first tube is alive. The resistance rl across R1 and Z is no longer infinite but has a comparatively low value. The feedback through R1 and R2 is decreased because most of it goes through rl. Hence the amplification due to regeneration is less than it was before. and the oscillation does not build up so easily. If rl is low enough it will not build up at all. This shows how the initial instability may be stopped by the warming-up of the first tube.

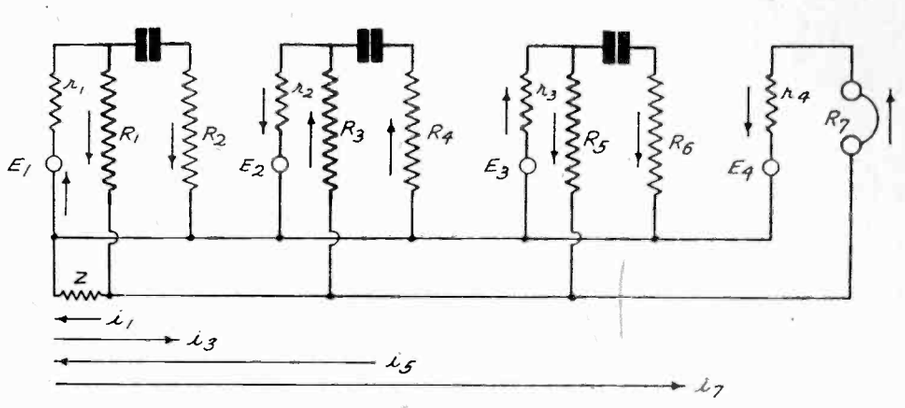


FIG. 2

A SIMPLIFIED DIAGRAM OF A FOUR TUBE RESISTANCE COUPLED AMPLIFIER ILLUSTRATING THE DIRECTIONS AND MAGNITUDES OF THE PLATE CURRENTS THROUGH THE COMMON IMPEDANCE.

Direction of Currents

If the first tube with its R1 and R2 is out of the circuit entirely, we have only the remaining tubes to deal with. But the process is exactly the same.

The arrows in Fig. 2 show the directions of the currents in the various impedances in the circuit. The long arrows under the main drawing represent the magnitude and directions of the various plate signal currents flowing through the common impedance. It will be seen that they alternate in direction. Thus il through R1 flows to the left, and is very small. The next current i3 through R3 flows in the opposite direction and is much amplified. The next flows in the same direction as the first and the fourth flows in the same direction as the second.

The total current flowing in Z, which determines the feedback, is the algebraic sum of the four currents. The direction of this feedback current depends on the relative magnitudes of the separate plate signal currents. It is only when the direction of the total current is the same as that of il that oscillation might occur. If the sum current flows in the other direction there will be suppression of the amplification.

Last Current Dominant

It is plain that, in general, the direction of the feedback current is determined by the current in the last tube, since this is by far the greatest.

The only way to prevent the feed back current altering the amplification is to prevent it from entering Z. Any one of the plate currents may be prevented from entering Z by putting a choke or resistance in series with the line to the plate and by providing a condenser to lead the current to the cathode or the filament. Putting a condenser across Z is very effective. That simply reduces the value of Z for high frequencies, and the larger the condenser is the lower is the frequency that may be considered high.

Push-Pull

would enable the introduction of push-pull. The only precaution would be that if you are using an A eliminator, you should be certain that the extra filament current drain occasioned by introduction of the third tube will not reduce the filament voltage seriously. Some AC eliminators have adjustable features to take care of this. To a lesser extent the same general precaution against overtaxing a storage A battery applies.

Push-pull has proven popular because its virtues have been popularly demonstrated. Technicians knew for many years that push-pull had fine advantages, but in the early days these advantages were hard to capitalize, because the transformers themselves afforded such distorted frequency response that their service in the cause of push-pull was of little value. Nowadays there are several high-grade push-pull and single-sided transformers on the market, and even the transformers used in factory-made sets are better than they used to be. Hence general public enjoyment of the benefits of push-pull has resulted, although the major beneficiaries are owners of custom-built sets.

A New Inductor

Permanent Magnet Used, but Armature Can't Hit Pole Faces

By Rodman B. Fellows

FOR a long time there was only one type of loudspeaker, the magnetic. There were many modifications of this type, but all worked essentially on the same principle, the attraction of a piece of iron by a permanent magnet toward itself.

There is one serious limitation on this type of speaker, which appeared first when power tubes were incorporated in radio receivers, and that is the impossibility of obtaining high sensitivity without at the same time reducing volume. To increase the sensitivity the armature, or the attracted piece of iron, had to be placed close to the pole faces of the attracting permanent magnet. This reduced the possible swing and hence the volume could not be great without rattling.

The Dynamic Speaker

The second type, the dynamic, was introduced as a result of the demand for greater clear volume without a decrease in sensitivity. This was an improvement as long as it was used for the purpose intended. But this type of speaker has its disadvantages, too. While there is practically no limitation to the volume that can be obtained from it, it cannot be made easily with permanent magnets. An electromagnet has to be used to establish the field, and this requires an external current source, which adds to the cost. Notwithstanding this point, the dynamic is the most popular type at this time, especially for receivers of considerable power output.

The Condenser Speaker

For a year or two there has been much talk about a condenser type speaker. Up to this time there has been more talk than demonstration. Only one company has made a definite announcement that a speaker of this kind has been perfected. Everywhere there is keen interest in the condenser, or electrostatic speaker, for it is realized that, in principle, it has many advantages.

The Inductor Type

And now comes an announcement of the inductor type of speaker. This is a radical departure from all other types. It partakes of the characteristics of the magnetic speaker in that it employs a permanent magnet, and it is like the dynamic in that the armature is free to move without striking the pole faces of the field magnet.

C. L. Farrand, who has developed the new type of speaker, looked to the induction type of electric motor for inspiration. The principle of operation of this inductor dynamic speaker can best be explained by reference to a simplified drawing of it, which is shown in Fig. 1.

N and S are the two poles of a strong permanent magnet. Each pole is split into two pole pieces, or extensions, P1 and P2. The armature winding, which carries the signal current, is divided into two equal parts, one C1 wound on P1 of the N pole, and the other C2 wound around P2 of the S pole.

The armature consists of two iron bars placed between the two pairs of pole faces in the manner shown in the drawing, and connected by means of two rods, one of which is shown between A1 and A2. Only the cross-sections of the armature bars

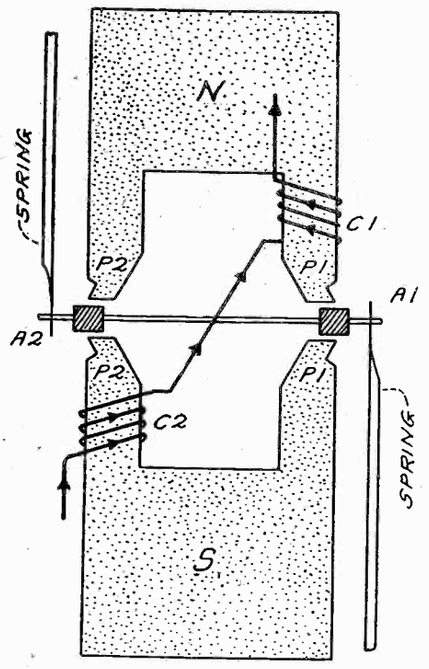


FIG. 1
A CROSS SECTION OF THE NEW INDUCTOR DYNAMIC SPEAKER

are shown, and they appear as small shaded rectangles.

