EIGHTH YEAR OF SERVICE

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RADIO ENGINEERING

for MAY 1928

Edited by M. L. MUHLEMAN

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New York, N. Y.

VOLUME VIII NUMBER 5

Editorial

INDUSTRY, as the living reflection of man, is in itself his most elaborate justification. It is man's individual efforts that make possible man's cooperative efforts.

Industry, as a specific adaptation, is dependent on the professional groups and the manual laborers who in turn must work out their salvation on a "cooperative competition" basis.

The success of an industry is a mere echo of the general activity of each group in their strife to maintain equilibrium in the various channels of progress.

The radio industry is a splendid example of such a condition. With the advent of a single engineering achievement, new merchandising plans are evolved, new production methods contrived and greater pressure exerted all along the line, by specialized groups, to meet new conditions imposed. Along with this, engineering minds have devised radically different designs, in surprisingly short spaces of time, in order to re-establish an equilibrium destroyed by sudden advances in production and merchandising plans.

It is indeed inspiring to trace the engineering developments of the past five years and to observe that the industry has not grown under the force of revolutionary inventions, which invariably lead to a certain amount of unethical exploitation, but rather upon sound improvements in basic methods. And further, to note the rise in the quality and class of advertising and publicity; the elimination of the bally-hoo, and the growth of the associations serving the industry.

The cooperative activities of the R.M.A., of the N.E.M.A., of the Better Business Bureau, of the National Association of Broadcasters, and the recently organized Federated Radio Trade Association indicate a purposeful move to strengthen every section of the underpinning of the radio industry.

The R.M.A. is sponsoring radio training schools for the express purpose of turning out competent service men, testers, etc.

The N.E.M.A. is recommending to set manufacturers an excellent warranty for radio receivers, for the protection of the public and the retail trade, much the same as a warranty on an automobile.

The N.A.B. has done and is doing much for both the public and the industry by bearing pressure on the legislative movements in connection with broadcasting.

The Better Business Bureau is doing splendid work in running down those who persist in practicing illegitimate business in the radio field and is thereby safeguarding the public.

The F.R.T.A. has performed a great service to the field in organizing the widely spread merchandising element.

It is too often the case that the efforts of associations related to the radio industry go unnoticed.

Unquestionably, the services rendered by the specialized groups and the associations, under the flag of cooperative competition, bring to bear the proper influence on the buying public whose confidence we must have.

M. L. MUHLEMAN, *Editor.*

Contents

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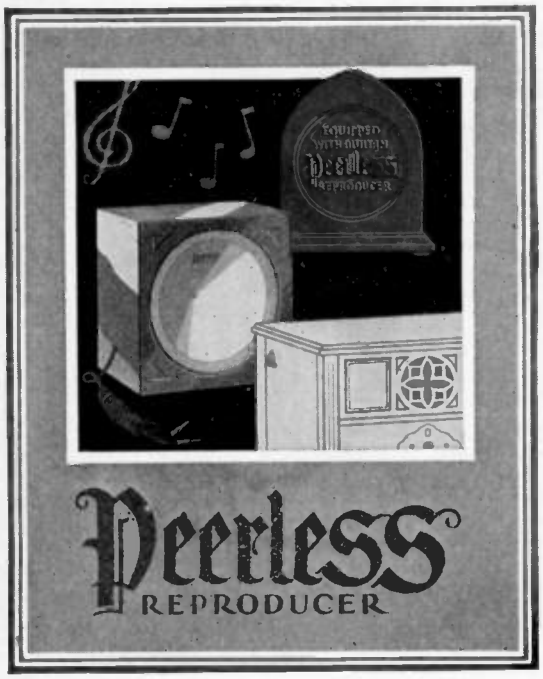

This little bronze emblem in the familiar shape of the famous Gothic Peerless Reproducer is available to all set-makers using the 7-B Peerless Unit. Attached to the cabinet, it is an evidence of Quality Construction that the dealer and jobber can point with pride.

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You can buy an *alleged* speaker cheaper than the Peerless 7-B Built-In Unit. So—if you want Peerless Reproducer in your new models, you should convince your buyer that your sets deserve Peerless—and nothing *less!* As the first step, why not write for full information on the Peerless 7-B Built-In Unit?

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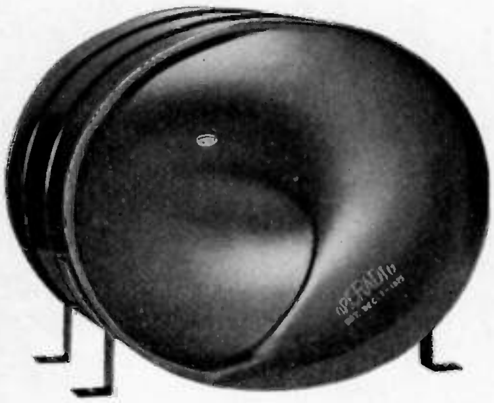

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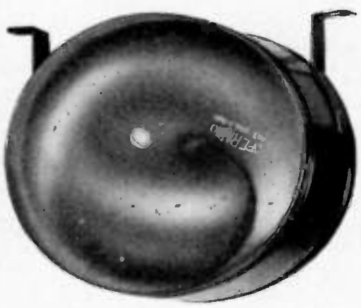

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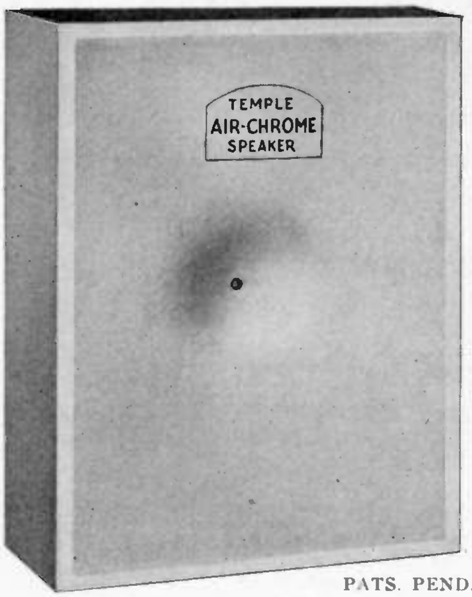
Temple Air-Chrome Speakers for Manufacturers & Engineers



PATS. PEND.

Here is Model F, the rectangular model. Can be mounted in any position. Temple Air-Chrome Speakers are licensed under the Whitmore inventions.

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The Temple Air-Chrome is of the open radiator type. Its diaphragm is so arranged that the larger front half is tuned to the lower frequencies and the smaller, or back half, to the higher frequencies. This type of construction makes possible the balanced tension principle whereby the slightest impulse is carried from the driving unit to the diaphragm without any loss. Lightness is combined with rigidity, climatic changes have no influence in that no paper is used, and the mechanical construction and design eliminates the inherent difficulties ordinarily met with in open radiator types.

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The inherent factors of the Temple Air-Chrome, plus the performance of a specially developed powerful Temple Double Action Unit, accounts for its handling capacity — for its enormous volume — its brilliancy — its full response to all audible frequencies. That's why the Temple Air-Chrome will not chatter — why it is suited particularly to every kind of power output.

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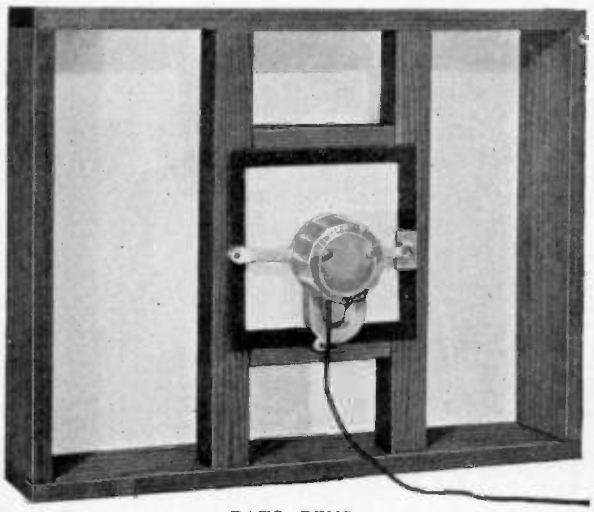

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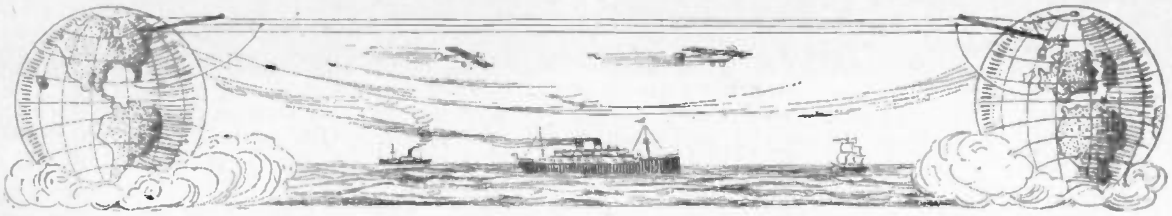


Data on the Voltage Amplification of Radio Frequency Transformers

Analysis of the Results Obtained with the Testing Apparatus Outlined in the Previous Article

*By Burr K. Osborn, B.S.**

PART II

THE types of transformers tested were those most commonly used in radio receiving sets. One such type uses a secondary coil wound on a 3 inch, thin bakelite tube with a primary coil about ½ inch long wound on a 2¾ inch tube inserted inside the filament end of the secondary. The number of secondary turns is so chosen that the broadest band is covered by a .0005 mfd. variable condenser. This is 47 turns when the wire is No. 22 double cotton covered. With the above conditions fixed, there are two possible variables; viz., the number of primary turns and the relative direction of the primary and secondary turns. For the sake of convenience, the relative direction of turns is said to be "continuous" if the direction of rotation is always the same as one proceeds from the plate of the amplifier tube, through the primary, to the filament end of the secondary, and through the secondary to the grid of the output tube. If the direction of rotation reverses as one passes from the primary to the secondary, the relative direction of turns is said to be "reversed." Fig. 5 and Fig. 6 show results obtained with transformers of this type.

Reversed Winding Preferable

Another type of transformer tested was identical with the previous type except that the primary was distributed so as to have an over-all length equal to the length of the secondary, which in this case was 1⅝ inches. Curves for this transformer are shown in Fig. 7 and Fig. 8. Comparison of these four figures shows that in both cases the reversed direction of winding gives the higher amplification at the maximum point on the curves. This effect is due to the presence of capacitive coupling as well as inductive coupling between the primary and secondary. Just how these two influences combine may best be studied with the aid of the vector diagrams of Fig. 9. First consider that the capacitive coupling alone is present as in the so-called "resistance coupled" amplifier. Fig. 9-A is the vector diagram for capacitive coupling only. I_p represents the alternating plate current flowing through the resistance R_p, and E_p is the IR drop across R_p and in phase with I_p. This voltage causes a flow of alternating current through the circuit made up of the inter-coil capacity C and the resistance R_g. In the practical circuit, R_g is actually a coil shunted by a tuning condenser and by the grid-filament capacity of the next tube, but since this circuit is tuned to resonance with the frequency being amplified, its reactance is zero and its impedance is very high and hence its effect in the circuit is not unlike that of a high resistance as indicated in the diagram by R_g. The current I_1 through C and R_g will be leading E_p by an angle dependent upon the relative reactances of C and R_g. The voltage across R_g, or E_1, will be in phase with I_1.

In the case of a transformer having the relative direction of the primary and secondary turns continuous, it can be shown that the primary and secondary voltages, E_p and E'_s, are 180° apart as shown in Fig. 9-B. In a practical transformer the actual secondary voltage is a resultant of the voltage due to electromagnetic induction E'_s and that due to inter-coil capacity E_1. This resultant is E_s in the diagram.

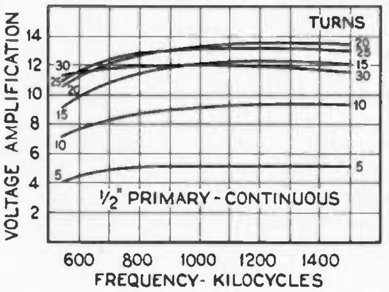


FIG.5

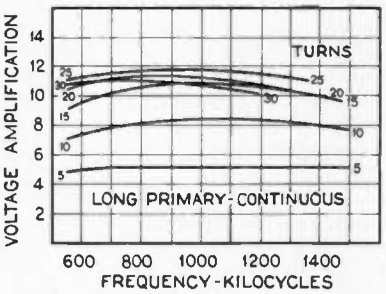


FIG.7

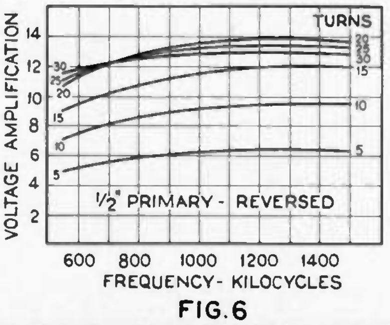


FIG.6

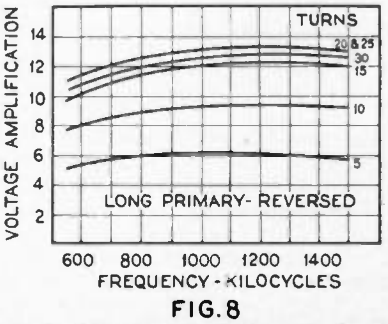


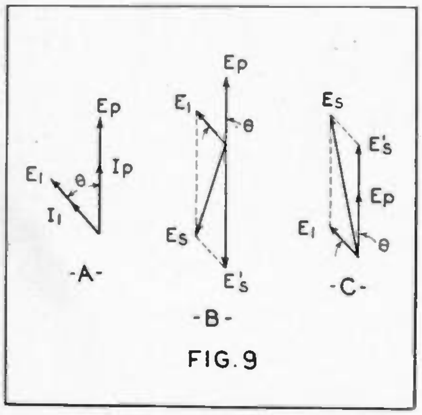
FIG.8

Group of curves obtained from short and long primary windings both continuous and reversed and with a various number of turns.

* *Department of Electrical Engineering, Michigan State College of Agriculture and Applied Science.*

In the case of the reversed winding, E'_s and E_p are in phase and E'_s combines with E_s as shown in Fig. 9-C. Inspection of the two figures will show that when the angle θ is less than 90°, the resultant, E_s, will always be greater with the reversed winding than with the continuous.

This means that for a transformer



A. Vector diagram for capacitive coupling. B. Vector showing resultant of inductive and capacitive voltages for transformer with continuous winding. C. Same for transformer with reversed winding.

designed for a particular frequency the reversed winding will give the greater amplification. However, the type of transformer being investigated is used over a wide band of frequencies, and inspection of Figs. 5, 6, 7, and 8 will show that the continuous winding, while giving lower amplification, amplifies more uniformly over the whole band. This is particularly evident in Fig. 7. The probable explanation of this condition is that the voltages due both to electromagnetic and electrostatic induction increase as the frequency increases, and since in the continuous winding the electrostatic voltage tends to oppose the electromagnetic voltage (see Fig. 9-B), the net increase in voltage at the higher frequencies is less than with the reversed winding. This effect is much more pronounced in Fig. 7 than in Fig. 5, because the inter-coil capacity is much greater in the case of the long primary. This increased capacity between coils has the undesirable effect of increasing the distributed capacity of the secondary coil, so that, except with a primary of very few turns, the transformer will not tune to the higher frequencies. This is why some of the curves of Fig. 7 stop short of the highest frequency.

Relative Selectivity

The selectivity of the transformer with the long primary is much poorer than of that with the ½ inch primary and the selectivity with the continuous winding is poorer than with the reversed winding. The accompanying table gives the selectivities of the several types of transformers tested. Practical experience with these transformers indicates that a selectivity of 25% (as defined in section on "Selectivity Tests") is the poorest allowable. 15% to 20% is better, especially where only one stage of radio-frequency amplification is used in the receiving set. From the standpoint of selectivity, then, the greatest number of turns which may be used with the full length, continuous primary is 10, which will give a nearly constant voltage amplification of 8 per stage. With the ½ inch primary we could use as many as 15 to 20 turns for the same selectivity and obtain a voltage amplification varying from 9 to 12 for 15 turns, or 10.6 to 13.5 for 20 turns.

Whether one would choose the transformer giving moderate but uniform amplification, or the one having higher but non-uniform amplification depends upon the particular application in which the transformer is to be used. The lack of uniformity shown by the 15 or 20 turn curves of Fig. 5 would not be objectionable in a one stage amplifier, since the falling off at the low frequency end is less than 25% of the maximum amplification. However, in the case of a two stage amplifier, where the over-all amplification is the square of the amplification per stage for any particular frequency, the maximum and minimum amplification using the transformer with the 15 turn primary would be approximately 144 and 85, or a falling off from the maximum of over 40%. This would have the effect of giving the receiving set a noticeably different sensitiveness in the two ends of the band. Hence, for a multi-stage amplifier it would be preferable to use the transformer with the long distributed primary and having a performance curve as shown by the 10 turn graph of Fig. 7.

Distributed Capacity

The two types of transformer mentioned above were chosen for the discussion of the effect of inter-coil capacity since they illustrate this point very clearly. Two somewhat similar transformers are one having the primary "scramble wound" in a slot ⅛ inch wide, and one having the primary wound on the same tube and adjacent to the secondary, but with about ¼ inch separation between the nearest ends of the two windings. In both of these arrangements the capacity between windings is so low that there is practically no difference in performance between the continuous and the reversed winding.

The effect of the slot wound primary (Fig. 10) is to cause a rapid falling off in amplification at the higher frequencies when the number of turns is greater than 20. This is due to the greater distributed capacity of the closely bunched winding which acts as a by-pass condenser and discriminates against the higher frequencies. The 20 turn curve of Fig. 10 shows a high and quite uniform amplification, but the selectivity, only 35%, is very poor. (See table.) The selectivity obtained with the 15 turn primary is fair, but the curve is not as flat as that of the 15 turn, ½ inch primary illustrated in Fig. 5. By using a small number of primary turns, say 10 to 15, for the sake of selectivity, and by shunting the primary with a suitably chosen value of capacity it is possible to obtain the same amplification at the extreme high and low frequencies, but the rise in the middle of the curve results in a deviation from uniform amplification as great as that in any of the transformers previously considered. Fig. 11 illustrates the results obtained with the primary and secondary adjacent on the same tube. These curves

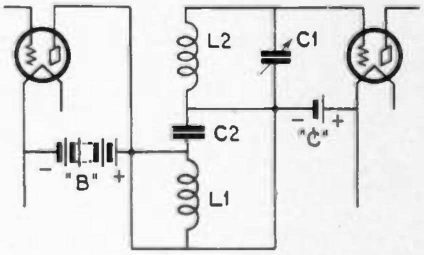


FIG. 14

Circuit diagram of radio frequency auto-transformer.

are very similar to those of Fig. 5, but owing to the lower mutual inductance of this form of winding, more turns are required for the same amplification and similar selectivity. The inter-coil capacity is a minimum with this type of winding and maximum tuning range is afforded with a condenser of given size.

The reason for the falling amplifi-

*Table of Selectivity**

Type of primary winding.	Cont. Rev.	Number of primary turns. 5	10	15	20	25	30	35	40	45	50
½-inch long, inside secondary	C	4	10	17	27	38	50	63	....	....	....
½-inch long, inside secondary	R	3	8	15	23	33	43	54	....	....	....
Long, distributed	C	14	24	30	36	43	....	....	....	....	....
Long, distributed	R	13	21	28	32	38	....	....	....	....	....
⅛-inch slot	C or R	....	13	23	35	49	64	....	....	....	....
¼-inch separation on same tube	C or R	....	6	10	14	19	24	30	36	43	50

* The figures give the average of the amplification at 1,250 and 1,350 kilocycles when the transformer is tuned to 1,300 kilocycles, expressed as a percentage of the amplification at 1,300 kilocycles.

cation at the lower frequencies with all of these transformers is, as in the case of audio-frequency amplification, the fact that the impedance of the transformer primary falls as the frequency falls while the resistance of the vacuum tube plate circuit to which it is connected remains constant and thus the voltage across the transformer is lower at the lower frequencies. This difficulty is overcome in audio-frequency amplification by increasing the primary inductance through the use of more turns or a larger core or both. That the same condition exists in the radio-frequency transformer may be seen by reference to Fig. 11 where the amplification at 550 kilocycles increases steadily as the number of primary turns is increased from 10 to 50. A further increase in primary turns would result in increased amplification up to a point where the impedance of the winding reduces the radio-frequency current flowing in the circuit. Apparently the voltage amplification has nothing to do with the ratio of primary and secondary turns. The decrease in amplification due to too many turns is clearly shown in Fig. 11 at the frequency of 1500 kilocycles. The amplification for the 50 turn primary in Fig. 11 is the same at the extreme high and low frequencies, and although it rises in the middle, the percentage drop from maximum is only 10.6%, which is very good, but unfortunately the selectivity is very poor; viz., 50 per cent.

When the investigation reached this point, it appeared desirable to reduce the coupling; i. e., increase the separation between the primary and secondary in order to improve the selectivity and at the same time to keep the necessary number of primary turns to give equal amplification at the highest and lowest frequencies. The graphs of this experiment, Fig. 12, show that while the selectivity is increased, the rise in the middle of the curve is more pronounced, thus reducing the uniformity of amplification. The 1½ inch separation with a selectivity of 25%, the poorest selectivity allowable, has a deviation from maximum amplification of 20%. It has approximately the same selectivity and 550 kilocycle amplification as the 20 turn primary of Fig. 11 and the 20 turn winding of Fig. 5. There would seem to be no advantage, then, in this type of winding since, in comparison with the more common types, it merely reduces the amplification at the higher frequencies without appreciably improving the uniformity of amplification.

Methods of Increasing Primary Impedance

Instead of increasing the number of primary turns to raise the primary impedance a condenser may be connected across the primary, or what amounts to the same thing, the primary may be wound in a narrow slot to increase its distributed capacity. Fig. 13 shows the peculiar results obtained with this transformer, each graph representing a certain separation between the bunched primary and the filament end of the secondary. 15% deviation from maximum is obtained with the one inch separation, but the selectivity is poor (about 30%) and the resonance peaks due to the tuned primary would be certain to cause trouble in a multi-stage amplifier.

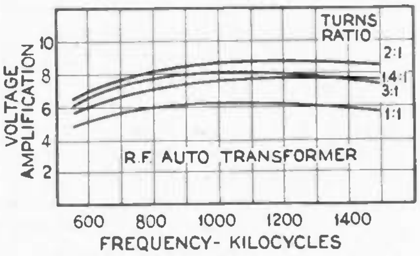


FIG. 15

Voltage amplification curves of a radio frequency auto-transformer such as shown in the diagram of Fig. 14.

A practical method of increasing the primary inductance at the lower frequencies is by means of a rotor connected in series with the primary and mounted upon an extension of the shaft of the tuning condenser. Thus referring to Fig. 11, if the primary and rotor were so proportioned that we would have the equivalent of a 35 turn primary at 550 kilocycles and a 20 turn primary at 1500 kilocycles we would obtain a voltage amplification of about 11 times at both frequencies with perhaps only a slight rise in the middle of the curve. Such a transformer is now available on the market.

Fig. 14 illustrates the connections of a type of transformer in which the primary and secondary are both included in the tuned circuit with the condenser C_1. The condenser C_2 is of large capacity and serves to insulate the plate battery from the filament while acting as a low impedance radio-frequency by-pass. Graphs of the voltage amplification of this transformer at various turns ratios are shown in Fig. 15. The lower voltage amplification as compared with previously discussed transformers is due to the fact that only a part of the voltage built up in the tuned circuit is impressed upon the output vacuum tube. The selectivity of all reasonable ratios of this transformer is about the same, 20 to 25 per cent. and since the uniformity of amplification is no better than is obtained with other transformers, there seems to be no particular reason for its use. It has the disadvantage that neither side of the tuning condenser C_1 is at ground potential. Thus the capacity of the operator's hand may change the tuning of the circuit.

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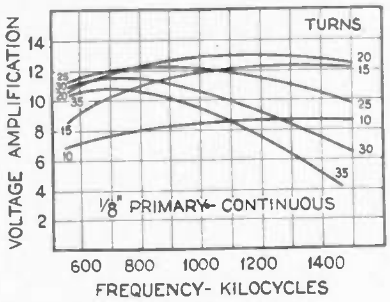


FIG. 10

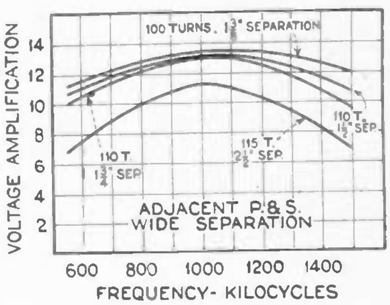


FIG. 12

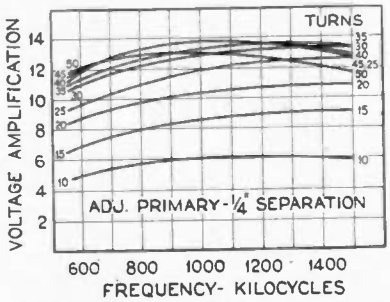


FIG. 11

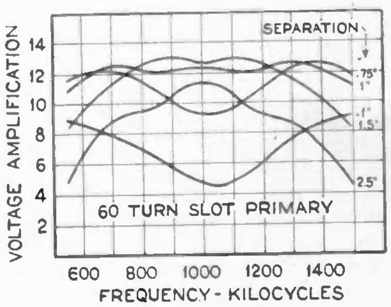


FIG. 13

Another group of curves obtained from various forms of primary coils and different degrees of coupling. Note the effect of distributed capacity on the curves of a slot wound primary, shown in Fig. 13.

The Fourth Annual R. M. A.

All Available Exhibition Space in Hotel Stevens Subscribed For; Visitors Expected. Special

PLANS are maturing for the premier radio industry event and trade conclave of 1928, the fourth annual Convention and Trade Show of the Radio Manufacturers Association, to be held June 11-15, at the Stevens Hotel, Chicago. An attendance of 25,000 to 30,000 persons connected with or interested in radio manufacturing and merchandising is expected.

During the week of June 11, coincident with the R.M.A. Trade Show, there will be held the fourth annual R.M.A. Convention, and also meetings of the National Association of Broadcasters and the Federated Radio Trade Association. The radio industry meetings and Trade Show will be staged simultaneously at the Hotel Stevens and the gathering of radio interests will be the greatest in the history of the industry. Problems incidental to radio manufacturing, distribution, engineering, and merchandising will receive attention at many national and group meetings. Addresses will be delivered by prominent national and industry figures and extensive programs of entertainment for guests and visitors are in preparation.

The last word in modern radio will be on exhibition in the Trade Show. The newest and latest in receiving sets, tubes, loud speakers, parts, cabinet, accessories, etc., will be displayed by about 300 of the leading manufacturers (all R.M.A. members), but only for the trade. The public will not be admittted.

Exhibition Space Oversubscribed

Over 30,000 square feet of space in the Stevens Hotel, the largest in the world, has been over-subscribed by R.M.A. members for the Trade Show. The space engaged is almost double that of the first and highly successful R.M.A. Trade Show in 1927 which occupied 19,000 feet of space. Reservations being made insure that virtually the whole Stevens Hotel will be used by the radio gathering for the largest assemblage of radio interests ever held under one roof. The entire ball room, foyer, and exhibition hall of the Stevens Hotel will be devoted to the Trade Show, and three entire floors have been reserved by exhibitors for demonstrating purposes.

Arrangements for the Trade Show are again in the hands of Major H. H. Frost, chairman of the R.M.A. Trade Show Committee, and the exhibition is again in direct charge of Mr. G. Clayton Irwin, Jr., of Hermann & Irwin, the managers of the R.M.A. Radio World's Fair in Madison Square Garden and the Chicago Radio Show held at the Coliseum, the annual public radio show features.

Invitation to the Chicago Trade Show will be sent to 25,000 radio jobbers and retail dealers.

R.M.A. Convention and Trade Show special trains will be run from several cities. A private section of the Twentieth Century Limited—probably two sections—will be chartered from the Atlantic Coast. One, and possibly two, special trains from the Pacific Coast, San Francisco and Los Angeles, are being arranged, and another from the South and Southwest is in prospect. The eastern R.M.A. special is again being organized by Mr. Leonard C. Welling and Mr. Dudley H. Cohen who are making plans for thorough entertainment of the radio travelers en route.

Entertainment Program

At Chicago during the entire week of June 11th a continuous and elaborate program of entertainment for the radio visitors is being completed by Henry C. Forster of Chicago, Chairman of the R.M.A. Convention Program Committee. The principal social event will be the annual R.M.A. banquet, on Flag Day, Thursday, June 14th. This will be staged at the Rainbo Gardens, the famous million dollar entertainment resort, one of the largest in the world, of Fred Mann. About 3500 persons can be accommodated at the Banquet. Chairman Forster is arranging for a sumptuous banquet and entertainment features surpassing anything in the history of the radio industry.

Instead of a long list of speakers at the banquet, there will be a lavish entertainment program, with celebrities of the musical and entertainment world appearing for a national chain broadcast. Rainbo Gardens also will be equipped with amplifiers within the banquet hall and music for diners and dancers will be furnished by Isham Jones' famous orchestra. Rainbo Gardens will be closed to the public during the R.M.A. festivities, but all of its various entertainment features will be in full blast, including the Spanish speed game of Jai Alai. Also there will be a revue during the banquet by professional entertainers. Special entertainment features for ladies accompanying the radio visitors, such as excursions, theatres, dances, etc., also will be provided.

Special Sessions

During the R.M.A. Annual Convention, which will be presided over by Mr. C. C. Colby of Canton, Mass., President of the Association, there will be open sessions for the discussion of radio problems and one or two closed sessions, including election of new Association officers. There will also be many meeting of R.M.A. committees and the R.M.A. membership will consider the proposed patent interchange plan and adoption of a new Constitution and By-Laws designed to increase the activities and extend still greater the influence of the R.M.A.

Special Convention Railroad Rates

A reduction of one and one-half fare on the "Certificate Plan" will apply for all members attending the R.M.A. Meeting, and also for the dependent members of their families.

The following directions are submitted for your guidance:

1. Tickets at the regular one-way tariff fare for the going journey may be obtained on any of the following dates (but not on any other date) JUNE 11th to 15th, INCLUSIVE. Be sure that, when purchasing your going ticket, you request a CERTIFICATE. *Do not make the mistake of asking for a "RECEIPT."*

2. Present yourself at the railroad station for ticket and certificate at least thirty minutes before departure of train on which you will begin your journey.

3. *Certificates are not kept at all stations.* If you inquire at your home station, you can ascertain whether certificates and through tickets can be obtained to place of meeting. If not obtainable at your home station, the agent will inform you at what station they can be obtained. You can in such case purchase a local ticket to the station which has certificates in stock, where you can purchase a through ticket and at the same time ask for and obtain a *certificate* to the place of meeting.

4. Immediately on your arrival at the meeting present your certificate to the endorsing officer, Mr. M. F. Flanagan, Executive Secretary, as the reduced fare for the return journey will not apply unless you are properly identified as provided for by the certificate.

5. Arrangements have been made for validation of certificate by a Special Agent of the carriers on June 11th to 15th, inclusive if the required minimum of 250 certificates is presented.

6. *No refund of fare will be made because of failure to obtain a proper certificate when purchasing going ticket.*

7. So as to prevent disappointment, it must be understood that the reduction on the return journey is not guaranteed, but is contingent on an attendance at the meeting, of not less than 250 members of the organization and dependent members of their families, holding regularly issued certificates obtained from ticket agents at starting points showing payment of regular one-way adult tariff fare of not less than 67 cents on going journey.

Convention and Trade Show

Nearly Double the Space Used Last Year. Thirty Thousand Trade Reduced Railroad Rates

8. If the necessary minimum of 250 certificates is presented to the Special Agent as above explained, and your certificate is duly validated, you will be entitled up to and including June 19th, 1928, to a return ticket via the same route over which you made the going journey, and one-half of the regular one-way tariff fare from the place of meeting to the point at which your certificate was issued.

9. Return ticket issued at the reduced fare will not be good on any limited train on which such reduced fare transportation is not honored.

Federated Radio Trade Association Convention

The Federated Radio Trade Association is actively at work in making plans for a Convention of all their members and prospective members during the coming Radio Manufacturers' Association trade show, June 11-15.

The attending radio wholesalers will hold a meeting under the auspices of the Radio Wholesalers Association for work on the completion of this newly formed organization and also to make standard recommendations on trade practices and Code of Ethics.

The Dealers Section of the Federated will also hold a separate meeting devoted exclusively to dealers problems and the perfecting of their organization to aid the dealers generally throughout the country.

The Manufacturers Representatives Section will also have time on the program for a meeting of their group to devise ways and means whereby they can increase the good will of the entire industry.

The Federated Radio Trade Association will hold a special meeting of their Board of Directors on Monday, April 16, in order to take care of their share of the urgent legislative business which is now before the Federal Radio Commission. They will appoint a committee of five to meet with similar committees from the other organizations in the radio industry to discuss ways and means for the reallocation of broadcasting stations with the Federal Radio Commission. The Board of Directors will also complete the plans for the coming Convention.

President Harold Wrape is very optimistic regarding the outcome of the present re-organization which was started in Milwaukee, February 15, 1928.

A Peace Note in Patent Dispute

A peaceful note in the controversies over radio patents was an announcement recently by Mr. A. J. Carter of Chicago, Chairman of the Special Patent Interchange Committee of the Radio Manufacturers Association, that the RMA patent cross-licensing plan, which has been in preparation since last fall, was virtually completed. It will be submitted to the RMA Board of Directors late this month and to the RMA membership for adoption next June at Chicago during the RMA Annual Convention.

RMA industry leaders in the East and West, in two groups, are completing the final draft of the cross-licensing plan. Mr. Carter and his western committee members, in co-operation with Mr. C. C. Hanch, special counsel for the RMA and "father" of the patent cross-licensing plan of the automotive industry, are holding special meetings at Chicago in concluding the cross-licensing plan. In the East, at Boston, Mr. C. C. Colby, President of the RMA. Mr. John W. Van Allen of Buffalo, RMA counsel, and other legal and technical experts are engaged.

Anticipating successful establishment of the patent cross-licensing plan, Chairman Carter of the Patent Committee states that several important radio patent groups have evinced intentions to enter the cross-licensing plan as soon as it may be put into effect.

Recent developments in the radio patent structure also have created wider interest in the RMA patent peace plan.

Tentative Program of the R.M.A. Fourth Annual Convention and Trade Show

TRADE SHOW HOURS

Monday,	June 11—	2:00 P. M. to 10:00 P. M.
Tuesday,	June 12—	1:00 P. M. to 10:00 P. M.
Wednesday,	June 13—	1:00 P. M. to 10:00 P. M.
*Thursday,	June 14—	11:00 A. M. to 5:00 P. M.
Friday,	June 15—	1:00 P. M. to 10:00 P. M.

Note.—*All Demonstration Rooms will be closed Thursday evening June 14, 1928, at 5:00 P. M. on account of R.M.A. Annual Banquet.

MEETINGS

Monday—
June 11—10:00 A. M. Registration.
10:30 A. M. Meeting R.M.A. Board of Directors Committee Meetings (to be scheduled).

Tuesday—
June 12—10:00 A. M. Opening Meeting R.M.A. Convention.
Welcoming Address—Honorable Wm. Hale Thompson, Mayor, City of Chicago.
Response—Mr. C. C. Colby, President R.M.A.
Address—Mr. Earle C. Anthony, President National Association of Broadcasters.
Address—Honorable Ira E. Robinson, Chairman Federal Radio Commission.
Address—Mr. Harold J. Wrape, President Federated Radio Trades Association.

Wednesday—
June 13—10:00 A. M. Closed R.M.A. Membership Meeting.
Meeting Radio Wholesalers Association, Dealers Section Federated Radio Trades Ass'n, Association Section Federated Radio Trades Ass'n, and Associate Membership of Manufacturers Representatives.

Thursday (Flag Day)—
June 14—10:00 A. M. Closed R.M.A. Membership Meeting.
Board of Directors, Federated Radio Trades Association.
Board of Directors, National Association of Broadcasters.
7:00 P.M. R.M.A. Annual Banquet.

Friday—
June 15—10:00 A. M. R.M.A. Board of Directors.
12:00 A. M. Joint Meeting Board of Directors, R.M.A., NAB., and F.R.T.A.

The Impedance Adjusting Transformer

An Explanation of the Function of Transformers Designed to Match Impedances

*By C. T. Burke**

THE writer has been moved to the preparation of this article by repeated evidence of misunderstanding of the function played by transformers designed to "match" impedances, culminating in the following evidence of a slight mental haze surrounding the subject. "A little consideration will show that if the primary impedance of this transformer is equal to the tube impedance and if the secondary impedance is equal to—'matches' is the usual word—the load impedance, one-half the voltage existing in the plate circuit will be expended in heating the plate. It is obvious then that the primary impedance again should be several times that of the tube."

An old professor of the writer's, an experienced author of text books, used to warn his classes that the phrase "it is obvious" is the invariable resort of an author when the conclusion it precedes is far from obvious from the premises.

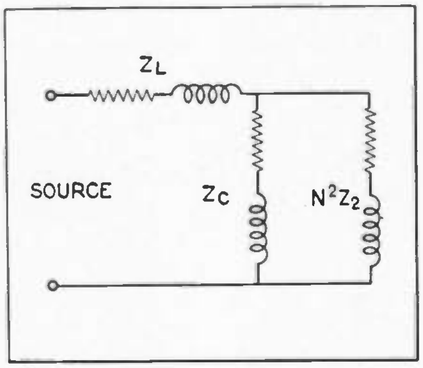
Relation of Impedances

In the first place, why is an impedance adjusting transformer? Briefly, when circuits of greatly differing impedance are connected together the efficiency of transfer from one circuit to the other depends on the relation between the impedances of the circuits. It may be demonstrated that the maximum transfer of energy is obtained when the impedance of the circuit in which the energy originates equals that of the circuit to which it is delivered, or, as it is usually expressed, when the impedance of the "source" equals that of the "sink."

Ordinarily, the impedances of the source and of the sink depend on factors of design which may not be altered to improve the impedance relation. This is where the transformer comes in. Suppose a source has an impedance of Z_1 and generates a voltage of E, and must be coupled to a sink having an impedence of Z_2. Maximum power transfer occurs when Z_2 equals Z_1. To the source this means that the impedance Z_2 must look equal to Z_1, that is, it must take the same current from the source as a sink impedance equal to Z_1 would. It is well known that in going through a step-down transformer, the voltage is divided and the current multiplied by the turns ratio of the transformer.

If E_2 = secondary voltage
I_2 = secondary current
I_1 = primary current

* *Engineering Department, General Radio Co.*



Equivalent circuit of an impedance adjusting transformer, represented by generalized impedances.

$$I_2 = \frac{E_2}{Z_2} = \frac{E_1}{N Z_2}$$

$$I_1 = \frac{I_2}{N} = \frac{E_1}{N^2 Z_2}$$

But for maximum energy transfer.—

$$I_1 = \frac{E_1}{Z_1}$$

Therefore

$$\frac{E_1}{Z_1} = \frac{E_1}{N^2 Z_2}$$

$$\text{and } N = \sqrt{Z_1 / Z_2}$$

In other words if the sink is coupled to the source with a transformer having a turns ratio N, equal to the square root of the ratio of the impedances, the circuit will act just as though the sink impedance equals that of the source.

Transformer Ratio

So far nothing has been said of the effect of the transformer impedance, the action of the unit in "matching" impedances depending entirely on its ratio and having nothing to do with the impedance of the transformer *per se*, by which is meant the impedance measured across the primary with the secondary open circuited. The transformer impedance does have an important effect on the efficiency of the device which may be shown from the approximate equivalent circuit shown.

The circuit consists of an impedance Z_L, (including the ohmic resistance and leakage reactance) in series with a parallel circuit consisting of N^2Z_2, the sink impedance as modified by the transformer, and Zc, the open circuit impedance of the transformer.

The transformer impedance forms a shunt across the sink, drawing current which increases the losses in the source and does not flow on into the sink. Proper design demands that the transformer impedance be enough larger than the reflected impedance of the sink to insure that practically all of the current shall flow through the sink. If the transformer impedance is equal to the tube impedance, only half the current output of the source would get into the sink, and *more than half* the voltage existing in the plate circuit would be lost. If the turns ratio is such as to make the equivalent sink impedance equal to the source impedance, and the transformer impedance is high, half the voltage will appear across the transformer, and half will be lost in the plate of the tube. This is the condition for maximum power output of any electrical device. The fire department arrives, of course, long before the condition of maximum output is reached in conventional power machinery.

Summary

To sum up, the matching function of the transformer is dependent on its turns ratio. The transformer impedance must be high enough to prevent appreciable shunting. The transformer does not, as one might be led to believe by reading the article already referred to, introduce factors of 2 at convenient points in a mathematical proof.

It is not always practical to obtain a sufficiently high primary impedance to prevent shunting. In inter-tube coupling transformers, the reflected impedance is higher than it is feasible to make the transformer impedance at low frequencies, and hence the shunting effect controls the behavior and design of the device. In another portion of the article referred to above, factors of cost, size, and coil distributed capacitance are ignored (illustrating the perils of "arm chair" engineering) and it is proved that inter-tube coupling transformers should have a ratio of about 9, although an error in extracting a square root gives a result of 3. The best commercial transformers have a ratio of about 3, so that the error in mathematics just offsets the error in assumptions. It is dangerous, however, to depend on such fortuitous circumstances in practical design problems.

The Problem of Radio Set Power Supply

Covering Design Problems and the Application of Condensers and Inductance Coils to Socket Power Units

By George B. Crouse*

PART V

THE most important elements which go to make up the filter circuit of a power supply, both as regards bulk and cost, are condensers or inductance coils, or both. Therefore, the economical design of a given filter circuit resolves itself largely into the proper design of these elements.

Condensers

The manufacture of condensers, like the manufacture of rectifiers, is a highly technical specialty involving the chemistry of papers and impregnating compounds, the mechanics of impregnation and winding and similar problems. For this reason the problem of the socket power designer is one of accurately specifying the rating, capacity and conditions of use, the actual construction details and materials being generally wisely left to the manufacturer. Samples of the finished product built to the specification should then be tested by the designer to ascertain whether the specified conditions have been met.

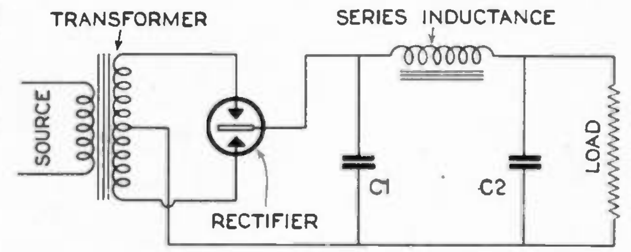


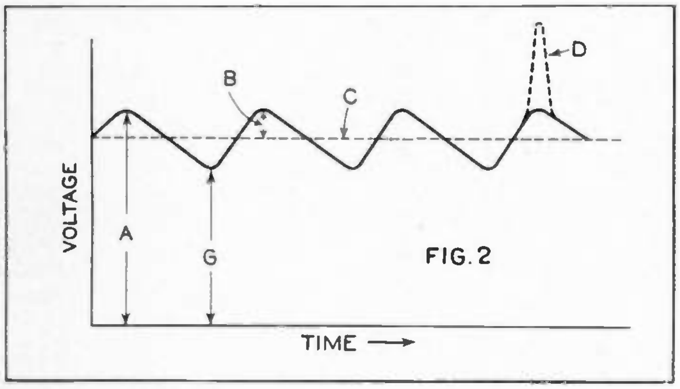
FIG. 1

Diagram of full-wave power unit employing an abbreviated filter mesh of the condenser input type.

If the condenser manufacturer is to turn out a satisfactory product, he should receive complete and definite information as to the conditions to be met.