Unbalance Produced

When no current is flowing in the coils, the armature is balanced by the magnetic attractions, and is held in the center. The two P1 poles try to pull the armature to the left while the two P2 poles try to pull it to the right. Since the poles are symmetrical, these forces balance each other. The position of rest is such that the reluctance in the magnetic circuit is minimum. That is, the armature bars place themselves so as to present the greatest possible area to the pole faces.

Now suppose that a signal current is sent through the coils in the direction indicated by the arrows along the wires. It is clear that SP2 is weakened by the added flux and that NP1 is strengthened. But the magnet as a whole is not changed in strength. Hence NP2 is weakened as much as SP2 and SP1 is strengthened as much as NP1.

Therefore the two P2 poles cannot pull so hard as the P1 poles. The force tending to pull the armature to the left is now considerably stronger than the force tending to pull it to the right. Hence the armature moves toward the left until the reluctance is again minimum.

When the current through the coils is reversed the two P2 poles become the stronger and the armature moves toward the right. Thus under the influence of an alternating current the armature moves back and forth in phase with the current.

Elimination of Leakage

The peculiar construction of the pole pieces is for the purpose of reducing as must as possible the leakage flux around the armature bars and also for the purpose of concentrating the flux. The power developed is proportional to the flux density so that the more intense the flux across the armature the more sensitive will the speaker be.

Just wherein is the inductor dynamic speaker superior to the magnetic? In the magnetic the direction of the motion of the armature is toward and away from the poles. The distance moved cannot be greater than the separation between the armature and the poles. In that, as has been stated, lies the chief disadvantage of the magnetic.

In the inductor speaker the direction of motion of the armature is parallel to the poles. Therefore the poles offer no limitation to the motion, no matter how close they may be to the armature. In this respect the inductor is as flexible as the dynamic speaker. Since the speaker is more sensitive the shorter the air gap, the sensitivity of the inductor can be increased without decreasing the possible volume. This is the principal advantage of this new type of speaker.

Flexible Mounting

In order that the distance between the poles and the armature may be made extremely short, it is necessary to mount the armature so that there can be no motion in the direction of the magnetic field. That is, the armature must be mounted so that it will act purely as a plunger without any appreciable rotation about its center. At the same time the mounting must be such that it does not impede the motion in any way.

Both of these conditions are satisfied by two long, flexible springs, shown in Fig. 1. The ends of these springs, which are not shown, are attached rigidly to the magnet in such a manner that the springs are at right angles to the armature when the system is at rest. It is plain that these springs will hold the armature exactly in the center when adjusted properly. The only chance for any displacement would be change in dimensions of the springs and the magnet structure due to temperature variations. Such changes can be disregarded, for they will be very small.

Slight Wobbling

There will also be a slight wobbling of the armature, or rocking, due to the fact that the springs are of finite length, but this also will be extremely minute if the springs are long compared with the maximum displacement of the armature and if the springs are at right angles to the armature in the rest position.

The springs do not serve to provide a restoring force to the armature, as in the magnetic speaker, but only to hold the armature midway between the poles. The magnetism supplies the restoring force. This fact not only eliminates distortion but also renders the unit more sensitive.

Spring Resonance Avoided

When a stiff spring is used to maintain the balance of the armature the natural period of vibration of the armature and spring falls in the audible scale, usually in the treble. When a note of corresponding frequency is struck the unit responds too freely and a marked distortion occurs.

(*Continued on next page*)

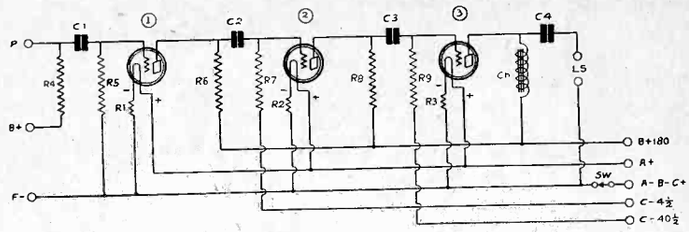
Voltage Dropped in Resistance Audio Is 'Gained,' Not Lost

The principal difference in the operation of the resistors shown in the illustrated audio amplifier is that in the plate resistors current flows, while in the grid general, through both AC flows; in the grid circuits literally and in the strictest sense, and in the plate circuits in the sense that there is an AC component of the direct plate current, often called a fluctuating direct current. The swing of the signal on the grid of the tube, which is AC, causes a corresponding fluctuation in the direct plate current in the same tube.

High voltage may be applied to the lower end of the plate resistors, because these resistors are of high value, surely .1 meg. or more, and the plate resistance of the tube is in series with this load. Let us assume, then, a total resistance of 120,000 ohms. What is the voltage drop across this resistance? Since the 180 volts are applied, all this voltage is dropped (not lost); five times as much dropped in the load, however, as in the tube, but it's all in the "plate circuit" and all useful. The current then would be 1.5 milliamperes, if the bias were zero, but as a negative bias is used, the current is less. Hence resistance coupling brings about low plate current consumption.

FIG. 1

A resistance coupled three-stage amplifier. Direct current flows through the plate resistors, but only alleviating current flows in the grid resistors.

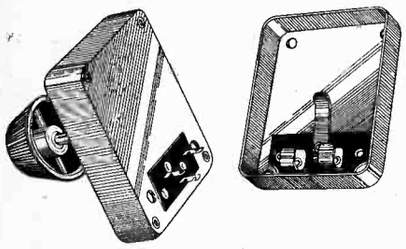


The plate resistance of a high mu tube, 240, would be about twice as great as that of a general purpose tube, such as 201A, therefore the high mu tube would cause still less plate current to flow.

A high mu tube amplifies much more than does a general purpose tube, if the circuit is resistance or impedance coupled. It is not always practical, however, to use several of the high mu tubes in one audio circuit, because of danger that over-amplification will help bring about motor-boating. In the detector circuit (tube not shown in diagram) the high mu tube may be used advantageously. It is in general better to use only on high mu tube if a three-stage resistance coupled audio amplifier is in service, and it may be the detector or the first or second audio tube, never the last tube.

Electrad Announces New Volume Control

Electrad, Inc., 175 Varick St., New York, announces the addition of two new



THE NEW VOLUME CONTROL, AT LEFT, AS IT ACTUALLY APPEARS. AT RIGHT THE FRONT IS REMOVED TO EXPOSE THE RESISTANCE MECHANISM

items to their already extensive line of radio receiver components.

One of these new items is the Super-Tonatrol, a variable non-inductive high resistance which will dissipate five watts at any position of the contact provided that one-tenth or more of the resistance element is used. The resistance element is graphite fused to an enamel base, resulting in smooth variation of the resistance and long life.

The other item is a fixed, wire-wound resistor wound on a high quality refractory tube and covered with a black insulating enamel. This resistor comes in various sizes from 11,500 to 205,000 ohms and from 7.5 to 100 watts dissipation. From one to four taps are provided on the resistors, according to the total resistance. These taps are Monel metal bands around the resistance element, provided with soldering lugs.