A complete specification on a condenser should include the following information:

1. The nominal capacity.
2. The permissible variations plus and minus from the nominal capacity.
3. The maximum working voltage to which the condenser is continuously subjected in normal operation.
4. The maximum A.C. voltage to which the condenser is subjected in normal operation.
5. The maximum working voltage to which the condenser may be subjected continuously for moderate periods under abnormal conditions, such as an open circuit output.
6. The maximum A.C. voltage to which the condenser is subjected under the conditions of (5).
7. The maximum peak voltage to which the condenser may be occasionally and instantaneously subjected under abnormal conditions, such as the sudden opening of an inductive circuit in series with it.



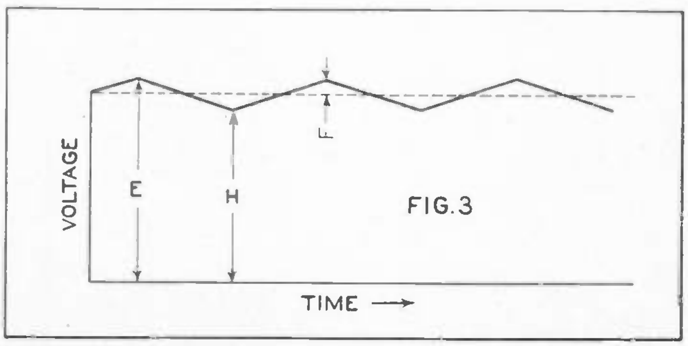
Rectified voltage applied to filter; as an example, to condenser C1 in Fig. 1. A, represents maximum working voltage; B, maximum A.C. voltage; C, average D.C. voltage and D, maximum peak voltage.

8. The maximum ambient temperature in which the condenser will be operated.

In order to accurately define these eight quantities, consider the condenser C1, in the simple filter mesh shown in Fig. 1. The nominal capacity will have been determined in the design of the mesh, as explained in detail in previous articles of this series. The permissible variations from this capacity will ordinarily have to be determined by experiment, by actually changing the capacity up and down to the limits where detrimental changes in the action of the filter or rectifier occur.

In specifying these limits it should be borne in mind that the wider the limits, the cheaper the condenser. The methods employed in the manufacture of these devices do not permit holding the capacity much closer than plus or minus 10%, and if a greater accuracy than this must be secured, it will be necessary to select such units as accidentally come within the tolerance, an expensive and wasteful process.

The definition of the various voltages mentioned in the specification will be clear from Fig. 2 and 3. Fig. 2 shows the voltage applied to condenser C1 under full load conditions. The maximum working voltage in normal operation is the height of the ordinate A. The maximum A.C. voltage under normal operation is the height B to the peak of the A.C. wave measured from the line C, which is the average D.C. value of the charge on the condenser. The dotted line D is the maximum peak voltage (item 7) which might arise due to the effect



Voltage conditions obtaining when the load on the filter is suddenly removed. E, is maximum working voltage and F the A.C. working voltage.

* Vice-president and Chief Engineer, Conner-Crouse Corporation.

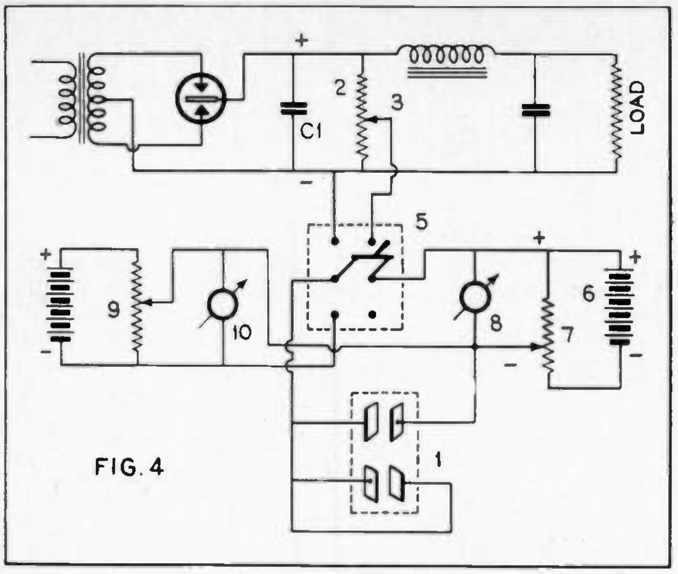


FIG. 4

Circuit arrangement, employing a cathode ray oscillograph, for measuring the A.C. working voltage across the input condenser in a filter mesh under load conditions.

of the series inductance (Fig. 1) when the load is suddenly opened.

In Fig. 3 are shown the conditions obtaining when the load is open. The height of the ordinate E represents the maximum working voltage and F the maximum A.C. voltage (Items 5 and 6).

It has been the practice in many cases not to specify the A.C. voltage. This quantity, however, is highly important. The alternating current flowing in the condenser not only generates heat due to dielectric hysterisis, which may accelerate decomposition of the organic impregnating compound, but it also sets up mechanical vibrational forces which tend to separate the layers of the condensers.

The various voltages mentioned are best determined by measurement on the actual apparatus working under the required load conditions. These measurements may be made with the vacuum tube voltmeter, the technique of which has been thoroughly discussed in many publications and needs no repetition.

Another convenient method of measuring these voltages has recently been worked out in the writer's laboratory, using the cathode ray oscillograph. The circuit arrangements for making these measurements are shown in Fig. 4. In this figure the deflecting plates of the tube are shown in the block 1, only one pair of plates being used for the measurement, the other pair being short circuited, as shown. Across the condenser C1 is connected the high resistance potentiometer 2 having a sliding contactor 3. The purpose of this potentiometer, which should be calibrated, is to reduce the voltage applied to the deflecting plates to a convenient value. With the double pole, double throw switch 5 thrown to the up position a known portion of the voltage across C1 will be applied to the plates in series with a reverse D.C. potential applied by means of the battery 6 and adjustable with the potentiometer 7.

In Fig. 5 is shown a view of the screen of the oscillograph on which will be seen a straight line displaced to one side. By adjusting the potentiometer 7, one end of this line may be made to coincide with the position of the undeflected spot. The D.C. potential read on the voltmeter 8 times the ratio read on potentiometer 7 will then be the height of the ordinate G in Fig. 2 (or H in Fig. 3), and the length of the line will be proportional to twice the ordinate B of Fig. 2 (or F of Fig. 3). The length of this line may be calibrated by throwing the switch 5 into the down position and adjusting the potentiometer 9 until the spot is deflected to the point J. The reading of the voltmeter 10 times the ratio read on potentiometer 7 will then be the required calibration.

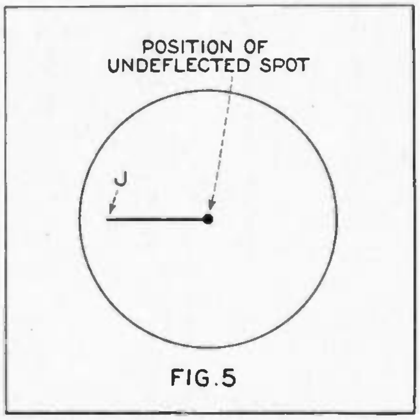


FIG. 5

Screen of oscillograph tube and the reflected line which indicates the extent of the A.C. working voltage.

The maximum peak voltage to which the condenser may be subjected under abnormal conditions, such as the sudden opening of the load in Fig. 1, is difficult to measure or estimate. An approximation may sometimes be obtained with a peak voltmeter, but all that can be usually done is to estimate it at approximately three times the maximum working voltage.

The ambient temperature to which the condenser will be subjected should be measured wherever possible in an actual model of the apparatus. These measurements should be made with the thermometer placed in the air surrounding the condenser, and on any warm metal parts which may be in contact with it. In every case the condenser should be mounted in the coolest available location. High temperatures soften the impregnating compound, accelerate decomposition and shorten life.

Up to date no satisfactory short test has been devised to determine whether a given sample of a condenser meets the specifications or not. Where a decision must be made quickly without time to run life tests, the designer must rely upon the skill, experience and integrity of the manufacturer.

He should, however, in every case keep samples picked at random from the shipments on life tests under all working conditions.

In regard to routine production tests, about all that can be done is to test the condensers at approximately the working voltage to determine that they are not short circuited when received. It has been pretty definitely established that the high voltage test for a period of a minute or two is not a measure of the quality of the condenser, may weaken a perfectly good unit, and in general serve no good purpose.

Curve illustrating the effect of the direct current flow on the A.C. inductance value of a filter choke, measurements of which are given.

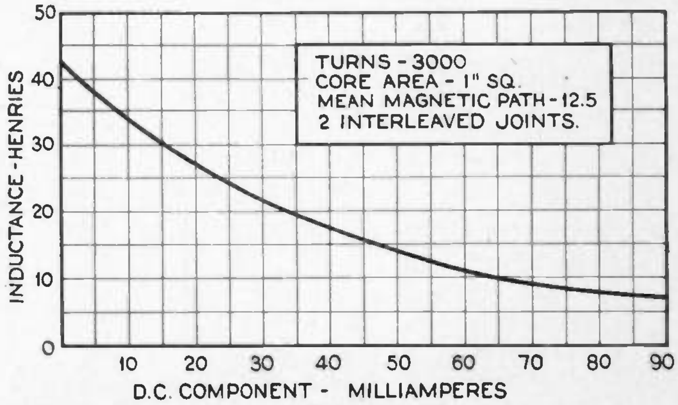


FIG. 6

Inductance Coils

Any circuit element which is interlinked with a magnetic flux constitutes an inductance, whose value is determined by the amount of the flux and the number of turns linked therewith. It is possible, where the permeability of the flux path is unity, to compute the value of the inductance of a given coil from theoretical considerations. Even in this case, however, when the number of turns becomes large the calculations become very complex and to be practical, must be approximate.

At the low frequencies with which we are dealing in socket power apparatus it is necessary, from practical considerations, to make the flux path at least partially of iron. The permeability of the iron varies with a great number of factors, and we must therefore have recourse, in the design of such coils, to approximate calculations supplemented by cut-and-try experimentation. Before proceeding to a detailed discussion of the method of designing such coils, we may profitably consider some of the fundamental factors.

Consider, for instance, the series inductance of Fig. 1. In the first place this coil must carry direct current drawn from the rectifier and the capacity C_1 and deliver it to the load.

It will be seen, therefore, that we must take into account the direct current characteristics of the coil. That is, it will probably be necessary for reasons of economy in the transformer and condenser design or perhaps because of limitation in the voltage available at the rectifier output to hold the D.C. resistance of the coil below a certain value. Furthermore, we must take account of the temperature rise, because as the copper heats up its resistance will increase and the voltage across the load will fall. We therefore cannot fix the permissible temperature rise on the basis of the allowable temperature to which the insulation may be subjected, but rather upon the allowable variation in D.C. voltage across the load. A further consideration in this connection is that a high series resistance will spoil the regulation of the circuit for varying load resistances. It was the neglect of this last consideration which accounted for some of the early "B" Socket Powers in which the output voltage would fall from several hundred volts on open circuit to 50 or 60 volts under full load.

As will be clear from the discussion of filter circuits in previous articles of this series, the coil is also acting as an A.C. circuit element, and its required inductance value will be determined by the design of the mesh.

We may consider first the effect of the direct current on the A. C. inductance value. In Fig. 6 is shown the actual measured inductance of a coil under varying D.C. currents. This coil consisted of 3,000 turns of wire on a core having a 1" x 1" section and a mean length of path of 12½", with two inter-leaved joints. It will be noted that the inductance begins to fall rapidly on the introduction of a D.C. component. The reason for this may best be seen in Fig. 7, which is the magnetization curve of ordinary silicon steel such as is used in transformer cores. Suppose that the direct current component through the coil is such that the direct current ampere-turns per inch have the value A. If on top of this we have a small A.C. component having an amplitude of B ampere-turns per inch we see that the change in flux occasioned by these A.C. ampere-turns will be the quantity C. Now, obviously, if the quantity A is reduced while B is kept the same, C will be increased, due to the increased slope of the magnetization curve at lower values of A, and therefore the smaller the D.C. component the greater will be the inductance of the coil. Comparing Figs. 5, 6 and 7 we find that in Fig. 7 the slope of the lower part of the magnetization curve appears to be straight, whereas Fig. 6 shows that even minute amounts of direct current cause a reduction in the inductance. This seeming contradiction is reconciled by taking account of the losses which always occur in an iron core. The flux set up by the alternating current, instead of sliding smoothly up and down along the magnetization curve, sets up a small hysterisis loop, as shown at D and the effective A.C. slope is the line joining the points of this loop, so that the effective slope is always less than that obtained by drawing a tangent to the magnetization curve.

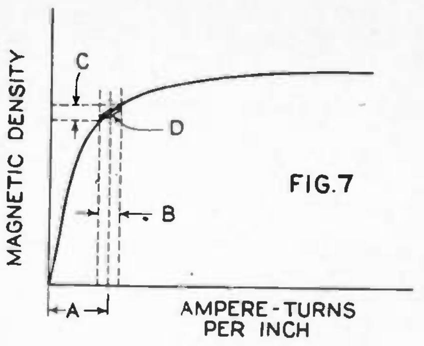


FIG.7

Magnetization curve of ordinary silicon core steel. Note the hysterisis loop D.

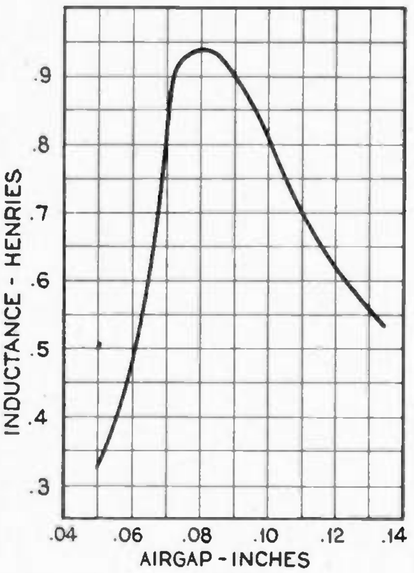


FIG. 8

Effect on the inductance of a coil with a change in the width of the air gap.

By introducing an air gap into the iron core it may be shown that the effective inductance of the coil may be increased when a D.C. component is present, and for any given value of the D.C. ampere-turns an optimum gap length will be found. This is shown in Fig. 8 in which the abscissa represents the length of the air gap and the ordinate the inductance, under constant A.C. and D.C. conditions.

Preliminary Calculations

Before starting the computations the following specification for the coil must be known:

1. The maximum D.C. component.
2. The maximum allowable D.C. drop, under full load.
3. The maximum allowable variation in D.C. drop with temperature.
4. The required inductance.
5. The approximate A.C. potential which will be applied across the coil.
6. The space limitations, if any.

The calculation of the D.C. factors differs in no way from similar calculations on standard apparatus and will not be discussed.

COIL NO.	TURNS	SIZE OF WIRE B. & S.	GAP IN INCHES	D.C. COMPONENT MILLIAMPS.	D.C. RESISTANCE, OHMS	INDUCTANCE, HENRIES
1	8000	36	.010	40	1250	29
1	12000	36	.018	40	1850	70
2	5000	27	.045	300	210	13.9
3	350	16	.060	1400	1.0	0.12

FIG. 9

Table of inductance characteristics of coils of various design.

In getting a start on the A.C. calculations the designer will be guided by his past experience, and in this connection every coil designed and built should be thoroughly tested and its characteristics listed in a table for future guidance. A portion of such a table is shown in Fig. 9.

Having selected an approximate size the inductance should be computed by the following procedure:

1. Introduce an air gap into the magnetic circuit such that the D.C. density of flux in the core will be approximately 90,000 lines per square inch.

2. At this density draw a tangent to the magnetization curve.

3. Assuming some arbitrary value of change of flux under the A.C. component, say 1,000 lines per square inch, determine the A.C. ampere-turns required to set up this flux through the iron.

4. By the usual formulae the A.C. ampere-turns required to drive this flux through the gap may be determined and we then have sufficient data to compute the inductance of the coil.

Similar calculations should be made for longer or shorter gaps until the optimum gap length is determined.

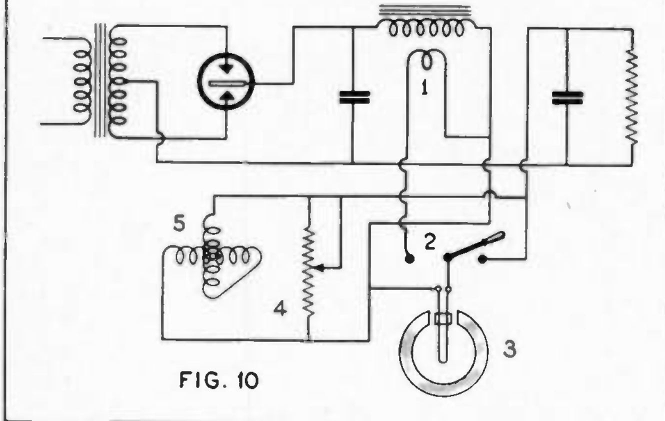


FIG. 10

Circuit arrangement, employing a vibration galvanometer, for the measurement of an iron core inductance under load conditions.

It will be noted that in making these calculations no account has been taken of the hysterisis effect discussed in connection with Fig. 7. It has been found that the tangent slope of the magnetization curve gives values which are near enough for preliminary calculation, and since the final determinations must be made experimentally, there is no point in greater refinement of the method for most practical work.

The following "rules of thumb" gleaned from the study of a large number of coils will be found useful in making these preliminary calculations and in exterpolating from a known coil to an unknown:

1. It is generally found that the optimum gap will be such that the D.C. flux density will lie between 70,000 and 100,000 lines per square inch.

2. The inductance of coils carrying direct current, and designed with the best air gap in each case and with the same direct current, will vary approximately as the first power of the number of turns instead of as the square.

3. In core type coils, having two coils, one on each leg, the inductance will be approximately 30% smaller than in a shell type, with a single coil, due to the flux leakage between the coils.

In case the alternating current potential across the coil is large, the core losses should be computed approximately by the methods used in transformer design, and the value of these losses converted into an equivalent shunt resistance across the coil. The effective impedance of the coil will then be the complex impedance resulting from the inductance of this shunt resistance. It should be remembered that the value of the impedance arrived at in this way will always be too high because the D.C. component increases the hysterisis losses and the presence of harmonics in the alternating current wave increases both the hysterisis and the eddy current losses.

Methods of Measuring Inductance

Because of the many factors which affect the inductance of an iron core coil carrying both D.C. and A.C. the safest method of measurement is one in which the coil is operated under the actual conditions of use. The following method, worked out in our laboratories, has proven very satisfactory. It requires comparatively inexpensive apparatus, is easily manipulated, and with proper care gives very accurate results.

As shown in Fig. 10, the coil to be measured is inserted into its working circuit and operated under normal load. Coupled to the coil is a secondary 1 comprising one or more turns which may be connected by means of the switch 2 to a vibration galvanometer 3. This galvanometer is undamped and sharply tuned to the fundamental frequency present in the rectifier output. The deflection of the galvanometer having been noted, the switch 2 is thrown to the right, whereupon the instrument is connected to the network comprising the variable resistance 4 and the variable inductance 5, the calibration of both of these elements being known. This network is inserted, as shown, in series with the coil to be measured, and therefore carries the same A.C. By throwing the switch 2 back and forth and adjusting the elements 4 and 5 until equal deflections are obtained on both sides we may, from the values of the resistance and variable inductance, obtain the inductance of the coil being measured. together with its resistive losses.

Where the iron losses in the core are small the variable inductance 5 may be dispensed with for approximate measurements.

This method is extremely useful in determining the best air gap, since the gap can be continuously varied and the relative inductance immediately determined by the variations in the deflection of the vibration galvanometer.

Calculation of Antenna Capacity

A paper just issued by the Bureau of Standards gives a discussion of methods and formulas for the calculation of the capacity of various common types of antennas. In the past two different basic methods have been used for such calculations, but the two methods have not always given the same result. The present paper shows that results of calculations by the two methods agree if appropriate formulas are used. One method, however, is the more general and useful. A set of working formulas for calculating the capacity of the more common types of antennas is developed. Tables of constants for facilitating numerical calculations are given, together with tables for the capacity of single-wire horizontal and vertical antennas and two-wire antennas. This paper, Bureau of Standards Scientific Paper No. 568, Methods. Formulas. and Tables for the Calculation of Antenna Capacity, by F. W. Grover. may be obtained for 20 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C.

British Television Journal

With the purpose in mind of meeting the public demand for information on Television, which has been given such wide publicity in England, a writer of technical radio articles has brought out a monthly magazine dedicated entirely to this subject.

A few of the articles contained in the first issue of "Television" are: "A Brief Outline of Television", "Seeing Across the Atlantic", "Some New Uses for Television", "Optical Projection", "Television in Warfare", "How to Make a Simple Televisor", "Light Sensitive Cells" and "Noctovision."

Copies of "Television" can be purchased in this country from the International News Company, 131 Varick Street, New York City. The price is 25c per copy.

Short-Wave Station 2XE

Description of a Crystal Controlled Short-Wave Transmitter Embodying New Features

By W. A. Schudt, Jr.

THE new short-wave station 2XE, owned by A. H. Grebe & Company, Incorporated, and situated atop the Grebe Radio factory in Richmond Hill, New York, began daily operation April 22nd, boardcasting simultaneously with WABC of the Atlantic Broadcasting Corporation, in New York. The short wave station, which has been designed so as to include all of the latest developments known to short-wave engineers, is quartz crystal controlled and operates on a frequency of 5121.6 kilocycles which is equal to an approximate wavelength of 58.5 meters.

Socket Power Unit Feeds Oscillator

The frequency of the quartz crystal used in this transmitter is 2560.8 kilocycles or approximately 117.1 meters. The oscillator consists of a 7½ watt tube and uses a standard socket power unit for supplying the plate current. All the votage dividing resistances have been taken out of the socket power unit giving a voltage of 280 at a drain of 40 milliamperes.

As a quartz crystal cannot handle high powers it is necessary to amplify the radio frequency current if large powers are to be used. Therefore a 50 watt tube is used for two purposes; one to double the frequency and at the same time to amplify the crystal oscillation to a higher power.

The plate voltage of this tube is supplied by a large generator delivering 1700 volts. This voltage is reduced to 1000 by inserting a resistance of proper value in series with the plate circuit. This circuit is now amplifying on a frequency of 5121.6 kilocycles or approximately 58.5 meters.

The final amplifier consists of a 250 watt tube using the full 1700 volts on the plate.

Since this tube operates on the same frequency as the preceding stage it must be neutralized so that no regeneration will occur between the final stage of amplification and the previous one. This neutralization must be done with a high degree of accuracy as any regeneration in the last amplifier will cause it to break into oscillation of its own accord thereby changing the frequency and causing the crystal to crack if the feedback gets into the crystal circuit.

R.F. Feed Lines

The output of the last amplifier is then fed into the antenna which has two radio frequency feed lines. The length of these feeders does not have anything to do with the radiating power from the amplifier but merely carries the radio frequency along the wires until it reaches the end of the feeders. However at the end of one of the feeders there is a wire extending which is exactly one-half wave length long, that is, 29.6 meters long. It makes it look as though one of the feeders is 29.6 meters longer that the other but this is not the case. This extended end is the real radiating portion of the system.

This last amplifier is modulated by means of constant current chokes in the positive lead of both the amplifier and the modulator tubes.

Unique Indicating Device

A unique idea incorporated in this transmitter is the small pickup coil which is placed near the last amplifier. A small amount of energy is picked up by this coil and run about twenty feet through two pieces of twisted wire to another coil which is placed on the operator's desk in another room. This coil is loosely coupled to a wavemeter having a galvanometer as an indication device. This wavemeter is tuned to resonance with the transmitter and the galvanometer shows a reading. In this way the operator does not have to leave his desk to see if the transmitter is still on the air. If something should go wrong he will immediately see that this indicating device is not reading properly and can adjust the transmitter to its original form.

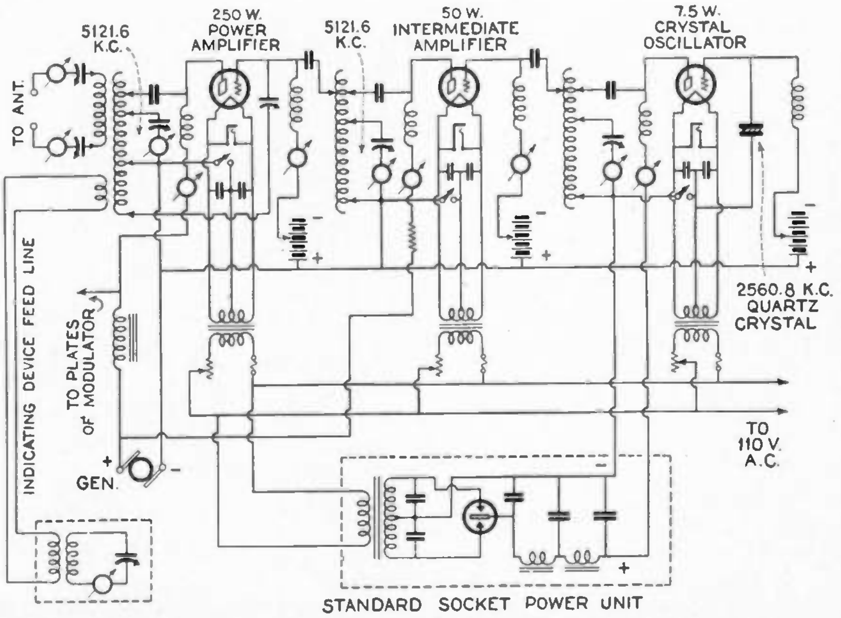
All the filaments are lighted by use of separate filament transformers which have taps at their exact electrical centers. Across the filament of each tube there is also a center tapped condenser which serves to keep the radio frequency off the filaments. An open circuit jack is used in each one of the filament circuits. This is for checking the voltage on each tube by means of a voltmeter.

Location

The transmitting plant of 2XE is located on the top floor of the plant at Richmond Hill. It is installed in a small room and is between two larger rooms, in which the powerful transmitters of WABC and WBOQ are situated. A control room with doors leading into all three transmitting points enables the operator to be in constant touch with all the apparatus in case of an emergency.

The 2XE antenna stretches from the tallest of three lattice work towers down, at an acute angle, into the transmitting room.

On May 15th the power of 2XE will be increased from 250 to 1,000 watts.



Circuit of the 250 watt short-wave re-broadcast crystal controlled transmitter. The 50-watt tube functions as an amplifier and frequency doubler.

The Mathematics of Radio

A Description of Inductances and the Calculation of the Value of Inductances of the Air Core Type

By John F. Rider, Associate Editor

PART VI

As in the case of capacity, we are not going to concern ourselves very much with the definition of inductance;—with what it is. Let it suffice to say that we know where in the radio circuit we require a certain amount of inductance. Knowing exactly what inductance is, will not aid us materially in the determination of its value when we have a certain winding on hand. Many books define inductance, but very few give illustrations of its calculation. Since the purpose of this treatise is to illustrate the methods of calculating and solving some of the problems which arise in every day radio practice, the definition of the phenomenon involved in radio, is deemed unnecessary.

The average reader knows where inductance is necessary. He knows the type of inductance required. . . . He knows the value required. If we show the means of solving for the required value of inductance, we have achieved our end. Therefore, we are going to pass right over the definition and enter into the discussion of the various types.

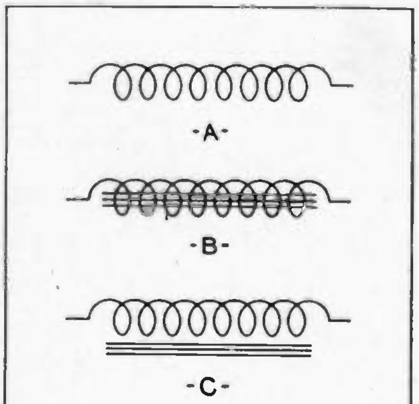


FIG.30

Inductance symbols. A is an air core inductance. B and C are iron core inductances

Types of Inductances

In Fig. 30, we show three types of windings, that is, three signs designating inductance. A is that of the inductance with air as its core. The statement that air is the core of this inductance should not confuse the reader. Air can be the core, even when the winding form is fibre, bakelite or some other solid insulating material. Inductances utilizing air as the core are usually employed in radio frequency circuits. In some instances however, air core inductances are also employed in audio frequency circuits. In this case the type of winding permits a fairly large value of inductance and it is suitable for use as an audio frequency choke. Drawings B and C of Fig. 30 indicate iron core inductances; the horizontal lines through the winding or below the winding indicate the presence of the iron or steel core.

The major difference between the air and iron core inductances, lies in the increase of inductance when the core is iron instead of air. That is to say, if two windings of equal dimensions and equal number of turns were arranged to have air and iron respectively as the cores, the inductance of the iron core unit would be much greater than that of the air core unit. Hence the major reason for the use of the iron, is to contain the required amount of inductance in the least amount of space.

The operating scope of air and iron core inductances is so great that we are going to deal with these items individually. This paper will concern itself solely with air core inductances, and the subsequent paper will deal with iron core inductances.

Air core inductances have been offered to the radio public in many shapes and patterns, all together too many, to permit their full description in these pages. The popular types have been chosen for examples, and the other types are described, but without actual illustrations. Fig. 31, A, B, C and D illustrates four popular types of air core inductances. A is the single layer solenoid. B is the spiral or pancake winding, C is the multiple layer coil and D is the bank wound type.

Calculation of Inductance Values

Because the single layer solenoid is the most popular type of inductance we will dwell at length upon the determination of its inductance. The method of determining the amount of inductance required in a circuit will be considered later in the text. The first and simplest formula is that of Lorenz, reading as follows:

$$L = a\,n^2\,K \qquad (18)$$

where L is the inductance in centimeters,

a is the mean radius of the coil in cms,

n is the number of turns,

K is a constant $= \frac{2a}{b}$

b is the length of the winding.

The following is the abridged Lorenz formula K constant table.

$\frac{2a}{b}$	K
.2	3.6324
.3	5.2336
.4	6.7101
.5	8.0747
.6	9.3389
.7	10.5134
.8	10.6079
.9	12.6305
1.0	13.5889
1.2	15.3379
1.4	16.8984
1.6	18.3035
1.8	19.5793
2.0	20.7436
2.2	21.8204
2.4	22.8149
2.6	23.7401
2.8	24.6048
3.0	25.4161
3.2	26.1800
3.4	26.9017
3.6	27.5854
3.8	28.2349
4.0	28.8533

The application of the formula is as follows. Suppose we have a winding of 50 turns of wire on a 3 inch outside diameter winding form. The length of the winding is 1 inch. What is the inductance? The formula is

$L = a\,n^2\,K$ and if we substitute we have

$L = 3.81 \times 2500 \times 25.4161$

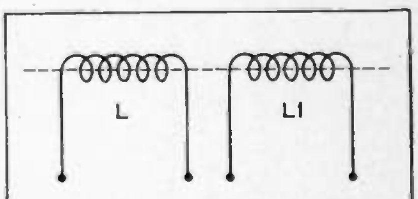
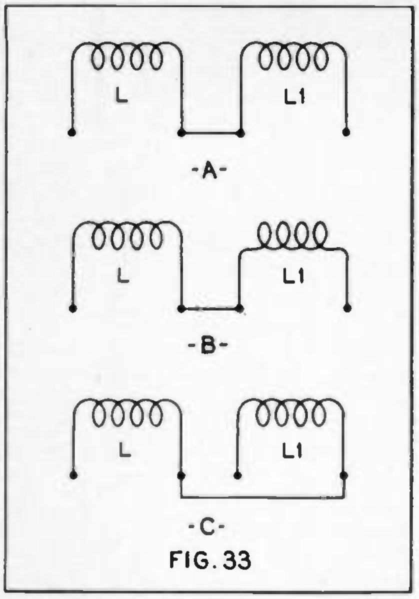


FIG. 32

Two inductively coupled coils. The dotted line represents the magnetic lines of force, the prime coupling medium.

(3.81 is the radius of the winding form times 2.54 since 2.54 centimeters is equivalent to 1 inch. 25.4161 is the constant equal to $\frac{2a}{b}$, equivalent to 3 inches, since the ratio between the diameter, which is equal to 2a, and the length of the winding is 3). Solving further



Illustrating the means employed for reducing or increasing the effective inductance of two coils.

L = 242.000 centimeters (approximately)

L = 242 microhenrys since

1000 centimeters equals 1 microhenry

1000 microhenrys equals 1 millihenry

1000 millihenrys equals 1 henry.

Let us now assume a coil of small diameter, say 1 inch and the winding consists of 80 turns, with a total length of 3.33 inches. What is the inductance of this single layer solenoid? Substituting these values into the formula we have,

L = 1.27 x 6400 x 5.2336

L = 42,509 (approximate) cms

L = 42.50 microhenrys

Nagaoka's Formula

Another formula of very good accuracy is the following, of Prof. Nagaoka.

$$L = \frac{pi^2 \times d^2 \times N^2}{b} \times K \qquad (19)$$

where pi is 3.1416

d is the diameter of the coil in centimeters,

N is the total number of turns,

b is the length of the coil in centimeters,

K is the constant as follows, again equal to the diameter by the length.

Table of K constants for Nagaoka formula:

d/b	K
.01	.9958
.05	.9791
.1	.9588
.15	.9391
.2	.9201
.25	.9016
.3	.8838
.35	.8665
.4	.8490
.45	.8337
.5	.8181
.55	.8031
.6	.7885
.65	.7745
.7	.7609
.75	.7478
.8	.7351
.85	.7228
.9	.7110
.95	.6995
1.00	.6884
1.5	.5950
2.0	.5255
2.2	.5025
2.4	.4816
2.5	.4719
2.6	.4626
2.8	.4452
3.0	.4292
3.2	.4145
3.4	.4008
3.5	.3944
3.6	.3882
3.8	.3764
4.0	.3654
4.2	.3551
4.4	.3455
4.6	.3364
4.8	.3279
5.0	.3198
5.5	.3015
6.0	.2854
6.5	.2711
7.0	.2584
7.5	.2469
8.0	.2366
8.5	.2272
9.0	.2185
9.5	.2106
10.	.2033

The application of these K constants are identical to those employed in the Lorenz formula. The calculation of the constant K is in both cases the ratio between the diameter and the length and can be solved without resorting to the metric system. The solution of the formula, however, necessitates conversion into the metric system.

Let us apply this formula to the solution of the first problem, where we have a coil of 50 turns on a 3 inch outside diameter winding form and the length of the winding is 1.0 inch. Substituting into the formula we have

$$L = \frac{3.1416^2 \times 7.62^2 \times 50^2}{2.54} \times .4292$$

L = approximately the same as obtained with the Lorenz formula.

Another formula applicable to the Nagaoka table of K constants, is

$$L = \frac{.03948 \times a^2 \times n^2}{b} \times K \qquad (20)$$

Here a is the radius and b is the length of the coil winding. The constant K is again equal to the diameter (or $\frac{2a}{b}$)

Inductance Calculation of Spider-Web Coil

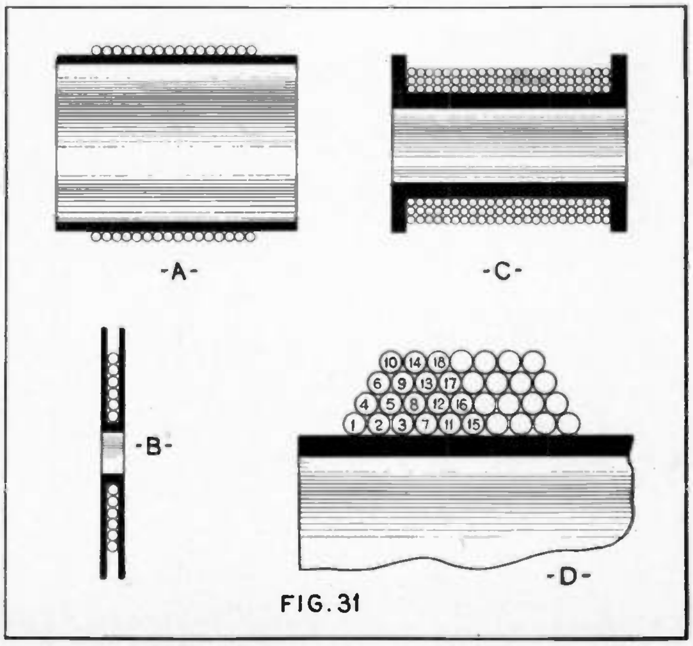
The pancake coil has been replaced by the spider-web coil in average radio receiver practice and the formula used for determining the inductance is

$$L = \frac{m^2 d}{100.000} \qquad (21)$$

where L = inductance in millihenrys which figure multiplied by 1000 will give the inductance in microhenrys.

m = the number of turns in the coil.

d = average diameter in centimeters.



Various forms of coil windings commonly used. A is the single layer or straight soleniod winding. B shows a pancake or spiral type winding. C is the common form of multiple layer winding while D is a bank wound inductance wherein the turns are staggered, as indicated by the numbers.

An example is as follows. We have a coil with 60 turns and a mean or average diameter of 3 inches. Substituting into the formula we have

$$L = \frac{3600 \times 7.62}{100,000} \text{ or}$$

$L = .27232$ millihenrys or

$L = 272.32$ microhenrys.

The Honeycomb Coil

The multiple layer coil has been replaced by the honeycomb coil wherever large values of inductance are required in a small space. The formula employed for determining the inductance of a honeycomb coil is as follows:

$$L = \frac{.315 \times r^2 \times N^2}{6r \text{ plus } 9e \text{ plus } 10h} \qquad (22)$$

where L is the inductance in microhenrys,

N is the total number of turns,

r is the average or mean radius in centimeters,

e is the thickness of the coil, measured from the inside to the outside, in centimeters,

h is the length of the coil in centimeters.

(1 inch is equal to 2.54 centimeters. This applies equally to all formulae.)

Referring again to the flat spiral or pancake, a rough estimation can be gained by following this rule; the inductance of a flat spiral of "n" turns may be calculated approximately as

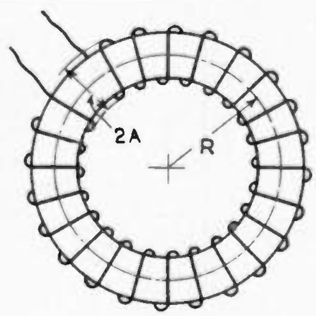


FIG. 34

An inductance of the Toroid type, often referred to as a "doughnut coil."

equal to a solenoid (single layer) of the same number of turns, with a diameter equal to the mean or average diameter of the spiral winding and a coil length equal to the width of the spiral winding, i. e., b, the usual term designating the length of the winding, being equal to R1—R2, where R1 is the radius of the outside turn from the center of the form and R2 is the radius of the inside turn from the center of the winding form.

The Toroid Winding

In Fig. 34 is shown a type of winding known as the toroid, commercially known as the "balloon" winding and under several other names. The

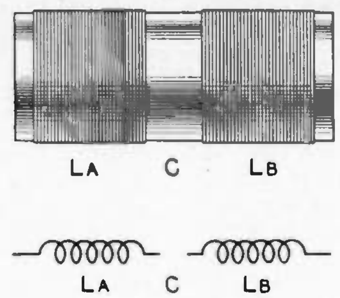


FIG. 35

Illustrating the properties of mutual inductance.

formula applicable to the determination of an inductance of this type of winding is

$$L = .01257 \times n^2 \times (R\text{—sq. rt. of } R^2\text{—}a^2) \qquad (23)$$

where R is the distance from the axis to center of cross section of winding,

a is the radius of the turns of the winding,

n is the number of turns of the winding.

Mutual Inductance

Now, while it is understood that coils possess certain values of inductance, two coils independent of each other, when placed adjacent to each other so that the magnetic lines of force from one will cut the turns of the other, will possess what is known as "mutual inductance," that is, a certain value of inductance between the coils (see Fig. 32). The calculation of this value is very complicated, since it depends upon the characteristics of L and L1, their relation, their distance apart, etc. In average practice, however, the interested person is confronted with the problem of determining the mutual inductance between two coils of practically like diameter and placed upon the same axis, as for example in Fig. 35. The determination of the mutual inductance between such coils is of great importance when calculating the total inductance of a radio frequency choke, which consists of a series of connected windings but with a certain amount of space between the windings.

Referring to Figs. 32 and 35, let us assume that the inductances of L and L1 or La and Lb are 150 and 200 microhenrys respectively. What is the

Relation of Wavelength and the Product of Inductance and Capacity

λ Wave length meters	CL C in μf L in cm	λ Wave length meters	CL C in μf L in cm	λ Wave length meters	CL C in μf L in cm
1	0.0003	125	4.40	285	22.87
2	.0011	130	4.76	290	23.66
3	.0018	135	5.13	295	24.50
4	.0045	140	5.52		
5	.0057	145	5.92	300	25.33
6	.0101			310	27.05
7	.0138	150	6.34	320	28.83
8	.0180	155	6.76	330	30.66
9	.0228	160	7.20	340	32.55
		165	7.66	350	34.48
10	.0282	170	8.13	360	36.48
15	.0635	175	8.62	370	38.54
20	.1129	180	9.12	380	40.7
25	.1755	185	9.63	390	42.8
30	.2530	190	10.16		
35	.3446	195	10.71	400	45.0
40	.450			410	47.3
45	.570	200	11.26	420	49.7
		205	11.83	430	52.0
50	.704	210	12.41	440	54.5
55	.852	215	13.01	450	57.0
60	1.014	220	13.62	460	59.6
65	1.188	225	14.25	470	62.3
70	1.378	230	14.89	480	64.8
75	1.583	235	15.55	490	67.6
80	1.801	240	16.22		
85	2.034	245	16.90	500	70.4
90	2.280			510	73.3
95	2.541	250	17.60	520	76.0
		255	18.31	530	79.0
100	2.816	260	19.03	540	82.1
105	3.105	265	19.77	550	85.2
110	3.404	270	20.52	560	88.4
115	3.721	275	21.29		
120	4.05	280	22.07		

mutual inductance between the two? Imagine the space C in Fig. 35 to be taken by a coil of sufficient turns to fill the space and calculate its inductance. Then the mutual inductance between the two windings La and Lb is equal to

$$2Mab = Labc \text{ plus } Lc - Lac - Lbc. \quad (24)$$

Labc is the self inductance of coils a, b and c in series. The theoretical maximum value of mutual inductance is equal to

$$M = \text{sq.rt. of } L \times L1 \text{ (Fig. 32)} \quad (25)$$

When coils are coupled to each other electromagnetically, the terms "loose" or "tight" are applied to the degree of coupling, and the term indicating the looseness or tightness of coupling is the "coefficient of coupling," usually expressed by the figure k. The value of the coefficient of coupling can be determined by applying the following formula:

$$k = \frac{M}{\text{sq.rt. of } L \times L1 \text{ (Fig. 32)}} \quad (26)$$

As a concrete example of this formula, let us consider Fig. 32 and assume that the inductance of L is 100 microhenrys. L1,200 microhenrys and the mutual inductance 120 microhenrys. What is the coefficient of coupling between the two inductances? Applying these figures to our formula we have the following:

$$k = \frac{120}{\text{sq.rt. of } 100 \times 200}$$

$$k = \frac{120}{447}$$

$k = .268$ (app)
$k = 26.8$ per cent (app)

When two coils are connected in series as in Fig. 33-A, but the coils are located at such a distance from each other that there is very little coupling, or that the two coils are at right angles to each other and there is no mutual inductance between the two, the total inductance is equal to the sum of the individual inductances. However, if these two coils are moved close to each other so that there is a certain amount of mutual inductance between them, the inductance, upon measurement will be found to have increased. If the connections of the

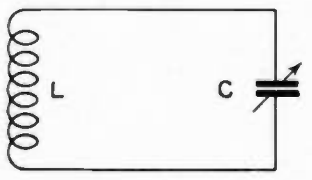


FIG. 36

A tuned oscillatory circuit composed of an inductance (L) and a variable capacity (C)

individual coils are reversed, as in Fig. 33-B, the inductance of the combination will be reduced. The mutual induction in this case is subtractive. The same effect is gained by reversing the connection between the two coils L and L1, as shown in Fig. 33-C.