FADA GOES ON AIR

A Fada Salon Hour is being broadcast weekly over the Columbia chain. The Fada program will be Tuesday at 10 p.m. Eastern Daylight Saving Time. An orchestra will broadcast salon music, concert vocal artists will be heard.

INCOMPARABLE COMPARISONS

Under the sub-heading "Tone quality More Perfect," the Kellogg Switchboard & Supply Co., 1066 West Adams Street, Chicago, in a publicity release says that its new receiver is "even more flawless and true to life than heretofore."

NEW WABC ANNOUNCER

Frank Knight, an Englishman in this country six years, experienced in broadcasting and theatrical work, is a new announcer at WABC, New York City.

Use of the Inductor Type of Loudspeaker

(*Continued from preceding page*)

The stiff spring also suppresses the response on the very low notes.

When the suspension is weak, as in the inductor speaker, the natural period of vibration falls in the bass, or even at a sub-audible frequency. This will aid in bringing out the low notes. The springs may be made so that the resonance of the spring and armature falls at any desired frequency.

There is no tendency to suppress the response of the higher frequency, because the springs can be made extremely light as well as weak. The armature, too, can be made light. The entire armature assembly, including the springs, weighs only 4.5 grams, compared with 8 to 15 grams for the coil in a dynamic.

Use in Push-Pull

The inductor speaker can be used directly in a push-pull amplifier. It is only necessary to bring out a tap from the junction of the two coils for the plate voltage connection. The two terminals are then connected to the plates. This does not mean it is safe to put the output of a 250 push-pull amplifier into the speaker. When the plate current is high the speaker windings must be protected, unless they have been wound especially for the large tubes.

Corwico Announces Guaranteed Arrestor

The Corwico Vulcan Lightning Arrester, is a new product, is manufactured by the Cornish Wire Company, 30 Church Street, New York City, to protect the set against lightning and dissipate some static charges.

In every box with a Corwico Vulcan Lightning Arrester is a guarantee in which the Cornish Wire Company agrees to repair or have repaired up to a cost of $100, any radio receiver, protected by a Corwico Vulcan Lightning Arrester, that has been damaged by lightning.

The Corwico Vulcan Lightning Arrester is approved by the Board of Underwriters and lists for one dollar.

6 MERGE INTO TUBE CORP.

The Marvin Radio Tube Corporation has been formed in a merger of the Universal Electric Lamp Co., the Special Electric Corp., the Continental Corporation, the Globe Electric Co. and the A. C. M. Corp. Officers are at Irvington, N. J.

New Phonovox Wins Praise of the Trade

The new Pacent Phonovox, recently released, has met with favor among the trade, which reports fine tone, freedom from needle scratch and ease of adjustment.

The magnetic unit has a cobalt steel magnet. The unit is extremely light in weight. The needle is easily inserted by means of a new fold-back arrangement which avoids needle jar and assures extreme rigidity. Adapters are furnished for both DC and AC tubes.

The new Super Phonovox is available in three different models; types 106A, 106B and 106C. Type 106A is without the tone arm and is designed for installation on phonographs or portables already equipped with the conventional tone arm. It comprises a new Phonovox head with swivel arm, AC and DC adapters and volume control. Model 106B is provided with counter-balanced tone arm with fold-back hinge, AC and DC adapters and volume control. Model 106C is the Ultra Phonovox, a pick-up de luxe, comprising the Ultra head attached to a new counterbalanced tone arm, with both AC and DC adapters, volume control, autoplug and performance curve. It has a motor switch incorporated in the base of the tone arm which serves as an automatic stop. This model is finished in gold, the others in bronze. Further information may be had by addressing the Pacent Electric Co., 91 Seventh Avenue, New York City. Mention RADIO WORLD.

New Scale of Pay Fixed by Musicians

Chicago.

Pianists and organists playing for broadcasts must not double up on these instruments, the Chicago Federation of Musicians ruled. There must be a separate player for each such instrument.

Both types of musicians are to get $90 a week (35 hours or less), with overtime at $1.50 a half-hour. For afternoon and evening sessions the scale is $115 a week.

NEW OPERATOR'S BOOK

The second edition of "Radio Operating Questions and Answers," by Nilson and Hornung ($2.00), published by McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, is just off the press. The book is especially suited to the needs of those who contemplate preparing for commercial operator licenses, but service men and radio fans will find a wealth of useful information in the book.

A New Inductor

Permanent Magnet Used, but Armature Can't Hit Pole Faces

By Rodman B. Fellows

FOR a long time there was only one type of loudspeaker, the magnetic. There were many modifications of this type, but all worked essentially on the same principle, the attraction of a piece of iron by a permanent magnet toward itself.

There is one serious limitation on this type of speaker, which appeared first when power tubes were incorporated in radio receivers, and that is the impossibility of obtaining high sensitivity without at the same time reducing volume. To increase the sensitivity the armature, or the attracted piece of iron, had to be placed close to the pole faces of the attracting permanent magnet. This reduced the possible swing and hence the volume could not be great without rattling.

The Dynamic Speaker

The second type, the dynamic, was introduced as a result of the demand for greater clear volume without a decrease in sensitivity. This was an improvement as long as it was used for the purpose intended. But this type of speaker has its disadvantages, too. While there is practically no limitation to the volume that can be obtained from it, it cannot be made easily with permanent magnets. An electromagnet has to be used to establish the field, and this requires an external current source, which adds to the cost. Notwithstanding this point, the dynamic is the most popular type at this time, especially for receivers of considerable power output.

The Condenser Speaker

For a year or two there has been much talk about a condenser type speaker. Up to this time there has been more talk than demonstration. Only one company has made a definite announcement that a speaker of this kind has been perfected. Everywhere there is keen interest in the condenser, or electrostatic speaker, for it is realized that, in principle, it has many advantages.

The Inductor Type

And now comes an announcement of the inductor type of speaker. This is a radical departure from all other types. It partakes of the characteristics of the magnetic speaker in that it employs a permanent magnet, and it is like the dynamic in that the armature is free to move without striking the pole faces of the field magnet.

C. L. Farrand, who has developed the new type of speaker, looked to the induction type of electric motor for inspiration. The principle of operation of this inductor dynamic speaker can best be explained by reference to a simplified drawing of it, which is shown in Fig. 1.

N and S are the two poles of a strong permanent magnet. Each pole is split into two pole pieces, or extensions, P1 and P2. The armature winding, which carries the signal current, is divided into two equal parts, one C1 wound on P1 of the N pole, and the other C2 wound around P2 of the S pole.

The armature consists of two iron bars placed between the two pairs of pole faces in the manner shown in the drawing, and connected by means of two rods, one of which is shown between A1 and A2. Only the cross-sections of the armature bars

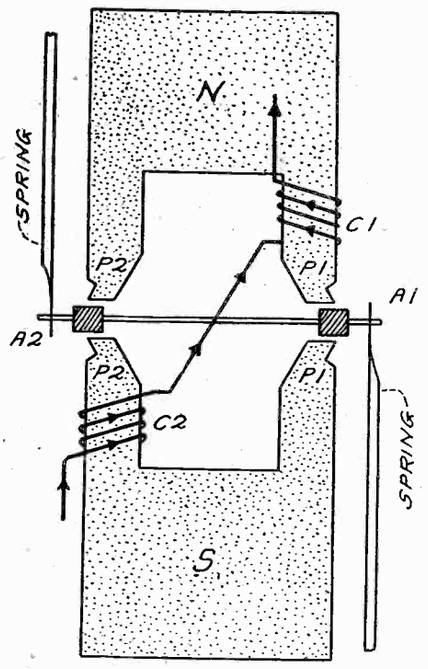


FIG. 1
A CROSS SECTION OF THE NEW INDUCTOR DYNAMIC SPEAKER

are shown, and they appear as small shaded rectangles.