Calculation of Inductance Required in Radio Circuits

Additional space need not be devoted to this subject, since it is very seldom encountered in practice today. Furthermore, the mutual inductance of coils is very seldom employed to reduce the total inductance of the circuit. It is true that the variometer makes use of the principle of adding or substracting the inductance of two coils. by varying their position with respect to each other but this unit is seldom employed in radio receivers of modern design. Therefore, we will proceed with the method of determining the inductance required in radio circuits.

Take for example the circuit shown in Fig. 36. Here we have a fixed inductance and a variable capacity. Suppose we wish to cover a certain waveband. Before we can determine the size of inductance required we must know the value of tuning capacity. Suppose C is .0005 mfd. What must be the value of L in order that the circuit respond to 400 meters? The value of inductance is determined by making use of the accompanying tables which give the relation between the inductance and capacity in oscillating circuits. To determine inductance with known capacity and wave length look opposite the wave length in the column marked CL. Opposite 400 we find 45.0. Divide this figure by .0005 and we obtain the quotient 90,000 which is the value of the inductance required to tune to 400 meters with a capacity of .0005 mfd. This inductance figure is given in centimeters and should be reduced to microhenrys by dividing by 1000. After reducing to microhenrys the value will be 90.

Suppose we wish to tune to 40 meters with a capacity of .0001 mfd. Opposite 40 in the wave length column we find .45 in the CL column. Dividing this figure by .0001 we obtain the quotient 4500 which is the value of required inductance expressed in centimeters. Reducing to microhenrys we obtain the value 4.5.

(Curves and tables for the design and construction of various types of inductances will be given in the subsequent installment.)

Book Review

PRINCIPLES OF RADIO COMMUNICATION, by Prof. J. H. Morecroft, Professor of Electrical Engineering, Columbia University; Past President, Institute of Radio Engineers. Assisted by A. Pinto, Electrical Engineer, Otis Elevator Co. and W. A. Curry, Assistant Professor of Electrical Engineering, Columbia University. Published by John Wiley and Sons, Inc., New York. 6 *x* 9 *inches,* 1001 *pages,* 831 *figures, cloth covers. Price* $7.50.

The new material incorporated in this edition so increased the size that it was thought advisable to delete much of the first edition. A considerable part of the chapter on Spark Telegraphy has been taken out, therefore, and two chapters of the earlier edition have been deleted. The chapter on radio measurements, and that on experiments, have been omitted.

Notable additions to the older edition occur in Chapter II. IV. VIII and X. In Chapter II many new radio frequencies are given. In Chapter IV, dealing with the general features of radio transmission, new material on field strength measurements, reflection and absorption, fading, short-wave propagation, etc., has been introduced. In Chapter VIII (radio telephony) a great deal of material on voice analysis has been added: the performance of loud-speaking telephones, frequency control by crystals, etc., has been discussed. In Chapter X, dealing with amplifiers, the question of distortionless amplification has been thoroughly dealt with, some of the material being given for the first time. The question of radio-frequency amplification, balanced circuits, push-pull arrangements, etc., have been explained.

The early part of the work deals with the behavior of circuits when excited by very high frequencies as used in present radio practice. The actual behavior of tubes in typical circuits is covered in a more thorough manner than has been attempted in other texts, and practically all the theoretical deductions are substantiated by experimetal data. A chapter has been devoted to each important phase of the radio art: Sections of the work are devoted to resistance, inductance and capacity, laws of oscillating circuits, vacuum tubes and their operation in typical circuits, continuous-wave telegraphy, radio telephony antennae and radiation, wavemeters and their use, and amplifiers. Throughout, the treatment has the merit of clearness and thoroughness, the curves and diagrams used for illustrating the text matter being particularly excellent.

RADIO FREQUENCY MEASUREMENTS, by E. B. Moullin, M.A., A.M.I.E.E. Published by J. B. Lippincott Company, Philadelphia, Pa.; 6" x 9", 278 pages, 134 illustrations, cloth cover, price $10.

This book is probably the most complete treatise on the subject of the theory and practice of radio frequency measurements ever published. As can be assumed from the title, the various phases of testing practice are covered in a technical manner, and in the majority of cases the problems and results are expressed mathematically.

The first Chapter deals with the valve generator or vacuum tube and covers the fundamental properties of the valve and such problems as the calculation of the amplitude of oscillation, of the amplitude for a cubic characteristic, different conditions for starting and stopping oscillations, the production of higher harmonics, etc.

Chapter 2 is entirely devoted to the measurement of potential difference and current and consequently involves the use of electrometers, cathode ray oscillographs, thermal ammeters, current transformers, etc.

The measurement of frequency is dealt with in Chapter 3, which is very complete. These measurements encompass the use of the high frequency alternator, measurement by spark photography, stationary waves on wires, measurement by harmonic ratios and of more popular interest, the relative calibration of a wavemeter scale, wave-length of frequency standards, and considerable material on quartz oscillators. This Chapter also includes notes on the use of buzzer excitation for obtaining a condition of resonance and methods of coupling wavemeters to a receiver.

The other Chapters in their order deal with the measurement of resistances, including special instruments for the rapid determination of decrement, the measurement of capacity, which also deals with the measurement of condenser resistance; the measurement of inductance from the early bridge system through to the present circuits, and apparatus employed in measuring inductance at high frequencies.

Chapters 7 and 8 are closely related to practice in the radio transmission field and cover the measurement of antenna characteristics and the intensity of radiated fields.

Miscellaneous measurements and notes are gathered together in Chapter 10 where the measurement of the harmonics produced by an oscillating vacuum tube is considered as well as measurements of voltage amplification, etc., in inter-stage valve amplifiers. Of particular interest is the material covering the calculation of the resonance frequency of compound circuits.

This book is particularly recommended for the engineers' and advanced experimenters' reference library.

THE THERMIONIC VACUUM TUBE (and its applications), by H. J. Van Der Bijl, M.A., Ph.D. (first edition, seventh printing). Published by McGraw-Hill Book Company, New York, N. Y., 6" x 9", 383 pages, 232 illustrations, cloth cover, price $5.00.

This book is so well known it hardly seems necessary to review its contents. However, there are probably numerous people who have not a full knowledge of the extent of the work. In some respects, it is highly technical, but it may be a relief to the general run of experimenters to know that it is possible to gain more constructive information on vacuum tubes from this book than any other work on the subject in spite of the mathematical treatment and the higher physics involved. The "Thermionic Vacuum Tube" has long been a standard reference book in the radio field and hardly a month goes by that a portion of the text is not quoted in some article. In treating the characteristics and idiosyncracies of the vacuum tube, Van Der Bijl has uncovered every bit of its history and wrestled with the subject from every point. Since the vacuum tube is the most important device employed in both receiving and transmitting circuits and is universally employed as a coupling medium, it is necessary that all of the various forms of circuits involved are covered in detail in order to make clear the action of the thermionic tube under each set condition.

The early part of the book covers the properties of the numerous types of vacuum tubes, which have been developed, and deals with the fundamental properties of electrons, the dislodgment of electrons, from atoms of vapors and gasses as well as the dislodgment of electrons from solid substances. The physics of the thermionic valve, covered in Chapter 4, deals with current-voltage characteristics, effect of voltage drop in the filament, effect of curvature of the characteristic, energy distribution at the anode, life of a vacuum tube, etc.

Further Chapters cover the influence of gas on the electron discharge, rectification of currents by the thermionic valve, complete treatise on vacuum tube amplifiers of all descriptions, including, of course, voltage and power amplification; static and dynamic characteristics of the tubes, plate resistances and impedances, mutual conductance, amplification constants as well as material on practical measurements of amplification and special amplification circuits.

Another full Chapter is given over to the use of vacuum tubes as oscillation generators and aside from covering the various forms of oscillating circuits, such as the Colpitts and Hartley circuits, regeneration, effect of internal capacities, etc., a method of procedure for the solution of the oscillation equations is fully dealt with in connection with conditions for oscillation in a two or three electrode tube.

Chapter 9 deals with modulation and detection of currents commencing with the elementary theory of modulation and detection and slowly working up to the various forms of detection employed and the measuring of the detecting current and detection co-efficient. This same Chapter covers heterodyne or beat reception as well as the reception of modulated telegraph, or telephone signals employing the zero beat method. Modulation as applied to radio transmitting and receiving systems is also covered as well as special vacuum tube circuits employed in multiplex telephony and telegraphy.

Chapter 10 is in one sense the most interesting one in the book as it covers

The Engineering Rise in Radio

By DONALD McNICOL

Fellow A.I.E.E., Fellow I.R.E.
Past-President, Institute of Radio Engineers

In the June issue of *Radio Engineering*, Donald McNicol, an authority who has lived with the radio art since the first experiments were performed, begins a complete account of the engineering development of radio. This will be continued in monthly issues throughout the year.

It will live as the who, when and what story of radio. It has taken years for Mr. McNicol to compile the material and insure its historical and technical accuracy.

In chronological order will be given the names of all the inventors and engineers who nursed this great industry into being and who brought it to its present state of usefulness.

No space is taken up with an account of the mythology of radio. The starting point is taken at the discoveries of electromagnetism and proceeds through the years of research to the present engineering achievements.

We feel that we are singularly fortunate in being able to present this material to our readers.

some very interesting miscellaneous applications of the thermionic tube, such as the electrostatic voltmeter, high-tension voltmeter, voltage and current regulator, power limiting devices, and the vacuum tube as a high tension switch. The very interesting and important subject of secondary emission is also dealt with as well as screen-grid tubes with inherent high amplification factor.

EXPERIMENTAL ELECTRICAL ENGINEERING (Volume 2), 3rd edition completely revised. Published by John Wiley & Sons, New York, N. Y. 620 pages, including index, 670 illustrations, 6" x 9", cloth cover, price $5.00.

This book was written expressly for engineers and for students in engineering laboratories and is beyond being of value to the man who has not had the advantages of a university course in electrical engineering. However, it is a very valuable reference work and will be found very useful to radio engineers.

The general subjects covered in the lengthy paragraphs are: electrostatic capacitance, capacitances and inductances in A.C. circuits; which is a subject that is never fully learned and yet of decided importance in connection with radio practice; alternating current bridges of various types for the measurement of inductance and capacity and for the purposes of comparison; also mutual inductance and frequency bridges.

A number of Chapters are given over to the synchronous converter and another Chapter to revolving magnetic fields which is followed by a wealth of material on induction motors of the single phase and polyphase type. Commutator motors are also covered at length and this material is followed by a number of Chapters on contactors and controls for motors used in every commercial field.

The last few Chapters in the book are also decidedly interesting, as they cover the mercury-vapor rectifier as well as thermionic rectifiers of the Tungston-Argon type, and the Kenotron.

One Chapter is given over to the applications and classifications of oscillographs of the electro-magnetic and cathode ray type. This is followed by data on the harmonic analysis of alternating current waves and—the last chapter in the book—detailed information on high frequency measurements.

It should be mentioned that a goodly portion of the work deals with experiments related to the various subjects already outlined. For an example, in the Chapter on high frequency measurements there are experiments covering the determination of frequency and co-efficient of coupling, calibration of a frequency meter, test of an electron tube generator, measuring the characteristics of a three electrode vacuum tube and the determination of the amplification factor, internal resistance and mutual conductance of a vacuum tube. A total of 14 experiments are delineated in this one Chapter.

VECTOR ANALYSIS, by J. G. Coffin (second edition). Published by John Wiley & Sons, New York, N. Y., 5" x 7½", 262 pages, illustrated, cloth cover, price $2.50.

Certain portions of the second edition of "Vector Analysis" have been rewritten and 14 pages of notes have been added to the appendix. In particular, a short digression of different varieties of Vectors; certain additional definitions of differential geometry with reference to curves in space, the demonstration of Frenet's valuable formulae for space curves; an interesting example of vector reasoning as applied to the solution of the differential equation of motion of an electron in a magnetic field; two new proofs of Stokes' Theorem not found, as far as we know, in any treatise of vector analysis; an additional proof of Gauss's Theorem; and proofs of two theorems in integration analogous to the Divergence Theorem.

Chapter 1 of the book covers the elementary operations of vector analysis; Chapter 2, scalar and vector products of two vectors, and Chapter 3, the like products of three vectors. Chapters 4 and 5 deal with the differentiation of vectors and differential operators while Chapter 6 covers the applications of vector analysis to electrical theory. Chapter 7 deals with the applications to dynamics, mechanics and hydrodynamics.

The Appendix includes some valuable formulae.

THEORY OF VIBRATING SYSTEMS AND SOUNDS, by Irving B. Crandall, Ph.D., member of the Technical Staff of the Bell Telephone Laboratories. Published by D. Van Nostrand Co., New York, N. Y., 6" x 9", 272 pages, including index, illustrations; cloth cover, price $5.

In recent years, great progress has been made in applied acoustics and a number of contributions have originated in the Bell Telephone Laboratories. The studies on which this book is based were made entirely in this atmosphere. Much of the present book received class presentation in a course given at the Massachusetts Institute of Technology, Department of Electrical Engineering. It is probably the most authentic book obtainable on the subject of vibration and sound and reflects the knowledge acquired through years of specialized research. The book could be intended only for the engineer or advanced experimenter, as the subjects are given mathematical treatment. The book opens with a discussion of simple vibrating systems and the general theory of vibrating systems in respect to resonance and filters. With the completion of these subjects, the work runs into propagation of sound and transmission problems, followed by the acoustics of closed spaces which covers absorption, reflection and reverberation.

Of special interest are the paragraphs dealing with the general theory of the circular membrane, oscillations, equations of motion, resonators coupled to diaphragms, the problem of the loaded string, acoustic filters, properties of wave motion, sound transmission in tubes, sound waves in three dimensions, and the material on the characteristics of conical horns, long exponential and finite exponential horns.

The Chapter on acoustics of closed spaces is decidedly interesting and covers the problems of architectural acoustics with sub-divisions on reflection, absorption and reverberation.

Also, the material on standing wave systems and acoustic difficulties.

EXPERIMENTAL RADIO (3rd edition), by R. R. Ramsey, Professor of Physics, Indiana University. Published by R. R. Ramsey, Bloomington, Ind., 5" x 7", 229 pages, 151 illustrations, cloth cover, price $2.75.

Experimental Radio was written principally for use as a laboratory manual for students and experimenters and covers in fundamental form all phases of high frequency measurements.

The book is actually a group of some 117 experiments covering most every imaginable phase of radio within the scope of the average experimenter. These experiments are carried out in a practical way, covering such subjects as the calibration of condensers, coils, wavemeters, and decremeters; the measurements of tube resistance, amplification constants, inter-element capacity and mutual conductance; the adjustment of and measurement of the input, output and the efficiency of oscillators and transmitters, and the radio frequency resistance of circuits, coils and condensers.

A certain amount of constructional data is also included on radio telegraph and telephone transmitters and the manner of adjustment. Also the construction and measurement of both R.F. and A.F. amplifiers and special radio laboratory apparatus.

There are a number of very interesting experiments covering special subjects, such as the measurement of field intensity, induction and radiation; the use of electrostatic voltmeter, and how to plot resonance curves from measurements taken on various devices and circuits.

Though there is a certain amount of mathematics involved in certain portions of the book, it is of a decidedly fundamental nature.

This book recommends itself to service men, custom-set builders, testers, and advanced experimenters.

Flexible Power Operated Amplifier

By William H. Fortington

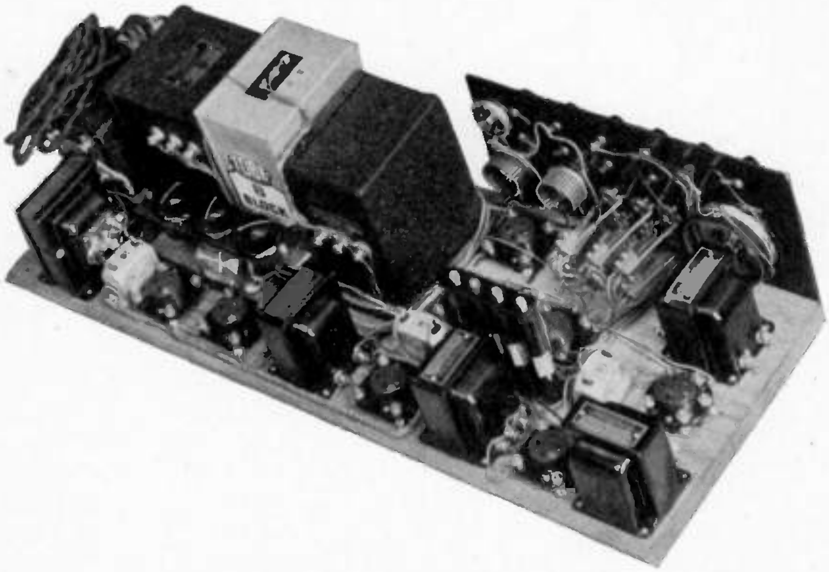
FOR several years now there has been a popular demand for a reasonably priced amplifier, to serve the purpose of addressing small audiences.

The application of such apparatus usually finds its place in dance halls, the dealers' store for attracting the attention of the passer-by, or other such publicity stunts. The use of an amplifier as an aid to the field of advertising has been somewhat curtailed, due to the high cost of suitable assemblies of equipment to accomplish the desired result. Maintenance cost has heretofore also entered, to a large degree, in the restriction of the application of medium and high power amplifier systems.

It is the intention therefore, of this article, to lay before the potential user some points regarding the design and application of an amplifier and power supply device, which will fill the majority of requirements of speech amplifier work.

While it is not the aim of the writer to introduce an amplifier of the ultra-high quality such as is required for very good broadcast transmission, nevertheless, the amplifier described herewith will be found to produce tonal quality superior to what we hear from many broadcasting stations on the air today.

It is therefore deemed unnecessary to go into the essential technicalities encountered in the design of amplifiers such as are used for broadcast purposes, but to enumerate only the points which come within the scope of amateur public address systems.



Open view of the Flexible Power-Operated Amplifier. Note the series of jacks on the panel, for looking into the plate circuits of the amplifier tubes. Observe also the volume control resistor bank, mounted behind the jacks.

The amplifier described in this article will handle a few watts of modulated energy and will deliver sufficient undistorted power in the output circuit, to handle a quarter kilowatt modulator in a transmitter. A speech amplifier in order to conform to the requirements of the average user in the semi-professional sphere, must operate under and conform to, the following conditions.

1. The input conditions of the amplifier must be flexible, inasmuch as it might be necessary to couple into a low impedance source, such as a telephone line, carbon granule microphone, or a high impedance source such as a plate circuit of a detector tube in a radio set, or a magnetic pick-up for the reproduction of phonograph records.

2. It must be low in maintenance costs and almost fool proof, which in the opinion of the writer calls for the elimination of all batteries, although in some cases it is advisable to use "C" batteries instead of deriving the "C" potential from the negative side of the "B" circuit.

3. It must produce a fairly uniform frequency response over a range of approximately 30 to 6,000 cycles per second, and at the same time be absolutely free from wave shape distortion, which is distortion in its worst form.

Perhaps it would be advisable to take each individual piece of apparatus, whether it be a transformer, or an impedance, and analyze its function in each individual part of the circuit.

Disregarding for the present, the input conditions to which the amplifier must adapt itself, we come to the first amplifier tube which in normal practice is essentially a voltage amplifier. Such tubes usually have an amplification constant of around 30, and an output impedance of anything between 50,000 and 100,000 ohms.

Since we are considering only A.C. operation in this article, the use of a tube having such a high amplification constant, cannot be entertained, for more than one reason, although the writer has satisfactorily operated a Western Electric 102-D tube on raw A.C. within strict limitations. There are several A.C. tubes available, having an amplification constant of around 15, which are eminently suited to the function of a voltage amplifier, and which will handle quite a reasonable amount of voltage on the input side. Bearing in mind the fact that the first amplifier tube is likely to be preceded by the detector tube of a radio set, the use of a tube of the 226 type seems to come nearer to fulfilling the necessary conditions, although this tube is by no means a voltage amplifier in the true sense of the word, but is adapted more to the handling of quite some power.

Assuming the potential at the plate of the tube to be around 135 volts, we find that the output impedance of this tube will be in the region of 7,500 ohms, but in the case of a tube of this type having a mu of 15, the output impedance is likely to run up as high as 25,000 ohms, with a corresponding drop in mutual conductance. It now remains to find a suitable load to satisfy the conditions in the plate circuit of this tube. The impedance of the external load should be at least twice that of the output impedance of the tube, with the two circuits coupled. In other words, if we have a choke with an impedance of at least 15,000 ohms, at 50 cycles (with a normal signal voltage impressed on the grid) the necessary conditions are satisfied. An inductance of 100 henrys is therefore sufficiently large, where the internal impedance of the tube is not more than 10,000 ohms. Where the impedance runs into the region of 25,000 ohms, at least 200 henrys should be introduced into the plate circuit to secure the desired degree of tonal quality.

Chokes having an inductance in excess of 300 henrys, are apt to be expensive and somewhat bulky, and where a high mu tube, having a very high output impedance, is to be used, it is necessary to use two inductances in series to obtain the optimum conditions of load. A choke (called such in this case, for want of a better name) with a great flexibility of application, is found in the Thordarson "Autoformer," inasmuch as the total inductance of the winding over all, is rated at 300 henrys. There is a tap taken at one-third of the turns from the end of the winding, which when used as the plate winding gives a voltage step-up ratio and at the same time leaves sufficient inductance in the plate circuit, to prevent distortion. It may, however, be used as a straight impedance if so desired, bearing in mind the fact that although the transformation ratio as a transformer is proportional to the effective turns in the plate and grid circuits respectively, the impedance ratios are proportional to the square of the turns ratio.

Incidentally it has been found that the best conditions under which the Autoformer will operate, is with a steady direct current of one to 8 milliamperes flowing in the plate winding. When used as a straight impedance the best results will be obtained with between .5 and 5 milliamperes in the winding.

The coupling condensers must be of such capacity that they will transmit without hindrance, the lowest frequencies on the musical scale.

The capacity of a coupling condenser is governed by the time-resistance factor of the grid circuit which is dependent on the input impedance of the tube, and not so much upon the impedance of the associated circuits. However, a capacity of one mfd. will be found to be none too large although this value, in the opinion of the writer, should not be exceeded.

As a stage of voltage amplification is followed by a current amplifier, a 226 tube will be found satisfactory in each capacity. Since this tube performs no special function other than a voltage current amplifier, it is not deemed necessary to treat the tube itself in any special manner.

The volume control depicted at Fig. 1, is constructed to give 11 steps of even increase in volume, producing a uniform gain in the output of the amplifier. Variation in each individual step is so designed as to produce volume increase without any audible jump between steps.

The constructor is warned as to the selection of the resistances to be used in this volume control. If reliable service is desired of the amplifier only resistances of the highest quality should be chosen.

The resistances used in this volume control are actually eleven in number, connected in series, in the following order:

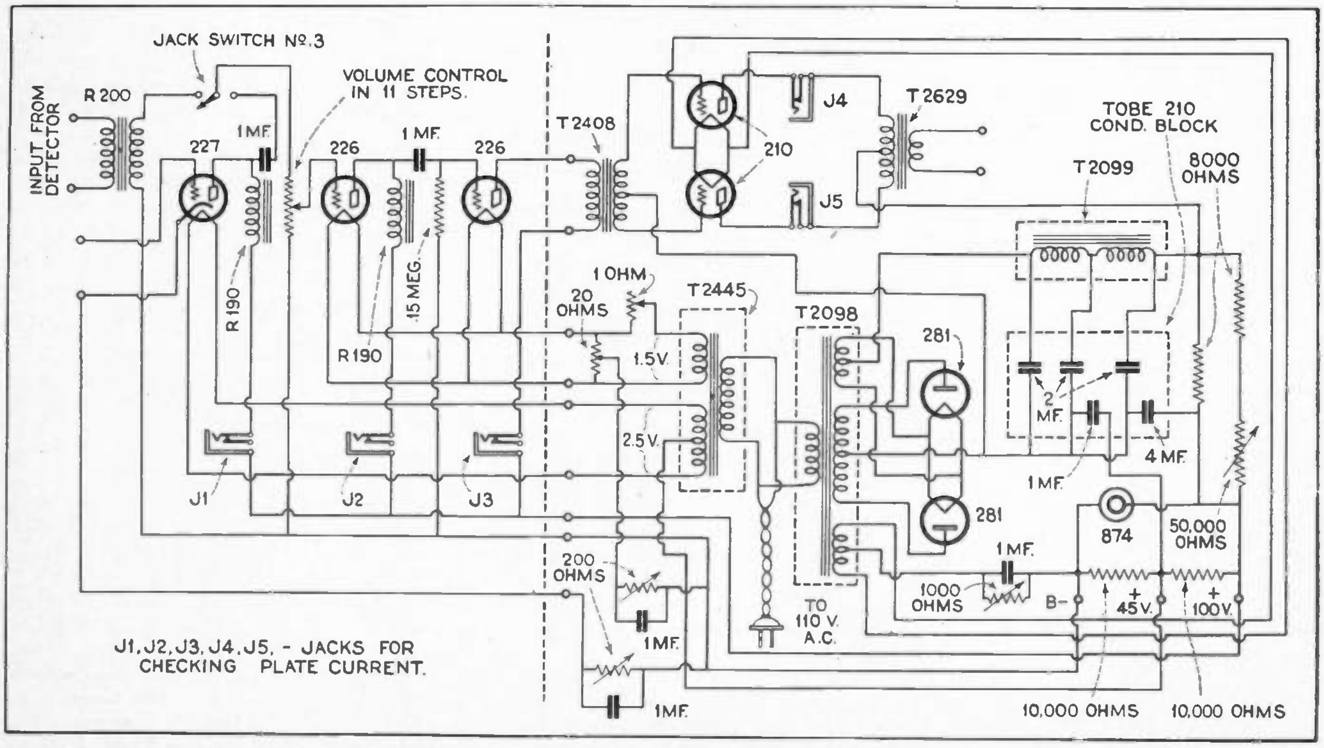
Ten thousand ohms, 5,000, 7,500, 10,000, 14,000, 20,000, 25,000, 35,000, 50,000, 75,000 and 100,000 ohms.

The constructor is liable to encounter some difficulty in obtaining resistance units with values of 14,000 and 35,000 ohms. The resistance of 14,000 ohms may be composed of two resistances of 10.000 and 4,000 ohms in series. In the same way the 35,000-ohm resistance may be composed of two resistances of 30,000 and 5,000 ohms in series. The over-all resistance of the volume control, that is, the amount of resistance that will be inserted in the grid circuit at maximum volume, should not be such that under normal signal voltages, the grid of the second amplifier tube will accumulate increasingly a negative potential.

When the amplifier is preceded by the additional stage or when the input is taken from a radio set, it will be found not necessary, if at all desirable, to bring up the volume to a level in excess of 70% of the total gain of the amplifier.

It must be constantly borne in mind that the apparatus is operated entirely from the electric light mains, and is therefore subject from its conception to some rather rigid limitations, in order to maintain a good quality of reproduction.

The design of battery operated amplifiers leaves the engineer much greater limitations of tolerance in his



Complete schematic diagram of the Flexible Power-Operated Amplifier. It will be noted that the input is transformer coupled, the following stages impedance-resistance coupled and the output, with 210's in push-pull, transformer coupled.

selection of components. The second amplifier tube is coupled into two 210 type tubes in push-pull.

Pages could be written upon the advantages of push-pull amplification alone, and it was with the latent idea that the amplifier might be subject to rather heavy duty, and perhaps quite some misuse, that the writer decided to adopt push-pull amplification in the output stage in order that several times the power output of a single 210 tube might be accommodated with very little additional cost.

Transformer T.2408 has a useful primary inductance of 100 henrys, with a limit in magnetizing current of approximately 15 milliamperes, which will take care of almost any power tube on the market today, provided such tubes are operated within the limitations of their dynamic characteristics.

The effective ratio of transformation of this transformer in a push-pull circuit is a unity. Since the voltage relations in the two grid circuits of the power tubes are in opposite phase, then the corresponding amplified signals in the plate circuits of these tubes will also be out of phase by a like amount, and by taking advantage of this effect it is possible to operate a transformer suitably designed so that the direct current components flowing in the primary windings of the transformer will neutralize, which apart from relieving the saturation of the core, allows considerably more inductance to be used in that winding. This enables the physical dimension of the transformer to be kept very small, and it is not uncommon to see push-pull transformers so badly overloaded and yet producing good tonal quality, until one tube is removed from its socket, when the full advantages of push-pull amplification will be brought home to the user.

In any case the current carrying capacity of the wire specified by the manufacturer should be strictly adhered to, otherwise a burn-out will result.

The design of the output transformer is dependent upon the conditions under which it is to operate.

The impedance of the secondary winding might be necessary to match a low impedance line or a low impedance coil in an electro-dynamic speaker, which is usually of the order of 100 ohms at 60 cycles.

The design of a transformer to operate between two widely dissimilar impedances is a much more complex problem than to design a transformer to operate between impedances whose ratios are unity or nearly so. Where the impedances are at a great variance, the problem is not so much the matching of the impedances by the transformer, but the matching of the impedances under closed circuit conditions when used in conjunction with the coupling transformer itself. This answers, to some extent, the question which is often asked as to why the choke and condenser method of coupling into a loud speaker gives better results than an output transformer.

In view of the above considerations, the writer decided to use the T.2629 transformer which is designed to couple two 210 type tubes into a moving coil speaker. Where it is desired that the output should be coupled into a high impedance speaker, it is necessary only to connect one end of the speaker winding to the center tap of the primary of the transformer, and the other end to one of the outer ends of the winding.

It is, of course, desirable to isolate the speaker from the D. C. component, by inserting a condenser of 2 mfd. or more, in series with one of the speaker leads and the transformer. The only disadvantage of this method of coupling a speaker in a push-pull amplifier, is that it leaves an unsymmetrical condition in the output circuit, in which it might be desirable to shunt the other half of the primary winding of the transformer with some form of reactive load, or better still, use another loud speaker to match the other.

PRACTICAL DATA ON SERIES FILAMENT OPERATED RECEIVERS

It is with pleasure that RADIO ENGINEERING announces an article, to appear in the June issue, covering in a practical manner the salient points of the design and development of receivers employing battery type tubes with the filaments connected in a series string to operate entirely from a high voltage, high current rectifier.

Accompanying this article will be numerous working diagrams showing how receivers of this type may be easily constructed. All necessary constants will be included.

The article is by William P. Lear who is well known in radio circles. The practical data comes as the result of extensive research carried on in Mr. Lear's laboratory.

Consideration of Input Conditions

Returning to the input of the amplifier, it is perhaps now necessary to explain why the first tube, depicted at Figure 1, was not mentioned or regarded as the first amplifier tube. As mentioned at the beginning of this article, an amplifier of this type must readily adapt itself to different input conditions. Where the output is taken from the detector tube in a radio set, much more power will be available than if the output were taken from a carbon granule microphone, or a high quality magnetic pick-up.

It is for this reason that the amplifier proper is preceded by a tube of the —27 type. A jack-switch is provided to cut the first tube in or out when necessary. The desirability of such an arrangement becomes apparent where an amplifier of this type is used for entertaining the public.

The input transformer, R200, has such characteristics as to recommend its use where the output from a radio set is to be amplified.

The characteristics of this transformer, as found by the writer, indicate a nearly uniform frequency response at frequencies from 60 cycles to 2000 cycles per second, gradually rising up to 6000 cycles and reaching a cut-off at approximately 8000 cycles per second. This cut-off characteristic assists in maintaining the degree of selectivity necessary in radio receivers in use today.

It is necessary to connect a by-pass condenser of about .002 mfd. from the plate of the detector tube to negative "B".

It is proposed to deal with the design and application of volume controls in a subsequent article, but perhaps a few words regarding the type used in this amplifier, would not be out of place.

While almost any well constructed volume control should prove satisfactory, the points enumerated earlier in this article regarding volume control resistances, must not be overlooked. The location of a volume control in a circuit must be such that it must maintain a constant impedance relation with the associated inductive circuits, bearing in mind that any load placed across the secondary of a transformer, is equivalent to the same load in the primary circuit, multiplied by the turns ratio of the transformer.

Where the volume control performs the double duty of grid leak and volume control, it must be remembered that at maximum gain the total resistance is in the grid circuit of the tube, and where this resistance value is sufficiently large, blocking will result.

It was for this reason that a total resistance of 350,000 ohms was chosen.

Importance of Tube Operation

In order that the tubes might be operated at the correct portion of their conductance characteristics, each plate circuit is equipped with a jack to facilitate the checking of plate current. Where the plate current can be observed it is a simple matter to adjust the grid biasing resistances to their proper value, and at the same time ascertain the amount of current flowing in each individual plate circuit.

This also assists in obtaining symmetrical operation of the push-pull amplifier. The same thing might also be applied with advantage to the two rectifier tubes in the full-wave circuit.

The use of a voltage regulator tube is optional, and is included in this specification only in view of the fact that the power supply might find an additional use on a radio set, where it is desirable to maintain a constant voltage at the plates of the detector tube and R.F. tubes, under varying conditions of load.

The use of by-pass condencers across the grid biasing resistances is certainly to be recommended, and much annoyance is likely to be caused the constructor if they are omitted. These condensers may be of the same type as the audio frequency coupling condensers, which are rated at a D.C. working voltage of 300 volts.

The constructor should encounter little difficulty in obtaining satisfactory operation from an amplifier of this type.

In order to avoid any confusion in the wiring of the apparatus the writer adopted the Belden Colorubber system of wiring, which facilitates the tracing of circuits and simplifies the matter of wiring. It is advisable to use No. 18 or 20 stranded Colorubber wire in apparatus of this description.

LIST OF PARTS REQUIRED

1—Thordarson 2098 Power Transformer.
1—Thordarson 2099 Choke Unit.
1—Thordarson 2408 Input Transformer.
1—Thordarson 2629 Output Transformer.
1—Thordarson R200 Transformer.
2—Thordarson R190 Chokes.
1—Thordarson 2445 Power Transformer.
1—Tobe R210 Condenser Block.
4—Tobe 1. Mfd., 300 Volt Condensers.
2—Carter 8,000 Ohm Resistors.
2—Carter 10,000 Ohm Resistors.
1—Carter 50,000 Ohm Variable Resistor.
1—Carter M.P. 20 Resistor.
1—Carter M.W. 1 Resistor.
1—Carter No. 3 Jack Switch.
5—Carter No. 102-A Jacks.
1—Carter M.W. 1,000 Resistor.
2—Carter M.W. 200 Resistors.
7—Benjamin No. 9040 Sockets.
1—Benjamin No. 9036 Socket.
12—X.L. Binding Posts.
13—Allen Bradley Volume Control Resistors.
4—Cartons of Belden Colorubber Wire.

An Experimental "222" Receiver

By John B. Brennan, Jr.

ALTHOUGH the UX-222 tube, otherwise known as the screen grid tube, has been with us for several months there are as yet few receivers capable of employing it effectively. Much general information has been printed about this tube and several technical journals have made their own investigations into its general behavior, which, they tell us makes a revision of our former understanding of the function of tubes in a radio frequency amplifier quite necessary.

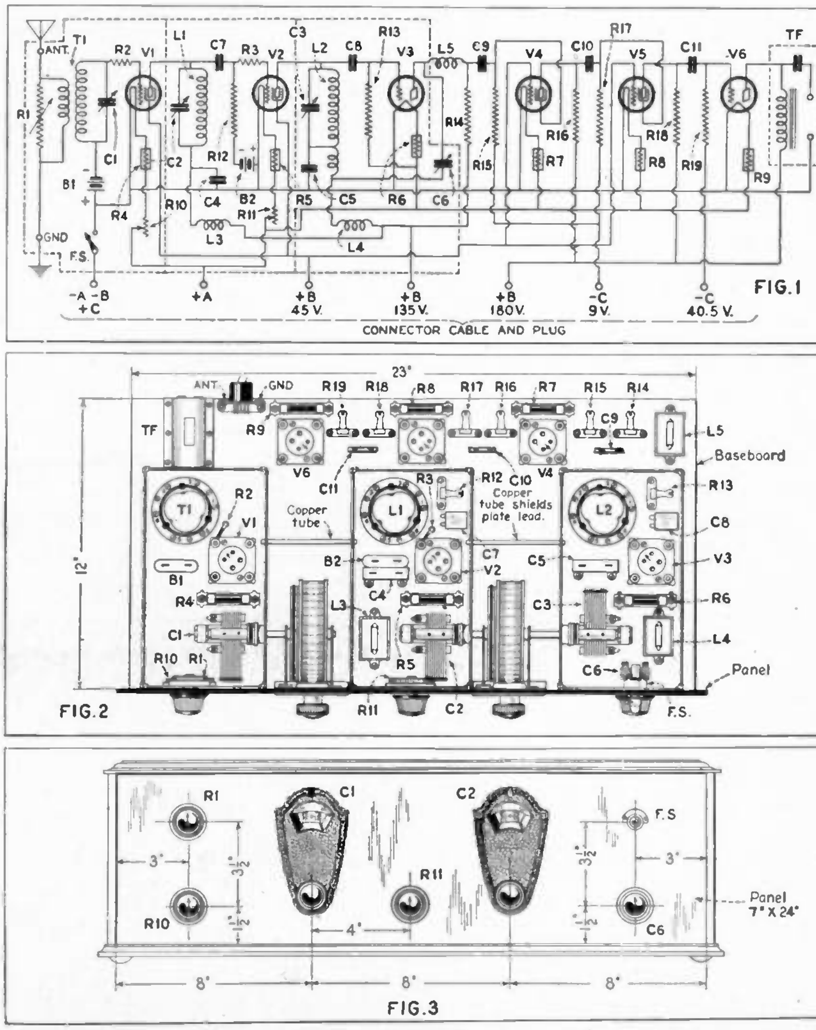
From all quarters it is predicted that in spite of the peculiarities of this new tube, it is with us to stay and the coming season will find many new applications and uses for it. Certainly, manufacturers of complete receivers and the vast army of home set-builders will have to reckon with this new tube in their future receiver designs.

Attempts have been made to adapt the 222 tube to existing receivers but generally the results are not commensurate with the labor or expenditures involved. To obtain the full practical benefit it is quite necessary to design around it a receiver that includes special features in the way of shielding and filtering not heretofore considered to be quite so necessary to the functioning of our more common types of receivers with which we have been familiar.

Facts About the 222 Tube

It has long been the aim of designers of tubes to produce one which would have considerably higher powers of amplification than the tube which we have become accustomed to using—the 201-A. This latter tube has a practical amplification factor of 8.

High amplification tubes have been produced before but prior to the introduction of the 222 tube it was found that increases in the amplifying capabilities of the tube were accompanied by a corresponding tendency on the part of the tube to cause oscillation due to the increase in the grid-plate capacity. Thus neutralization problems were more pronounced, a decidedly disadvantageous feature. Under these conditions the tubes that were possible of practical employment in a receiver had amplification factors of about 20, or in that neighborhood. Imagine the great advance that is now possible by the use of the 222 tube which has a maximum amplification of 300 and a practical one of about 125, depending upon the conditions under which it is used. Together with this seemingly impossible factor of amplification the construction of the tube is such as to reduce to a veritable minimum its internal or grid-plate capacity. This means that the tube may be employed without the need for incorporating in the circuit any system of neutralization. However, due to the enormous amplification obtained by the use of the 222 tube, oscillation occurs due to other causes and to successfully control the tube it is necessary at the present to include losser controls in the circuit (or redesigned R. F. transformers) until such a time as our knowledge of this tube and its behavior is more clearly understood.



Schematic diagram and constructional layouts of the Experimental "222" Receiver. Note that screen-grid tubes are also used in the resistance coupled audio amplifier.

So that set-builders may experiment with this new tube a receiver has been designed wherein two such tubes are employed in the radio frequency end of the receiver. A regenerative detector system is employed using condenser feedback. Three stages of audio frequency amplification make up the audio channel. It consists of a resistance coupled amplifier wherein two 222 tubes are used as "space-charge-grid" amplifiers and feed into a final power stage employing a 171 type of tube. The complete circuit of the receiver is shown in Fig. 1.

Fig. 2 shows the layout of the parts employed in building the Experimental 222 Receiver. The several tuned stages are completely enclosed in box shields and it will be noted that the plate-to-grid connecting leads between the box shields are encased in grounded copper tubing. A drum dial actuates the condenser of the first tuned stage while another controls the second R.F. stage and detector circuits, being ganged together for the purpose. The condensers are insulated from the box walls, on which they are mounted, by pieces of micarta or other insulating material.

The panel layout of the receiver is shown in Fig. 3.

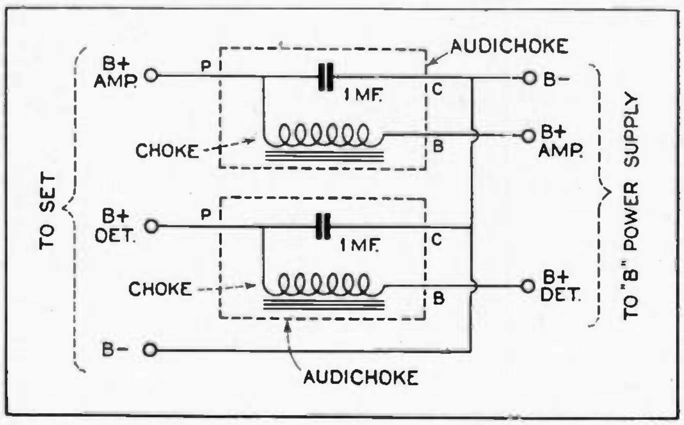
LIST OF PARTS REQUIRED

C1, C2, C3—Hammarlund Midline Condensers, .00035 Mfd.
C4, C5—Tobe Bypass Condensers, Type 301, 1. Mfd.
C6—Hammarlund Midget Condenser, 100 M-mfd.
C7, C8—Tinytobe Condensers, .00025 Mfd.
C9, C10, C11—Tinytobe Condensers, .006 Mfd.
T1—Aero Antenna Coupler, No. 963.
L1, L2—Aero R.F. Regenerative Kit, 953.
L3, L4—Samson R.F. Chokes, No. 125.
L5—Samson R.F. Choke, No. 85.
R1—Electrad Royalty Variable Resistance, Type J. 0-200,000 Ohms.
R2, R3—Electrad Fixed Wire Grid Resistances, 1,500 Ohms.
R4, R5, R7, R8—Amperites, No. 622.
R6, R9—Amperites Nos. 1A and 112 respectively.
R10, R11—Yaxley Rheostats, No. 130K 30 Ohms.
R12, R13—Durham Grid Leaks, 2 Megohms.
R14, R16, R18—Durham Resistors, .25 Megohm.
R15, R17, R19—Durham Resistors, 2 Megohms.
V1, V2, V4, V5—UX-222 Tubes.
V3—CeCo Detector Tube, Type H.
V6—CeCo Power Amplifier Tube, Type J-71.
8 Durham Single Resistor Mounts.
2 National Drum Dials
1 National Tone Filter (TF).
1 Yaxley Midget Battery Switch, Type 10.
2 UX-222 Tube Shields (Remler).
3 Alcoa Aluminum Box Shields 5" x 6" x 9".
1 Yaxley Connector Cable and Plug, No. 669.
1 Micarta Panel 7" x 24" x 3/16".
1 Baseboard 23" x 12" x ½".
2 Boxes Corwico Braidite.
B1, B2—1½ Volt Everready Flashlight Cells.

A Power Supply Stabilizer

By Lewis B. Hagerman

THE popularity of the "B" power supply, or eliminator, has created several rather difficult problems for the radio set owner, constructor and experimenter. While there is no question but that "B" power units are vastly superior to batteries in any form, they do not readily adapt themselves to the flawless operation of every set.



Left. — Schematic diagram of the Power Supply Stabilizer which can be used in conjunction with most any receiver and amplifier. Below. — View of the Power Supply Stabilizer ready for connection to receiver and power unit.