Unbalance Produced

When no current is flowing in the coils, the armature is balanced by the magnetic attractions, and is held in the center. The two P1 poles try to pull the armature to the left while the two P2 poles try to pull it to the right. Since the poles are symmetrical, these forces balance each other. The position of rest is such that the reluctance in the magnetic circuit is minimum. That is, the armature bars place themselves so as to present the greatest possible area to the pole faces.

Now suppose that a signal current is sent through the coils in the direction indicated by the arrows along the wires. It is clear that SP2 is weakened by the added flux and that NP1 is strengthened. But the magnet as a whole is not changed in strength. Hence NP2 is weakened as much as SP2 and SP1 is strengthened as much as NP1.

Therefore the two P2 poles cannot pull so hard as the P1 poles. The force tending to pull the armature to the left is now considerably stronger than the force tending to pull it to the right. Hence the armature moves toward the left until the reluctance is again minimum.

When the current through the coils is reversed the two P2 poles become the stronger and the armature moves toward the right. Thus under the influence of an alternating current the armature moves back and forth in phase with the current.

Elimination of Leakage

The peculiar construction of the pole pieces is for the purpose of reducing as must as possible the leakage flux around the armature bars and also for the purpose of concentrating the flux. The power developed is proportional to the flux density so that the more intense the flux across the armature the more sensitive will the speaker be.

Just wherein is the inductor dynamic speaker superior to the magnetic? In the magnetic the direction of the motion of the armature is toward and away from the poles. The distance moved cannot be greater than the separation between the armature and the poles. In that, as has been stated, lies the chief disadvantage of the magnetic.

In the inductor speaker the direction of motion of the armature is parallel to the poles. Therefore the poles offer no limitation to the motion, no matter how close they may be to the armature. In this respect the inductor is as flexible as the dynamic speaker. Since the speaker is more sensitive the shorter the air gap, the sensitivity of the inductor can be increased without decreasing the possible volume. This is the principal advantage of this new type of speaker.

Flexible Mounting

In order that the distance between the poles and the armature may be made extremely short, it is necessary to mount the armature so that there can be no motion in the direction of the magnetic field. That is, the armature must be mounted so that it will act purely as a plunger without any appreciable rotation about its center. At the same time the mounting must be such that it does not impede the motion in any way.

Both of these conditions are satisfied by two long, flexible springs, shown in Fig. 1. The ends of these springs, which are not shown, are attached rigidly to the magnet in such a manner that the springs are at right angles to the armature when the system is at rest. It is plain that these springs will hold the armature exactly in the center when adjusted properly. The only chance for any displacement would be change in dimensions of the springs and the magnet structure due to temperature variations. Such changes can be disregarded, for they will be very small.

Slight Wobbling

There will also be a slight wobbling of the armature, or rocking, due to the fact that the springs are of finite length, but this also will be extremely minute if the springs are long compared with the maximum displacement of the armature and if the springs are at right angles to the armature in the rest position.

The springs do not serve to provide a restoring force to the armature, as in the magnetic speaker, but only to hold the armature midway between the poles. The magnetism supplies the restoring force. This fact not only eliminates distortion but also renders the unit more sensitive.

Spring Resonance Avoided

When a stiff spring is used to maintain the balance of the armature the natural period of vibration of the armature and spring falls in the audible scale, usually in the treble. When a note of corresponding frequency is struck the unit responds too freely and a marked distortion occurs.

(*Continued on next page*)

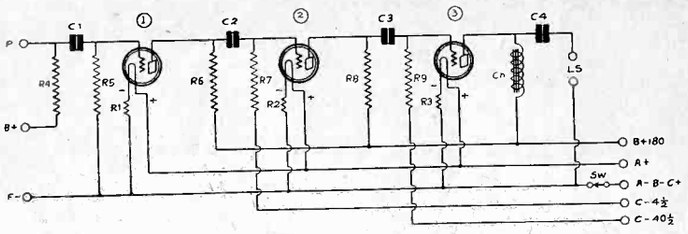
Voltage Dropped in Resistance Audio Is 'Gained,' Not Lost

The principal difference in the operation of the resistors shown in the illustrated audio amplifier is that in the plate resistors current flows, while in the grid general, through both AC flows; in the grid circuits literally and in the strictest sense, and in the plate circuits in the sense that there is an AC component of the direct plate current, often called a fluctuating direct current. The swing of the signal on the grid of the tube, which is AC, causes a corresponding fluctuation in the direct plate current in the same tube.

High voltage may be applied to the lower end of the plate resistors, because these resistors are of high value, surely .1 meg. or more, and the plate resistance of the tube is in series with this load. Let us assume, then, a total resistance of 120,000 ohms. What is the voltage drop across this resistance? Since the 180 volts are applied, all this voltage is dropped (not lost); five times as much dropped in the load, however, as in the tube, but it's all in the "plate circuit" and all useful. The current then would be 1.5 milliamperes, if the bias were zero, but as a negative bias is used, the current is less. Hence resistance coupling brings about low plate current consumption.

FIG. 1

A resistance coupled three-stage amplifier. Direct current flows through the plate resistors, but only alleviating current flows in the grid resistors.

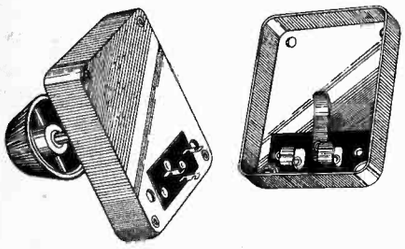


The plate resistance of a high mu tube, 240, would be about twice as great as that of a general purpose tube, such as 201A, therefore the high mu tube would cause still less plate current to flow.

A high mu tube amplifies much more than does a general purpose tube, if the circuit is resistance or impedance coupled. It is not always practical, however, to use several of the high mu tubes in one audio circuit, because of danger that over-amplification will help bring about motor-boating. In the detector circuit (tube not shown in diagram) the high mu tube may be used advantageously. It is in general better to use only on high mu tube if a three-stage resistance coupled audio amplifier is in service, and it may be the detector or the first or second audio tube, never the last tube.

Electrad Announces New Volume Control

Electrad, Inc., 175 Varick St., New York, announces the addition of two new



THE NEW VOLUME CONTROL, AT LEFT, AS IT ACTUALLY APPEARS. AT RIGHT THE FRONT IS REMOVED TO EXPOSE THE RESISTANCE MECHANISM

items to their already extensive line of radio receiver components.

One of these new items is the Super-Tonatrol, a variable non-inductive high resistance which will dissipate five watts at any position of the contact provided that one-tenth or more of the resistance element is used. The resistance element is graphite fused to an enamel base, resulting in smooth variation of the resistance and long life.

The other item is a fixed, wire-wound resistor wound on a high quality refractory tube and covered with a black insulating enamel. This resistor comes in various sizes from 11,500 to 205,000 ohms and from 7.5 to 100 watts dissipation. From one to four taps are provided on the resistors, according to the total resistance. These taps are Monel metal bands around the resistance element, provided with soldering lugs.

FADA GOES ON AIR

A Fada Salon Hour is being broadcast weekly over the Columbia chain. The Fada program will be Tuesday at 10 p.m. Eastern Daylight Saving Time. An orchestra will broadcast salon music, concert vocal artists will be heard.

INCOMPARABLE COMPARISONS

Under the sub-heading "Tone quality More Perfect," the Kellogg Switchboard & Supply Co., 1066 West Adams Street, Chicago, in a publicity release says that its new receiver is "even more flawless and true to life than heretofore."

NEW WABC ANNOUNCER

Frank Knight, an Englishman in this country six years, experienced in broadcasting and theatrical work, is a new announcer at WABC, New York City.

Use of the Inductor Type of Loudspeaker

(*Continued from preceding page*)

The stiff spring also suppresses the response on the very low notes.

When the suspension is weak, as in the inductor speaker, the natural period of vibration falls in the bass, or even at a sub-audible frequency. This will aid in bringing out the low notes. The springs may be made so that the resonance of the spring and armature falls at any desired frequency.

There is no tendency to suppress the response of the higher frequency, because the springs can be made extremely light as well as weak. The armature, too, can be made light. The entire armature assembly, including the springs, weighs only 4.5 grams, compared with 8 to 15 grams for the coil in a dynamic.

Use in Push-Pull

The inductor speaker can be used directly in a push-pull amplifier. It is only necessary to bring out a tap from the junction of the two coils for the plate voltage connection. The two terminals are then connected to the plates. This does not mean it is safe to put the output of a 250 push-pull amplifier into the speaker. When the plate current is high the speaker windings must be protected, unless they have been wound especially for the large tubes.

Corwico Announces Guaranteed Arrestor

The Corwico Vulcan Lightning Arrester, is a new product, is manufactured by the Cornish Wire Company, 30 Church Street, New York City, to protect the set against lightning and dissipate some static charges.

In every box with a Corwico Vulcan Lightning Arrester is a guarantee in which the Cornish Wire Company agrees to repair or have repaired up to a cost of $100, any radio receiver, protected by a Corwico Vulcan Lightning Arrester, that has been damaged by lightning.

The Corwico Vulcan Lightning Arrester is approved by the Board of Underwriters and lists for one dollar.

6 MERGE INTO TUBE CORP.

The Marvin Radio Tube Corporation has been formed in a merger of the Universal Electric Lamp Co., the Special Electric Corp., the Continental Corporation, the Globe Electric Co. and the A. C. M. Corp. Officers are at Irvington, N. J.

New Phonovox Wins Praise of the Trade

The new Pacent Phonovox, recently released, has met with favor among the trade, which reports fine tone, freedom from needle scratch and ease of adjustment.

The magnetic unit has a cobalt steel magnet. The unit is extremely light in weight. The needle is easily inserted by means of a new fold-back arrangement which avoids needle jar and assures extreme rigidity. Adapters are furnished for both DC and AC tubes.

The new Super Phonovox is available in three different models; types 106A, 106B and 106C. Type 106A is without the tone arm and is designed for installation on phonographs or portables already equipped with the conventional tone arm. It comprises a new Phonovox head with swivel arm, AC and DC adapters and volume control. Model 106B is provided with counter-balanced tone arm with fold-back hinge, AC and DC adapters and volume control. Model 106C is the Ultra Phonovox, a pick-up de luxe, comprising the Ultra head attached to a new counterbalanced tone arm, with both AC and DC adapters, volume control, autoplug and performance curve. It has a motor switch incorporated in the base of the tone arm which serves as an automatic stop. This model is finished in gold, the others in bronze. Further information may be had by addressing the Pacent Electric Co., 91 Seventh Avenue, New York City. Mention RADIO WORLD.

New Scale of Pay Fixed by Musicians

Chicago.

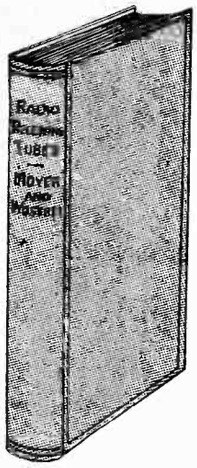
Pianists and organists playing for broadcasts must not double up on these instruments, the Chicago Federation of Musicians ruled. There must be a separate player for each such instrument.

Both types of musicians are to get $90 a week (35 hours or less), with overtime at $1.50 a half-hour. For afternoon and evening sessions the scale is $115 a week.

NEW OPERATOR'S BOOK

The second edition of "Radio Operating Questions and Answers," by Nilson and Hornung ($2.00), published by McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York, is just off the press. The book is especially suited to the needs of those who contemplate preparing for commercial operator licenses, but service men and radio fans will find a wealth of useful information in the book.

NEWEST BOOK ON VACUUM TUBES



"RADIO RECEIVING TUBES," by James A. Moyer and John F. Wostrel, first edition just off the press. No radio service man, experimenter or student of radio should be without this authoritative book on the principles and applications of vacuum tubes. It answers all your questions relating to receiving, amplifying and rectifying tubes. It is a complete discussion of tube principles, functions and uses, thoroughly up-to-date.

In this book the essential principles underlying the operation of vacuum tubes are explained in as non-technical a manner as is consistent with accuracy. The book covers the construction, action, reactivation, testing and use of vacuum tubes as well as specifications for vacuum tubes and applications for distant control of industrial processes and precision measurements.

Price $2.50

RADIO WORLD
145 West 45th Street, New York City
(Just East of Broadway)

LACAULT'S BOOK

"Super-Heterodyne Construction and Operation," giving the master's most masterful exposition of the theory, performance and construction of this fascinating type of circuit, is a necessity to every serious radio experimenter. More than 100 pages and more than 50 illustrations. Buckram cover. This book by R. E. Lacault, **FREE** if you send $1.00 for an 8-weeks subscription for Radio World. Present subscribers may accept this offer. Subscription will be extended.

RADIO WORLD 145 W. 45th St., N.Y. City Just East of B'way

Aluminum Subpanel for the New, Highly Selective SG Diamond

Battery or AC Model (specify which)

The best appearance of the New Diamond of the Air results from using the official aluminum subpanel, 10 x 20 inches, with the four sockets built in, and with self-bracketing front. Hardware and insulating washers supplied with each sub-panel. The aluminum sub-panel is exactly the same as the one used in the laboratory models of the battery operated and the AC Screen Grid Diamonds. Holes are drilled for mounting parts, but as this aluminum drills like bakelite you can drill any holes you want.

RADIO WORLD, 145 W. 45th St., N. Y. City.
(Just East of Broadway)

☐ Enclosed please find $3.00 for which please send one aluminum subpanel 10x20" for the new battery model 4-tube SG Diamond of the Air, with sockets built in, and with self-bracketing front and side and rear supports; also send hardware and insulating washers.

☐ Enclosed please find $2.35 for which please send 7x21" drilled Bakelite front panel for the new battery model Diamond.