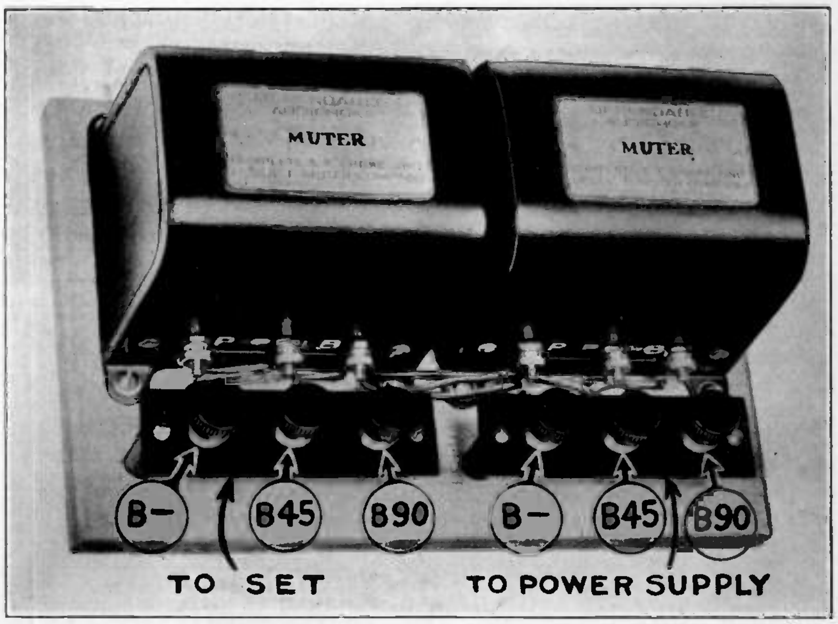
The use of "B" supplies in conjunction with the audio amplifying circuit of the new type of set, which is particularly designed to be efficient on very low notes, results in the majority of cases in what is commonly called, "motorboating," or an intermittent "putting" that is very objectionable. This is created by the much higher resistance of the "B" supply, compared with the "B" battery, which results in an audio frequency regeneration, or feedback, through the common "B" leads, and evidences itself not only in "motorboating" but also in howls and distortion at various frequencies very difficult to detect.

It is a common misconception that if an amplifier is constructed of the best of audio transformers, power tubes, etc., and supplied with sufficient "B," or plate potential, and the correct grid and filament voltages, reproduction is sure to be perfect. Certainly, these things are very important, but they do not prevent audio frequency regeneration that is bound to be present to a greater or lesser degree in any audio amplifying circuit in which the individual circuits are not isolated by some means so that a feed-back between the stages is impossible.

The Leslie F. Muter Company, realizing the necessity for such a choke coil, has designed a unit called the Audichoke, which is a choke of special design and a non-inductive condenser built into one compact unit and partially wired so that it can be easily installed in any radio set without altering its present circuit.

The electrical characteristics of the Audichoke are as follows: the inductance value is 100 henries, the D.C. resistance, 445 ohms, the condenser capacity 1 mfd. and it will withstand many times the voltage to which it is subjected in ordinary use.

For the average set using two stages of amplification, two Audichokes are necessary. If the set uses three stages of resistance, impedance or transformer coupled amplification, three



Audichokes are required. They are wired into the circuit by simply inserting into the "B" positive leads to the detector and amplifier stages, with the exception of the last stage.

In other words, take a radio set with the customary "B" leads of negative; "B" positive 45 volts; "B" positive 90 volts; and "B" positive 135 or 180 volts. An Audichoke is inserted in the 45 volt and 90 volt leads, but not in the high voltage lead. The latter is unnecessary because the same result is obtained with an output filter which should always be used in conjunction with a power tube and the plate current of the last tube may be so great as to render the choke ineffective.

Where Audichokes are to be adapted to a set that is already built, or in the laboratory or service shop where a number of sets are used on the same "B" supply, a very efficient unit can be constructed of two Audichokes, as shown.

This is instantly adaptable to any radio receiver and is extremely easy to attach. When complete, it makes a power supply stabilizer that will adapt any power supply to any set and definitely prevent audio frequency regeneration in any form. To connect, merely run the "B" negative, "B" positive detector and "B" positive amplifier of the set to the respective posts on the stabilizer, and the corresponding posts on the other side of the unit. to the power supply. The high voltage or power amplifier lead remains connected directly to the set.

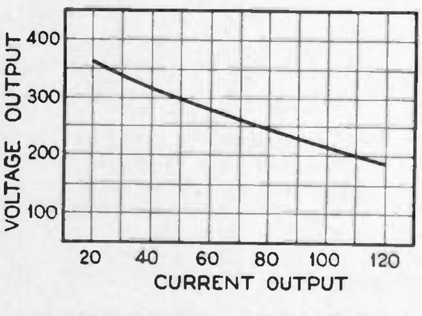
The operation, tuning. etc., will remain the same as before. It will be possible to approach nearer the oscillating point, however, which is where the set is most sensitive, than before, and the tone of the receiver will be noticeably improved, particularly in the reproduction of voice.

An Economical 171 B-Eliminator

By J. R. Francis

A PERFECT B-eliminator can be constructed without the necessity of employing chokes in the filter system . . . "What is the advantage?" you naturally ask. One word will suffice as the answer and that is Economy.

The function of the filter system in an eliminator is to prevent A.C. in the D.C. output. Expressed differently, the filter system must filter, which in this case is to by-pass the A.C. component of the pulsating output of the rectifying tube and permit only the passage of D.C. into the output circuit. Upon anaylsis, we find that all A.C. must be by-passed, regardless of frequency. Furthermore, the function of the chokes is to retard the flow of A.C. and cause it to pass through the condensers. Whichever way we view the action, we find that the important items are the condensers, functioning as paths of least resistance for the A.C. and also as reservoirs for the tube output. If the comparatively small values of capacity utilized in the conventional eliminator filter system function as satisfactory paths for the A.C., why not eliminate the chokes and compensate for the retarding action of the chokes by providing paths of even lower resistance for the A.C., by means of large values of capacity? The reservoir action of the condensers in the conventional filter will still be retained with these large capacities.



Voltage regulation curve of the eliminator described.

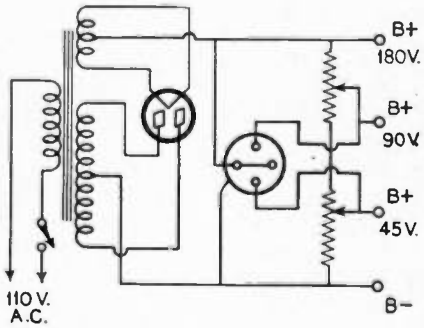
With this idea in mind, the experiment was carried out, using an electrolytic condenser, and the results were highly successful.

The filter chokes were eliminated and the total cost of the eliminator was appreciably reduced. It is easy to appreciate the reduction in price when we say that this unit consists of the power transformer, a socket, the electrolytic condenser and two small resistances . . . That's all.

We are going to dismiss the operating characteristics of the eliminator by quoting an excellent voltage regulation curve and again mentioning that its operation is perfect.

The designation Q 2-25-2-10 associated with the condenser signifies that the capacitance unit contains two condensers of 25 mfd. each and two of 10 mfd. each. The condenser is of the electrolytic type utilizing an aluminum oxide coating upon an aluminum sheet. The coated aluminum is the anode and the electrolyte is the cathode, the coating being the dielectric. The advantages of this type of condenser are: large capacity within a small space, it is not subject to gradual deterioration because the action of the direct current in the eliminator hardens the oxide coating, it is automatically self healing if momentarily punctured. This is a very great advantage, since an instantaneous surge will not ruin the condenser. Punctured one moment, it is healed by the next cycle of current through it. It is sealed and not affected by moisture and the electrolyte cannot spill. It does, however, possess one disadvantage which fortunately is of no consequence in this eliminator. The permissible peak voltage is 400 volts, but the transformer and resistance in this eliminator have been selected to provide the correct voltage and current output without permitting a peak voltage in excess of this value when the unit is in operation.

The transformer used supplies the correct plate voltage for the tube-condenser combination and provides the full output of 125 mils at 180 volts without excessive heat. The circular mil area of the transformer windings is such that undue heat is not created when the unit functions at full load. Furthermore, it is suitable for all 110-120 volt power circuits with a frequency range of from 50 to 133 cycles. Supplementing this, the design of the transformer is such that excellent voltage regulation is obtained, with a varying input voltage. This is accomplished by the use of a large core. By the use of an abundant core, the line



Schematic diagram of the Economical 171 B-Eliminator which dispenses with the usual chokes.

voltage may fluctuate over a fairly large range without an appreciable change in the output. This is a decided advantage in operation, since the exact line voltage figure varies in different parts of the country.

The resistances used are designed to provide maximum heat radiating surface since they are open to the air on all sides. In addition each resistance constitutes a calibrated resistor in itself, since each effective turn between the end contacts is equal in resistance to the total resistance divided by the effective turns. For example. the type B resistance has 30 effective turns, and with a total resistance of 5,000 ohms, each turn is equal in resistance to 5000/30 or 166 ohms. The type D resistance has 98 effective turns.

The wiring of the unit is very easy. Since the copper case of the condenser constitutes the negative terminal, the contacts on the can cover are the other leads of the condensers. The two 25 mfd. units are connected together and form the reservoir condenser of 50 mfd. across the tube. The two 10 mfd. condensers are connected across the voltage divider resistances.

Summing up the complete unit, we have an efficient 171 type "B" eliminator capable of supplying 180 volts at 100 to 110 mils, with units of the highest electrical design, affording perfect satisfaction at a very economical cost for a unit of this type. The complete unit is mounted upon a baseboard 5"x12"x½".

LIST OF PARTS REQUIRED

1—Jefferson 465-141 Transformer.
1—Mershon Q 2-25-2-10 Condenser.
1—Electrad Type D-100 Truvolt Resistor with one slider tap.
1—Electrad Type T-50 Truvolt Variable Resistor.
1—Eby Socket.
4—Eby Binding Posts (B-, B45, B90 and B180).
2—Rolls Wheeler Flex-O-Color Connecting Wire.

A Convenient Power Plant for A.C. Operated Sets

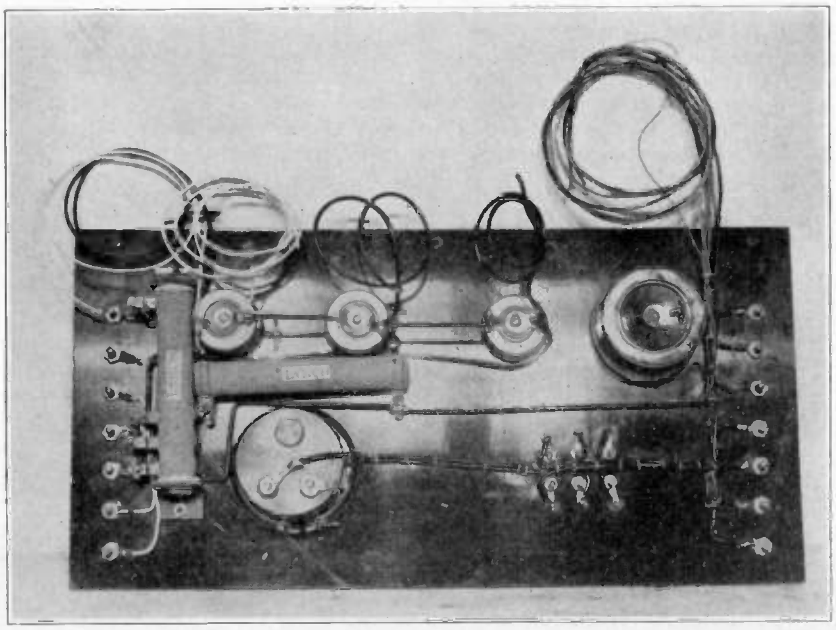
By Perry S. Graffam

A.C. Adapter Harnesses are holding the center of the radio stage at the present time as they make it possible to convert one's tuned R.F. set into a modern A.C. tube job without any changes in wiring. An excellent Harness is the Carter designed for use with an A.C. filament transformer which gives the three voltages common to the -26 and -27 type of tube including the power tube; 1½, 2½ and 5 volts.

As long as we are going into the elimination of the "A" battery why not combine this with a "B"-eliminator and make a single job for the complete electrification of the set without various separate units, all requiring individual leads. This latter system makes electrification almost as messy as the old "A" and "B" battery arrangements.

The writer has designed a power supply unit which does exactly the above, a complete "A", "B" and "C"-eliminator to work with the -26 and -27 type of A.C. tube. This gives four "B" voltage taps, three "C" bias taps and three filament lighting taps. Such a unit can be used with the Carter Harness or one can rewire their set and use this unit.

Above: Sub-base layout of the apparatus forming a convenient power plant for A.C. operated sets. Below: Layouts of the fixed and variable resistors, and the voltmeter on the panel.



In the design of this unit it was decided that flexibility must be a feature if the utmost efficiency was to be obtained. Since one is making a custom built supply they may as well spend a little extra and have the type of unit which could not be obtained commercially, since commercial production practice forbids the incorporation of such features.

Working along these lines a means is supplied for controlling the various filament voltages by the connection for line voltage fluctuation on the input side of the filament transformer. This is accomplished with a power Clarostat which is connected in the primary of this transformer. Any line voltage fluctuation may thus be compensated for and the filaments will receive the exact voltage they require.

On the National main power transformer used in this supply unit, two filament lighting taps are left unused but are available in case one cares to use a power tube such as the 210 or L-10 CeCo type. The new UX-250 power tube will handle the same amount of energy as a 210 with only 250 volts of "B" and it uses this voltage tap for lighting its filament. Since the National "B" Supply Unit incorporated in this device will give nearly that top voltage, this tube may be adapted to one's set with this "A", "B" and "C" unit.

After the A.C. has been stepped up to a high voltage by the transformer the current is rectified into direct current by a Raytheon BH tube. A certain amount of A.C. ripple still exists after rectification takes place and this is ironed out by the choke coils and Tobe condenser block.

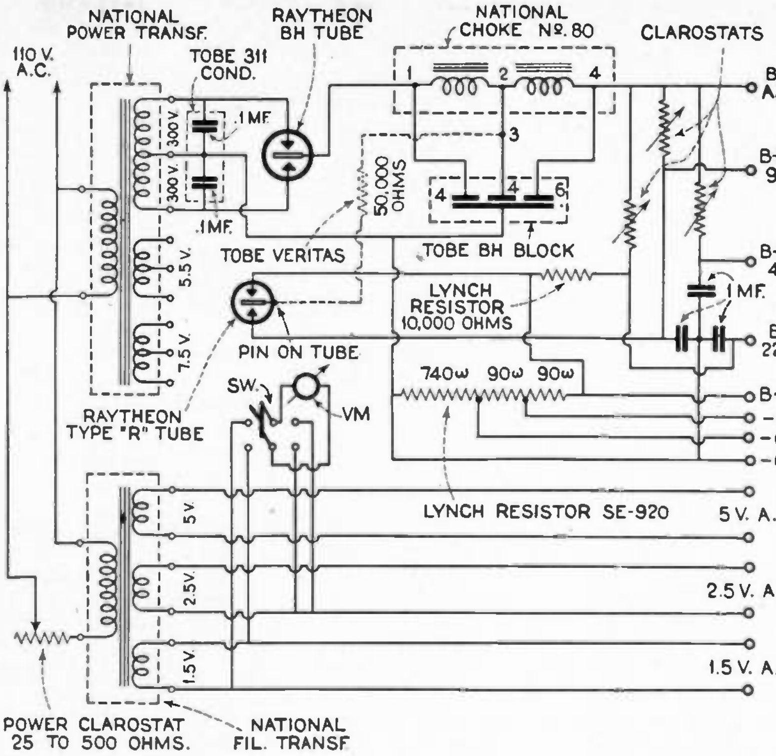
We now have a source of high voltage and need only make arrangements for tapping off at the points where certain voltages are desired. This is obtained through a series of Clarostats and a fixed resistance.

An important point is the maintenance of the R.F. voltage at a given point and this is insured by use of a Raytheon regulator tube, or a UX-874 or CX-374. When the latter type of tube is used the 50,000 ohm Veritas resistance shown in the diagram by a dotted line may be omitted.

The connection for this resistor is made to one of the mounting screws on the socket, the actual contact with the brass pin on the side of the tube being achieved by fastening a piece of spring on this socket mounting screw so that it will press against the pin when the tube is inserted in the socket.

The Jewell A.C. voltmeter is controlled by a switch so that it may be thrown in or out of the circuit as desired. This switch is so arranged that it permits a correct reading on either the 1½ or 2½ volt lines, the voltage being controlled by the power Clarostat as described earlier in this article.

The "B" voltages and "AC" voltages have been described. A word about the "C" voltages is also necessary. The Lynch SE resistor is in series with the negative "B" return of the unit. The drop in voltage across this resistor provides the desired values of "C" bias, C-1 giving about 4.5 volts, C-2. 9 volts and C-3, 40.5 volts respectively for the power tube; such as the CeCo J-71.



Above: Complete schematic diagram of the "Convenient Power Plant for A. C. Operated Sets." Below: Front panel view of the same unit.

LIST OF PARTS REQUIRED

1—National Power Transformer.
1—National Type 80 Filter Choke.
1—National Type F-226 Filament Transformer.
1—Tobe BH Condenser Block.
3—Tobe No. 301 Filter Condensers, 1. Mfd.
2—Tobe No. 311 Buffer Condensers.
1—Tobe 50,000 Ohm Veritas Resistor (if Raytheon R tube is used).
1—Lynch SE-920 Resistor.
1—Lynch 10,000 Ohm Resistor.
1—Amer. Mechanical Lab. Power Clarostat.
3—Amer. Mechanical Lab. Standard Clarostats.
1—Jewell A.C. Voltmeter, Type 135 (0-5 volts).
14—Eby Binding Posts.
1—Raytheon BH Rectifying Tube.
1—Raytheon R Voltage Regulator Tube or—
1—UX-874 or CX-374 Voltage Regulator Tube.
2—General Radio UX-349 Sockets.
1—Celeron Panel, 7" x 14".
1—Baseboard, 11" x 14".
1—D.P.D.T. Switch.
50 ft. Acme Celatsite Hookup Wire.

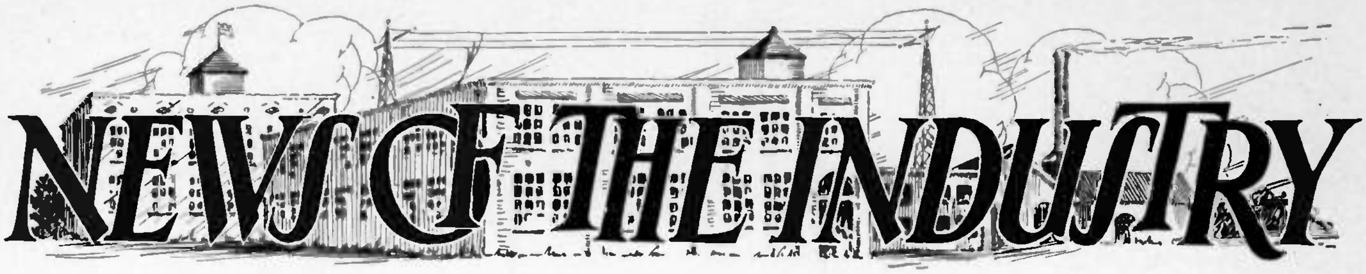
Radio Training Course Launched Successfully

THE first vocational training course for radio service men of a national enterprise undertaken by the Radio Manufacturers Association has been launched successfully at Newark, New Jersey. The new vocational training school, established by the Essex County, New Jersey, Board of Education in cooperation with the RMA, has opened its doors with an initial class of high-grade youths embarking upon a full three years training course. The Essex County course is well financed and organized under the direction of Robert O. Beebe, Director of the Essex County, New Jersey, schools and Mr. James F. Johnson, Assistant Supervisor of vocational training. A night radio school also is contemplated.

Success of the initial radio servicing school established by the RMA has interested many other institutions of technical training including the Baltimore Board of Education, a Pittsburgh radio school, Y. M. C. A., private trade schools, and even correspondence institutes and technical employment concerns. Public interest in radio as a vocation also has been widely evinced. And the RMA endeavor to develop trained radio service men, to aid not only the radio industry, but the public in its purchase and satisfactory use of radio sets, is regarded as of such importance that the RMA Board of Directors is establishing a special committee to develop and execute a program for national development of radio service schools.

Radio manufacturers, jobbers and retail dealers of Newark and the adjacent New Jersey vicinity aided in planning the Newark vocational course and are making contributions of man power and material toward its success.

That opportunities in the radio industry not only as service men, but as salesmen and in other higher capacities exist for men having technical service training, is the opinion of radio industry leaders of the RMA Board of Directors. Most of them believe that salesmanship as well as technical training should be given in service vocational courses. Special personal qualifications also are regarded as desirable. In considering the question of securing for the public and the industry a supply of trained service men by establishing vocational training courses nationally, the manufacturing industry leaders, of the RMA directorate, agree that a grammar school education for trainees is imperative and high school training desirable.



NEWS OF THE INDUSTRY

Erla Granted Magnavox Dynamic License

The Electrical Research Laboratories, manufacturers of Erla Radio Receivers and Radio Parts, of Chicago. have been granted a license by the Magnavox Company, of California, to manufacture electro-dynamic cone speakers.

The Erla electro-dynamic speakers will be used in the console type Erla receiving sets and will also be sold to radio manufacturers and cabinet manufacturers.

The Company is going into production on two distinct types, one designed primarily for radio receivers and the other for use with electric reproducing phonographs and radio-phonograph combinations.

The Electrical Research Laboratories are in a position to supply cabinet manufacturers with a combined dynamic cone speaker and power amplifier designed for quick installation as a single unit in a cabinet having available for speaker purposes a space measuring 14" long, 10" high, and 12" deep.

Amrad Adds Newark Distributor

The Newark Electrical Supply Company of Newark, New Jersey, have recently concluded arrangements to act as exclusive Amrad Distributor in the Newark territory according to an announcement made today by W. H. Lyon, General Sales Manager of the Amrad Corporation.

Amrad Appoints Nolan to Important Post

James J. Nolan, formerly in charge of radio sales at the Hub Cycle & Auto Supply Company, of Boston and recently connected with The Amrad Corporation in the capacity of Mershon Sales Engineer, has been appointed to the important post of Western Division Manager.

Mr. Nolan's new headquarters will be at the Amrad branch factory located at 2235 So. La Salle Street, Chicago. Illinois. of which he will have complete charge.