☐ Enclosed please find $3.25 for the 10x20" aluminum subpanel, etc., for the new AC Screen Grid Diamond.

☐ Enclosed please find $2.35 for the 7x21" drilled Bakelite front panel for the new AC Screen Grid Diamond.

☐ Enclosed please find $5.00 for both the aluminum subpanel, etc., and the drilled Bakelite front panel of the battery model.

☐ Enclosed please find $5.25 for both the aluminum subpanel, etc., and the drilled Bakelite front panel of the AC model.

Name .....

Address .....

City..... State.....

New Diamond (AC or Battery Model)

PARTS FOR THE AC DIAMOND

CA, CG, C7—Three Aerovox .0005 mfd. mica fixed condensers, moulded, @ .25	$0.75
C3, C4, C8—Three Aerovox .006 mfd. mica fixed condensers, moulded, @ .50	1.50
C6, C9—Two Aerovox .02 mfd. mica fixed condensers, moulded, @ $1.00	2.00
C10—One Aerovox 4 mfd. condenser	2.50
C1—One Hammarlund Equalizer, 70 mfd.	.40
C2, C5—One Hammarlund Midline double condenser, each section .0005 mfd. (MLD23)	6.00
R1, SW—One Electrad Royalty volume control (0-5,000 ohms) with 110-volt Hart & Hegeman AC switch built in	1.50
R2—One Electrad 900-ohm resistance strip (grid suppressor type)	.20
R3—One Lynch 50,000-ohm resistor, with clips	.20
R4—One Electrad 2,000-ohm resistance stub	.20
R5—One Electrad 2,000-ohm type B resistor (B20).	
T1, T2—Two National A100 audio frequency transformers @ $5.70	11.40
T3—One filament transformer; one winding 2.5 volts at 9 amperes or more, one winding 2.5 volts at 3.5 amperes or more, one winding 5 volts at 2 amperes or more (merchandised by Guaranty Radio Goods Co.)	6.00
PL—One Yaxley pilot light bracket with green jewel and lamp	.55
Ant., ground, speaker —, speaker +, four binding posts @ .10	.40
One roll Braidite wire	.30
One 7 x 21-inch front panel	2.35
One 10 x 20-inch official AC Diamond aluminum subpanel, self-bracketing, with three five-prong sockets and one four-prong socket built in	3.25
Front and subpanel together	5.25
Porcelain AC socket, screw plug 3-way plug, cable (lamp cord) and wall plug	.75
One dial	.90
Two knobs (one for tickler, the other for volume control) @ .20	.40
Note: The optional condenser, CX, is .006 mfd. @	.50

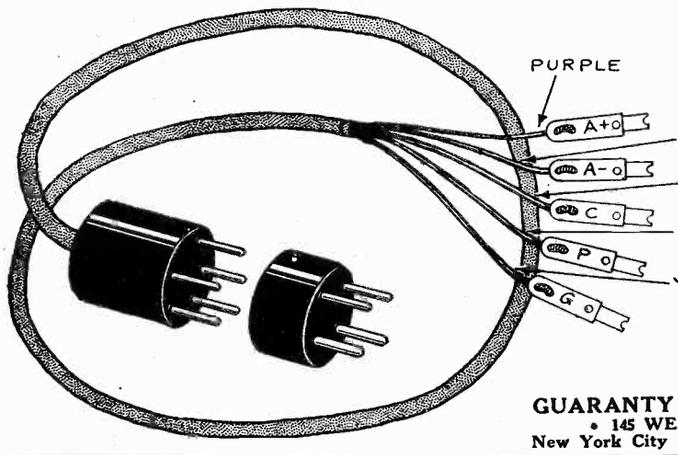
PARTS FOR BATTERY MODEL DIAMOND

C1—Aerovox .0005 moulded fixed	.25
C2—Hammarlund .0005 mfd. Midline	3.30
C3, C4—Two Aerovox moulded .006 mfd. @ .50 ea.	1.00
C5—Hammarlund .0005 mfd. Midline	3.30
C6—Aerovox .00025 moulded fixed with clips	.30
C7—Aerovox .0005 moulded fixed	.25
A1—622 Amperite with mount	.85
A2, A3, A4—Three 1A Amperites, three mounts @ .85	2.55
R1—50-ohm Frost rheostat	1.00
R2—5-meg. Lynch metallized leak	.40
T1, T2—Two National A100 audios @ $5.70 ea.	11.40
Ant., Gnd., Sp. —, Sp. + posts @ .10 ea.	.40
P1—Yaxley jewel window bracket .35 with pilot lamp .20	.55
Sw—Yaxley No. 10 A battery switch	.35
7 x 21-inch front panel	2.35
10 x 20-inch official battery Diamond subpanel, self-bracketing, with four sockets affixed; subpanel hardware, insulated bushings, washers	3.00
Front panel and subpanel together	5.00
Two dials with pointers	2.00
Two knobs @ .20	.40
One roll stranded Braidite	.30
Hammarlund 70 mmfd. Equalizer	.40
Four Kelly tubes: one 222, two 201A, one 112A or 171A	7.00

GUARANTY RADIO GOODS CO.
145 WEST 45th STREET
(Just East of Broadway)
NEW YORK CITY

PLUG AND CABLE for any SHORT WAVE ADAPTER

May also be used as a 5-Lead Battery Cable and Plug, in conjunction with a 5-prong (AC227) socket.



Handiest thing for ANY short-wave adapter. Put detector tube of your present set in socket of any short-wave adapter you build, put plug in detector socket of your broadcast receiver. Cable 34". Leads identified both by color scheme and tags 5-prong plug and 5-lead cable for AC short wave adapter. May be used as 5-lead battery cable plug with UY socket (Cat. No. 21AC) $1.50 4-prong extra plug only necessary addition to other for battery short-wave adapter (Cat. No. 21-BAT) $0.50. Cat. No. 21AC and 21-BAT ordered together $1.75.

GUARANTY RADIO GOODS CO.
145 WEST 45TH STREET
New York City Just East of Broadway

SUBSCRIBERS!

Look at the Expiration Date on Your Wrapper

Please look at the subscription date stamped on your last wrapper, and if that date indicates that your subscription is about to expire, please send remittance to cover your renewal.

In this way you will get your copies without interruption and keep your file complete.

SUBSCRIPTION DEPARTMENT
RADIO WORLD
145 WEST 45TH ST., N. Y. CITY

RADIO WORLD, published every Wednesday, dated Saturday of same week, from publication office, Hennessy Radio Publications Corporation, 145 West 45th Street, New York, N. Y., just east of Broadway. Roland Burke Hennessy, President; M. B. Hennessy, Vice-President; Herman Bernard, Secretary. Roland Burke Hennessy, Editor; Herman Bernard, Managing Editor; J. E. Anderson, Technical Editor.

FILL OUT AND MAIL NOW

SUBSCRIPTION BLANK

RADIO WORLD

RADIO WORLD *145 West 45th Street, New York City (Just East of Broadway)*

Please send me RADIO WORLD for ..... months, for which please find enclosed

SUBSCRIPTION RATES:
Single Copy.....$ .15
Three Months..... 1.50
Six Months..... 3.00
One Year, 52 Issues..... 6.00
Add $1.00 a Year for Foreign Postage; 50c for Canadian Postage.

Gothic Polo Speaker, $15.00

Housed in a beautiful Gothic structure of genuine walnut; hand-rubbed to an attractive finish, the Polo driving mechanism and cone combine best quality reproduction with finest appearance. The grille is specially constructed for two-tone effect, so popular in walnut these days. The Polo Speaker in the Gothic housing is an adornment, besides being an outstanding speaker in performance. The design of the cabinet is exclusive. The height is 12½". Shipping weight, 10 lbs. Cat. No. T.M.P.G.....

Guaranty Radio Goods Co.

145 West 45th Street New York City

Volume Control for A-C Set

It makes no difference what make of A-C set you have. The chances are you need a real volume control. That's easy. Just install a VOLUME CONTROL CLAROSTAT across antenna and ground binding posts. Now you're all set!

There's a Clarostat for every purpose. Ask your dealer about it.

CLAROSTAT MFG. CO., Inc.
291 N. 6th St., Brooklyn, N. Y.

CLAROSTAT

FAMOUS NATIONAL

Velvet B Eliminator $16.13
180 Volts (with 280 Tube)

Latest Model National Velvet-B. Type 3580, in handsome crackle finish black metal casing, for use with sets up to and including six tubes. Input 105-120 volts AC, 50 to 60 cycles. Output, 180 volts maximum at 35 milliamperes. Three variable output intermediate voltages. (Det., RF. AF). Eliminator has excellent filter system to eliminate hum, including 30 henry choke and 18 mfd. Mershon condenser. No motorboating! (Eliminator Licensed under patents of the Radio Corporation of America and associated companies.)

Guaranty Radio Goods Co.
145 W. 45TH STREET
(Just East of Broadway)
NEW YORK CITY

GUARANTY RADIO GOODS CO.,
145 W. 45th St., N. Y. City

☐ Please send C. O. D. on 5-day money-back guaranty, one National Velvet B (180 volts maximum with three variable intermediate voltages), with 280 tube, at $16.13.

☐ Enclose find $16.13. Please send above. You are to pay cartage.

Name .....

Address .....

City..... State.....

5-DAY MONEY-BACK GUARANTY

Fourteen Circuits

Each Shown in Colored Picture Diagram, Colored Schematic Diagram and Front Panel Layout

Get This FREE Book!

Complete AC electric receivers, with B eliminators included, also AC receivers without B eliminators, also battery operated models, all easy-to-build circuits, using your own parts.

RADIO WORLD, 145 W. 45th St., N. Y. City.
(Just East of Broadway)

Gentlemen: Enclosed please find $1.00 for which please send me Radio World each week for eight weeks (regular price, $1.20) and besides send me a FREE copy of the 1929 edition of The Radio Blueprint Library of AC and Battery Hookups.

Name .....

Address .....

City..... State.....

Note: Present mail subscribers may take advantage of this offer by putting a cross in this square. ☐ Your subscription will be extended eight weeks

Recent Issues of Radio World, 15 cents each. Any number published in 1928 available for a short while. Six issues 75 cents, 10 issues $1.00. Send stamps, coin or money order NOW, before the issues are sold. Radio World, 145 West 45th Street, New York City.

AGENTS AND SALESMEN WANTED

Sell $5.00 Men's Daily Necessity for 50c. Cost quantities 20c. Sample postpaid 30c. Catalog hundreds household articles free. Mills Sales Co., 901 Broadway, New York.

HIGH RESISTANCE VOLTMETERS

O-300 v., in portable type, full nickel finish, 30" tipped cord (illustrated at left). (Cat. No. 346) $4.50

O-500 v., Tests ALL power packs, B eliminators, etc. Same casing as above. (Cat. No. 347) $5.00

Just the thing for service men, custom set builders, home experimenters.

GUARANTY RADIO GOODS CO.
145 W. 45th St., N. Y. City

Your Choice of Any One of These Nine Meters FREE!

☐	0-6 Voltmeter D.C.	No. 326
☐	0-50 Voltmeter D.C.	No. 337
☐	6-Volt Charge Tester D.C.	No. 23
☐	0-10 Amperes D.C.	No. 338
☐	0-25 Milliamperes D.C.	No. 325
☐	0-50 Milliamperes D.C.	No. 350
☐	0-100 Milliamperes D.C.	No. 390
☐	0-300 Milliamperes D.C.	No. 399
☐	0-400 Milliamperes D.C.	No. 394

Equip Yourself Now With Necessary Meters!

To do your radio work properly you need meters. Here is your opportunity to get them at no extra cost. See the list of nine meters at left. Heretofore we have offered the choice of any one of these meters free with an 8-weeks subscription for RADIO WORLD, at $1, the regular price for such subscription. Now we extend this offer. For the first time you are permitted to obtain any one or more or all of these meters free, by sending in $1 for 8-week's subscription, entitling you to one meter; $2 for 16 weeks, entitling you to two meters; $3 for 26 weeks, entitling you to three meters; $4 for 35 weeks, entitling you to four meters; $5 for 44 weeks, entitling you to 5 meters; $6 for 52 weeks, entitling you to six meters. Return this offer with remittance, and check off desired meters in squares at left.

RADIO WORLD will help you in your radio work, so you will be able to use the meters most valuably. Keep abreast of all the new circuits. Intimate details on perfecting existing sets, and get inside track on sensitivity, distance reception, tonal quality, and news of radio, technical and non-technical. Enjoy the writings of Dr. Lee De Forest, McMurdo Silver, J. E. Anderson, Herman Bernard and a host of other radio engineers who contribute their knowledge to you through the medium of RADIO WORLD, the first and only illustrated national radio weekly. You can find no magazine that better caters to your needs than RADIO WORLD. Short waves? RADIO WORLD will tell you all about them. Extremely sensitive broadcast receivers? Their construction and operation are fully discussed with confident regularity. Power supplies—push-pull or otherwise? AC receivers? Seven grid tubes? Large receivers that give a super-abundance of performance—small, economical receivers that give performance out of all comparison to their size? Are you interested in these? Then you're interested in RADIO WORLD.

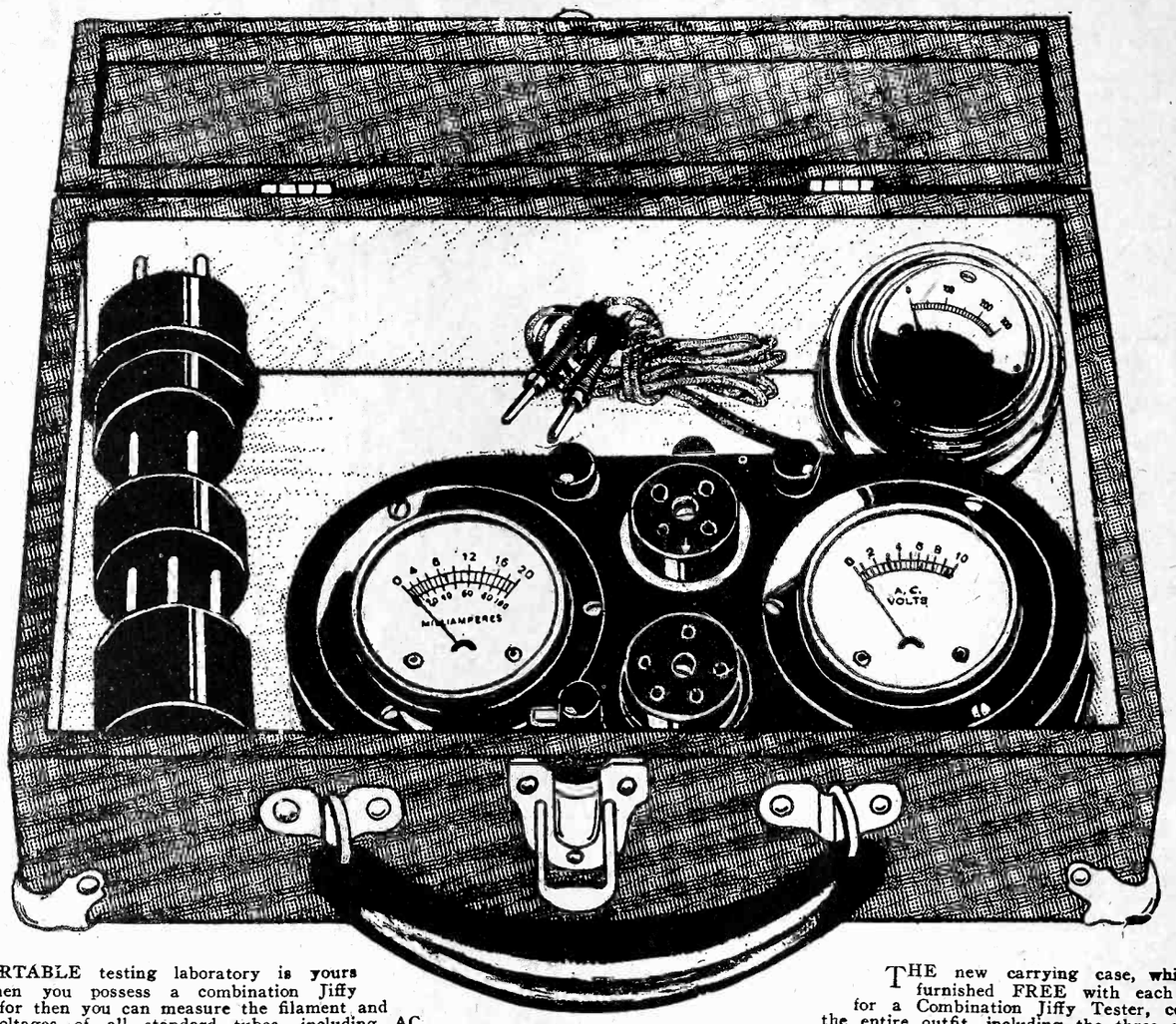
Present mail subscribers may renew their subscription under this remarkably generous offer. Put a cross in square. ☐

RADIO WORLD

145 W. 45th St., N. Y. City—Published Weekly.
All Newsstands. 15c per copy—$3, six months—$6 a year

New Style DeLuxe Leatherette Carrying Case FREE with each Jiffy Tester!

This combination of meters tests all standard tubes, including the new AC screen grid tubes and the new 245 tube, making thirteen tests in 4½ minutes! Instruction sheet gives these tests in detail.



A PORTABLE testing laboratory is yours when you possess a combination Jiffy Tester, for then you can measure the filament and plate voltages of all standard tubes, including AC tubes, and all standard battery-operated or AC screen grid tubes; also plate voltages up to 500 volts on a high resistance meter that is 99% accurate; also plate current.

The Jiffy Tester consists of a 0-20, 0-100 milliammeter, with change-over switch and a 0-10 volt AC and DC voltmeter (same meter reads both), with two sockets, one for 5-prong, the other for 4-prong tubes; a grid bias switch and two binding posts to which are attached the cords of the high resistance voltmeter; also built-in cable with 5-prong plug and 4-prong adapter, so that connections in a receiver are transferred to the Tester automatically. Not only can you test tubes, but also opens or shorts in a receiver, continuity, bias, oscillation, etc. The instruction sheet tells all about these tests.

In addition you can test screen grid tubes by connecting a special cable, with clip to control grid (cap of tube) and other end of special cable to the clip in the set that went to the cap before the tube was transferred to the tester.

THE new carrying case, which is furnished FREE with each order for a Combination Jiffy Tester, contains the entire outfit, including the three meters, cable and plug, and three adapters (one for 4-prong tubes, two for 199 tubes). This case is 10½x7¾x3½" and has nickel corner pieces and protective snap-lock. The case is made of strong wood, with black leatherette overlay.

To operate, remove a tube from the receiver, place the cable plug in the vacant receiver socket, put the tube in the proper socket of the Tester, connect the high resistance meter to the two binding posts, and you're all set to make the thirteen vital tests in 4½ minutes!

The Combination Jiffy Tester is just the thing for service men, custom set builders, experimenters, students, teachers and factories. Order "Jiffy 500." The price is only $14.50.

If a 0-600 AC and DC high resistance meter (99% accurate) is desired, so house electricity line voltage and power transformer voltages can be measured, as well as plate voltage, instead of the 0-500 DC voltmeter, order "Jiffy 600" at $15.50.

GUARANTY RADIO GOODS CO., 145 W. 45 St., N. Y. City. (Just East of Broadway).

☐ Please ship at once on 5-day money-back guaranty one "Jiffy 500," at $14.50, consisting of
(1) One Two-in-One 0 to 10 voltmeter for AC and DC. Same meter reads both. Scale especially legible at 1½ to 7½ volts. This meter reads the AC and DC filament voltages.
(2) One DOUBLE reading DC milliammeter, 0 to 20 and 0 to 100 milliamperes, with change-over switch. This reads plate current.
(3) One 0-500 volts high resistance voltmeter, 99% accurate; with tipped 30" cord to measure B voltages.
(4) One 5-prong plug with 30" cord for AC detector tubes, etc., and one 4-prong adapter for other tubes.
(5) One grid switch to change bias.
(6) One 5-prong socket.
(7) One 4-prong socket.
(8) Two binding posts.
(9) One handsome moire metal case.
(10) One instruction sheet.
(11) One de luxe carrying case.
(12) One screen grid special cable.

☐ If 0-300 DC high resistance 99% accurate voltmeter is preferred to 0-500, put check here. Price is same, $14.50.

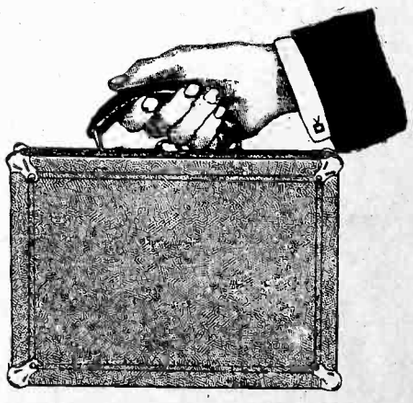
☐ Same as above, except substitute a 0-600-volt AC and DC high resistance 99% accurate voltmeter (same meter reads both) for the 0-500 DC meter. Price $15.50.

NAME .....

ADDRESS .....

CITY .....STATE.....

FIVE-DAY MONEY-BACK GUARANTY



The new de luxe leatherette carrying case is compact and handy. Size 10½" long, 7¾" wide, 3½" deep.