Peoria Distributor Takes on Amrad

The National E. & A. Supply Company of Peoria. Illinois. well known distributors of radio and automotive merchandise, have just signed up with the Amrad Corporation to handle Amrad merchandise in their territory, according to an announcement made today by W. H. Lyon, General Sales Manager of The Amrad Corporation.

Amrad Establishes Branch Factories

The rapid growth and expansion of the Amrad Corporation has necessitated the addition of two branch factories in order to handle the increased production for the year 1928, according to an announcement made today by A. B. Ayers, the general manager of the Amrad Corporation. The main Amrad factory, located at Medford Hillside, Mass., will be devoted entirely to the manufacture of radio receiving set chassis, power packs and Mershon Condensers.

The chassis will be mounted in cabinets at the branch factories located at Charlestown, Mass., and Chicago, Ill. The Charlestown branch has a total of 11,000 square feet of floor space and the Chicago factory comprises 7,000 square feet located at 2235 So. LaSalle street.

These branch factories, while more or less of an innovation in the radio business, will assist materially in giving better service to the large list of Amrad distributors and will greatly facilitate production problems.

Muter Constructing New Plant

The Leslie F. Muter Company takes pleasure in announcing the construction of its new, modern, fire-proof factory, at 85th Street and South Chicago Avenue, Chicago, Illinois.

The property will front 200 feet on South Chicago Avenue, by 150 feet on 85th Street, is adjacent to the New York Central and Pennsylvania railroads, and will be served by a separate switch track for receiving raw materials and shipment of the finished products.

The building will be of concrete and pressed brick construction. having the entire manufacturing facilities on the first floor enabling the most efficient methods of production and assembly. The executive offices, laboratory, and broadcasting station will be located on the second floor.

The new building will be occupied about June 10th, at which time it is proposed to extend an invitation to all dealers, jobbers, and manufacturers to inspect the new quarters during the Trade Show.

Freed-Eisemann Appoint New Advertising Manager

The Freed-Eisemann Radio Corporation announces the appointment of M. J. Adler as advertising manager, who succeeds Ray L. Speicher, who advances to the promotion department.

Acme E. & M. Appoint New England Representative

Recently, Roger V. Pettingell, located at 1101 Statler Bldg., Boston, Mass., was appointed representative by the Acme Electric & Mfg. Company of Cleveland, Ohio, large manufacturers of numerous radio products, to cover the entire New England territory.

Who Needs West Coast Representation?

The F. E. Sette Company, Manufacturers, Agents, of 255 Ellis Street, San Francisco, Calif., are interested in securing new radio lines to represent throughout the west coast territory.

R.C.A. Photophone, Inc.

Formation of a new company to be known as "R.C.A. Photophone, Inc." was announced recently by Major General James G. Harbord, President of the Radio Corporation of America, who will act as Chairman of the Board of Directors of the new subsidiary company. The enterprise has been entirely financed by the Radio Corporation and the General Electric and Westinghouse Companies and there is no public offering of its securities.

The R.C.A. Photophone, an apparatus for synchronizing motion pictures with voice and music, will be sold to motion picture theatres, schools, churches and other institutions. Engineers of the Radio Group are now at work in their laboratories on a simplified photophone device suitable for use in the home, which will make it possible. it is stated, to reproduce "talking movies" in the home very much as the ordinary radio broadcast programs are now being received in more than eight million homes.

General Harbord announced that the

other members of the Board of Directors would be Owen D. Young, Gerard Swope, Paul D. Cravath, E. M. Herr, E. W. Harden, Cornelius N. Bliss, James R. Sheffield and David Sarnoff.

The President of the new company will be David Sarnoff and Elmer E. Bucher will be Vice President, in charge of commercial activities. Doctor A. N. Goldsmith will be Vice President in charge of technical matters. The other officers of the company will be George S. De Sousa, Treasurer; Lewis MacConnach, Secretary and Charles J. Ross, Comptroller. A Board of Consulting Engineers has been created and its members are: A. N. Goldsmith, C. W. Stone and S. M. Kintner.

Principle of Photophone

It is stated that while various methods have been devised for "talking movies," experience has shown that the most practical is that of recording pictures and sound on the same film. This is the method employed by the Photophone.

Easily operated reproducing apparatus for use in theatres, schools and churches will be nationally available. An entire opera, musical comedy or drama can be electrically recorded on the film, just as it is seen and heard, and then reproduced from the same film. Whatever can be seen or heard, whether it is a nightingale singing or an army in battle, can now be recorded and reproduced for both the eye and the ear. Moving picture dramas with complete orchestral accompaniment, or with music and speech, will be available for nation-wide use.

Standard films without the sound can be used without any change in the machine. The only thing the operator has to do is to close one switch when he is projecting pictures with sound, and open it when he does not want the sound. Any type of "talking film" can be used in the machine. The type of sound reproducer to be used will vary with the size of the room in which the pictures are to be shown.

Intended Field

Mr. Sarnoff stated that the new company would make its products available to the entire motion picture industry, as well as to individual home-users. Through the National Broadcasting Company, another Radio Corporation associate, it will be able to obtain programs and artists which can be recorded and reproduced by the R.C.A. Photophone.

Experimental motion picture laboratories at 411 Fifth Avenue have been established by the Photophone Company for the development of "talking movie" technique. With 20,000 motion picture houses, 150,000 churches and 270,000 schools in the United States, the new company expects to develop a very large market for its apparatus.

Philco Absorbs Murdock and Announces A.C. Set

The radio industry has heard many rumors regarding merger activities of the Philadelphia Storage Battery Co., maker of Philco Socket Powers.

These rumors are now cleared up by an official announcement from the Philco Company stating that it has bought the Murdock Radio Corporation of Chelsea, Mass. This firm has been headed by Daniel and William Murdock, manufacturers of radio sets from the kindergarten days of the industry, and was one of the first licensees of the Radio Corporation of America.

This new merger, important in itself, follows on the heels of the recently announced absorption of the Timmons Radio Products Corporation, of Germantown, Pa., by Philco. The Timmons Company is producer of the Timmons Talker. With the merger the Murdock Company ceases operation, though in the case of the Timmons Company that business will be continued as a separate unit of the Philco organization.

It has also acquired license under patents of Radio Corporation of America, General Electric Co., Westinghouse Electric and Manufacturing Corporation and the Hazeltine Corporation.

All these activities mean that Philco is going to step out with a new radio set having the benefit of all the improvements in radio that have gone before, plus innovations supplied by its own engineering division.

Van Horne Company Reorganizes

The Van Horne Company, Inc., of Franklin, O., for many years manufacturers of vacuum tubes, recently reorganized and will continue under the leadership of Mr. Van Horne. The Van Horne Company tube plant and assets were bid in from the Receiver and confirmed by the Court on April 16th by J. S. Van Horne.

It will be remembered that the Van Horne Company was one of the first to introduce typical A. C. tubes and have spent thousands of dollars in the development of these tubes along with the heater type tubes.

A new process of coating the cathode and a new method of evacuation have been developed by the Van Horne Company.

American Headquarters of Leipzig Trade Fair

The American headquarters of the Leipzig Trade Fair will hereafter be located in the Salmon Tower Building, 11 West 42nd St., New York. This central location has been chosen to better serve the increasing number of business men who take part in the Leipzig Fair. The New York representatives of the Fair will lend every assistance to exhibitors and buyers visiting Leipzig. The office maintains free commercial information service for American business men interested in trade with Germany.

Annual Meeting, Radio Division of NEMA

Merchandising advertising and time-payment financing will be among the subjects for discussion at the annual meeting of the Radio Division, National Electrical Manufacturers Association, to be held at the Drake Hotel, Chicago, Ill., June 4 to 7 inclusive, according to an announcement by Louis B. F. Raycroft, Vice President of NEMA in charge of the Radio Division.

While commercial aspects of the industry will receive the heaviest accent during the meeting, technical subjects, including wired radio and radio standardization will also form part of the program.

General Transformer Corporation

Nathan Goldman and Benjamin C. Goldman have just formed the General Transformer Corporation with an authorized capitalization of $100,000. Mr. Nathan Goldman who for the past three and one half years has been part owner and General Manager of the Transformer Corporation of America is president and treasurer of the new company. Benjamin C. Goldman is secretary.

They will manufacture all types of low voltage transformers and specialize on Transformers, Chokes and Power Packs for Radio Power Supply Units, and Audio Frequency Transformers.

Mr. Kendall Clough, director of the Research Laboratories of Chicago, formerly with the All American Company, and now consulting engineer for the Silver-Marshall Company, will act in a similar capacity for the General Transformer Corporation.

The General Transformer Corporation have leased the entire fourth floor at 900-910 W. Jackson Boulevard, Chicago.

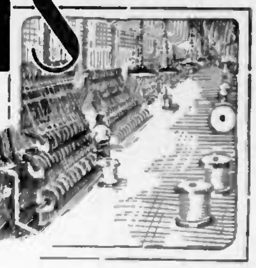
They will shortly be in position to offer test samples to Radio Set Manufacturers.

New Electrad Booklet

Under the title of "What B-eliminator Shall I Build," there has just been published an interesting book, consisting of thiry-two pages, which gives instructions and illustrations on the use of variable wire wound resistances, in such nationally known power supply units as Thordarson, Samson, National, Amertran and Silver-Marshall.

Electrad, Inc., 175 Varick St., New York, will be very pleased to send this book upon request.

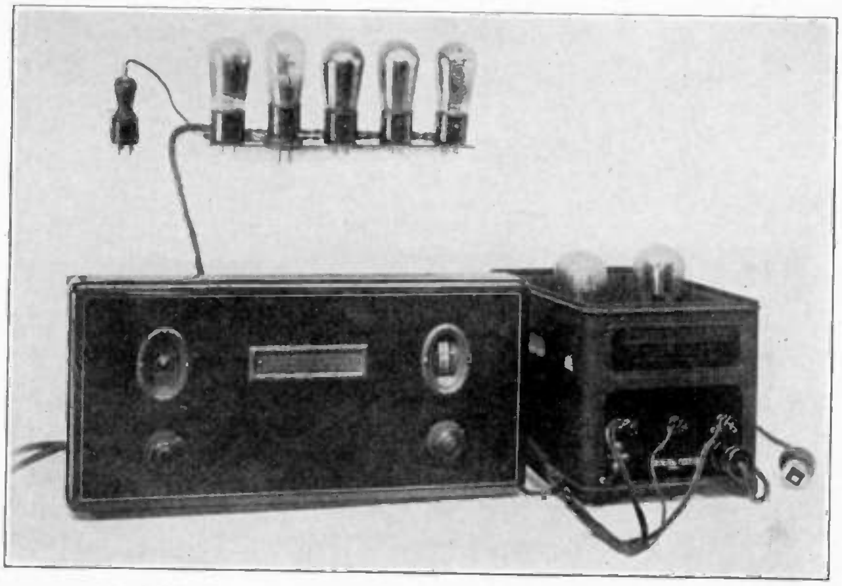
NEW DEVELOPMENTS OF THE MONTH



Receptrad Type S-P Gang Adapter

The Radio Receptor Co., Inc., of 106 Seventh Ave., New York, N. Y., have introduced an S-P Panel Type Gang Adapter which greatly facilitates the application of Powerized A.C. electrification circuits to many popular sets.

Space requirements particularly are entirely fulfilled, as this type of adapter can be used in the closest quarters without interfering with the set lid or cabinet-work.



Receptrad S-P Panel Type Gang Adapter and Powerizer shown set up with a Radiola battery operated set. This Powerizer and Adapter can be adapted to most of the battery operated sets on the market.

The S-P Adapter consists of a thin insulating strip on which are mounted the specially wired conversion sockets for the A.C. tubes. The prongs of the conversion sockets fit the standard tube sockets in the receiver. Filament and plate current for the A.C. tubes is supplied by the Powerizer.

Mar-Co Dynamic Reproducers

The Martin-Copeland Company, of Providence, R. I., have introduced a line of electro-dynamic speakers in which are incorporated a number of new features.

Mar-Co reproducers employ what is technically known as a free edge cone. However, perhaps the term "semi free edge" would be more accurate, in that the edge, or the periphery of the cone is secured to the frame-work by means of a very soft and pliable piece of leather. The paper is corrugated to prevent the setting up of undesired frequencies, and is specially treated with a compound to prevent changing its shape, or the absorption of moisture due to atmospheric changes and humidity.

At the apex of the cone is secured a coil consisting of a comparatively few turns of fine wire. The coil is freely suspended within a magnetic field of great strength and constancy. The forces on this coil, which produce the sound are dependent only upon the current in it, and not upon its position in the field, and being non-magnetic, will not over-saturate. This and other factors result in complete freedom from distorting harmonics introduced by the speaker itself. The motion of the coil is lateral across the air gap, hence, its movement is not restricted or retarded, as would be in the case of the conventional magnetic reed reproducer. Striking of the pole pieces, or chatter, as a result, is almost impossible. The inductance of the freely suspended coil is extremely low, and in conjunction with the transformer to which it is connected, offers practically a pure resistance load to the tube or tubes of the audio amplifier, thus resulting in a high power factor, and its impedance will vary but slightly with respect to rapid changes in frequency. As a consequence, the response curve of the speaker is remarkably flat, it is claimed.

Mar-Co dynamic reproducers have no inherent cut-off and will respond with equal fidelity and volume down to 50 cycles. While the unit is capable of reproduction over the entire audio frequency spectrum, 50 to 12,000 cycles, a filter has been deliberately added, to prevent response to frequencies exceeding 6,500 cycles. The average broadcasting station, or phonograph record, does not transmit impulses beyond this range. The addition of this filter further prevents response to tube and other extraneous noises, which usually mar the background of music.

The Mar-Co dynamic reproducer will be available in the following three models:

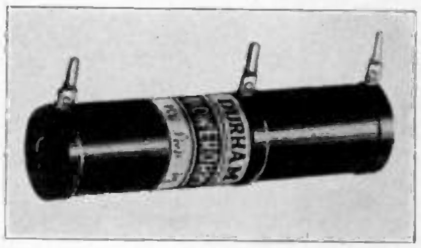
Type D110, for operation on 110 V-50 to 60 cycles A.C. Has rectifier built in. Rectifier has a useful life of approximately 3,000 hours and is easily changed.

Type D90, for operation on 90 to 110 V., D.C. Can be operated from the 90 V. tap of "B" eliminators or 110 V., D.C. house circuits.

Type D6, for operation on 6 V storage batteries. Current drain is ½ ampere.

New Durham Power Resistor

The International Resistance Company, manufacturers of Durham Resistors and Resistor Mountings now announce a complete line of Power Resistors, known as Powerohms, ranging from ⅛ watt to 50 watts. To fulfill the demand created by radio television and other recent developments, the International Resistance Company are producing resistors of unheard of sizes and ranges—from 1 inch to 24 inches in length, ranging from 20 megohms to as high as 500 megohms.



Durham Power Resistor.

Acme Announces New Condenser Line

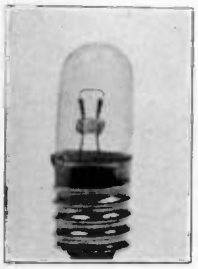
The Acme Wire Company of New Haven, Connecticut, makers of the well-known Celatsite Wire and Parvolt Condensers announces a complete line of wound By-Pass and Filter Condensers to meet every requirement of modern radio practice, including complete groupings of Filter condensers in handsome metal housings with lead-in terminals designed for the more important AC and DC power supply units such as Samson, Thordarson, Hi-Q, Victoreen, Silver-Marshall and Amertran.

Acme High Voltage Condensers.

Acme Parvolt By-Pass Condensers are now available in all standard Mfd capacities and voltage ratings, while the Parvolt Filter types are made in standard Mfd capacities and in ratings of 200, 400, 600 and 800, 1000 and 1500 volts. All are tested for sustained duty and not only meet the standards of the R. M. A. but have an added factor of safety self-imposed by Acme to overcome any possibility of breakdown from sudden voltage surges.

New Radio Panel Lamp

A new panel lamp for illuminating the dials of alternating-current operated radio sets has been announced by the National Lamp Works of the General Electric Company, Cleveland,



Mazda low voltage A.C. radio panel lamp. This lamp is designed to work from any standard filament heating transformer for A.C. tubes.

Ohio. This lamp is designed to receive current from the filament circuit of 2.5-volt vacuum tubes, and thus eliminates the necessity of providing an extra transformer winding to supply the proper voltage. The lamp has the following specifications:

Amperes—0.45
Overall length—1⅛ inches
Light center length—13/16 inch
Bulb—T-3 clear
Base—Miniature screw
List price—20 cents
Designation—MAZDA Lamp No. 41

The design of the lamp is such as will insure the set owner maximum satisfaction with adequate light for close setting and reading of the dials. At 2.5 volts it gives about the same amount of light as Mazda lamp No. 40 at 6.0 volts.

Arcturus 127 A.C. Tube

The Arcturus Radio Co. have announced a new type A.C. tube (a replacement tube for 2.5 volts detecting circuits) carrying a guarantee of 1,000 hours.

Long life of these new tubes has been achieved, according to engineering reports, by designing a heater and cathode combination in which the filament or heater burns at a very low temperature. It is said that it is difficult to perceive the incandescence of the hot filament. In order to abbreviate the time lag, occasioned by the low temperature filament (the time between the turning on of the current and the normal operation of the tube) the spacing between the cathode and the

The new Arcturus 127 A.C. replacement tube which has a 2.5 volt filament. It is claimed that this tube reaches full emission more rapidly than the standard —27 type tube.

heater has been reduced, increasing the rapidity of heating roughly with the square of the decrease in spacing. This has occasioned the design of a special insulating coating on the heater. It was also found necessary to conserve the heat radiated by the filament. This can be accomplished by applying well known principles of thermo dynamics—the use of a cathode material having rapid heat absorbing properties, and by insulating it from heat conducting surfaces by supports having low thermal conductivity.

It is claimed by the manufacturer that the 127 tube heats in from six to fifteen seconds after the current is turned on, depending upon the exact heater voltage. Variations in heater voltage, occasioned by line regulation as high as twenty-five per cent of normal operating voltage of 2.25 volts are tolerable with the 127 tube, it is claimed.

DeJur A.C. Line Voltage Regulator

The laboratory of the DeJur Products Co., announces the development of a new A.C. line voltage regulator. This unit permits the determination of the actual A.C. line voltage input into the A.C. receiver, B-eliminator or power amplifier, by means of an 0 to 150 A.C. voltmeter. The line voltage control is in the form of a high wattage variable resistance, which is varied until the desired voltage input value is indicated on the meter. A male plug is provided whereby the unit can be connected to the house power supply, and a female plug is provided for connection to the A.C. receiver, B-

De Jur Line Voltage Regulator.

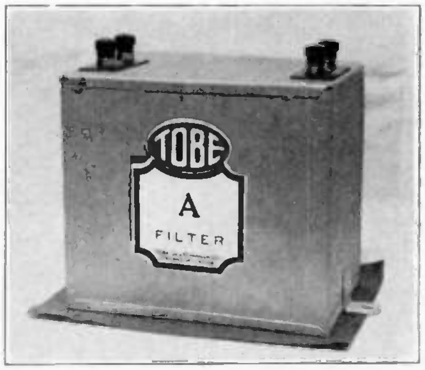
eliminator or power amplifier input transformer.

The wattage rating of the control resistance is sufficient to permit its use with all types of A.C. receivers and power packs. The unit is simple to operate and technical knowledge is not necessary for its installation.

Tobe A Filter

The Tobe Deutschmann Co., of 11 Windsor St., Cambridge, Mass., have introduced a new type A Filter which is composed of a dry condenser having a capacity of 3,600 mfd. cased with chokes of proper size, to supply humless A-current to any set when the A Filter is connected to a battery charging rectifier having the required current output.

Four binding posts are mounted on top of the case to make connections to the charger and receiver.



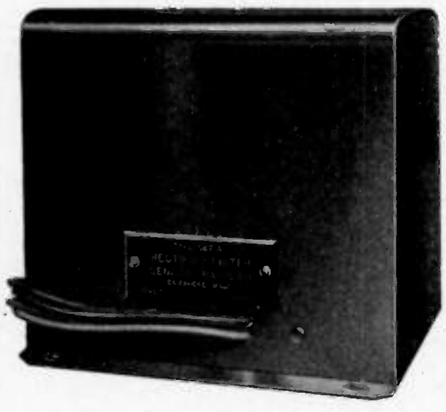
Tobe A Filter

General Radio 587A Speaker Filter.

General Radio Power Equipment

The General Radio Company of Cambridge, Mass., have produced new equipment for use in connection with the 250 power amplifier tube. The high plate current of this tube requires that the transformers and chokes employed in the plate supply unit be so designed that saturation and overheating effects are eliminated.

To cover the requirements of this tube there has been developed a new full-wave power transformer, a half-wave power transformer, a power speaker filter and a rectifier filter.



General Radio 527A Rectifier Filter.

With the exception of size, the physical appearance of the new units is identical with that of previous General Radio apparatus of the same classification.

The type 565B Full-Wave Transformer is designed to be used in connection with two 281 rectifiers. The plate voltage winding is for 1,200 volts with a center tap. There are also two 7.5 volt secondaries for the filaments of the rectifier tubes. The primary is designed for a 105 to 120 volt, 50 to 60 cycle line. This transformer is rated at 200 watts. Its dimensions are 5¾" x 5¼" x 5¼".

The type 565A Half-Wave Transformer is designed to be used in connection with one 281 tube or equivalent. The primary is designed for use on 105 to 120 volt, 50 to 60 cycle line. There are four secondaries; one of 600 volts for the plate voltage, two of 7.5 volts for the filaments of a rectifier and power amplifier tubes and one of 2.5 volts for the filaments of 226 or 227 type tubes in case this transformer is incorporated in a complete two or three-stage amplifier. This transformer is rated at 200 watts and is of the same dimensions as type 565B.

The type 587A Power Speaker Filter, designed expressly for the 250 type power amplifier tube, employs a choke having an inductance of approximately 15 henrys and a continuous current rating of 100 milliamperes.

General Radio 565B Full-Wave Transformer.

The direct current resistance of the choke is 250 ohms. Two microfarad condensers are used on each side of the speaker line to insulate it from the high voltage. Connections to the input side are in the form of leads while the speaker is connected to the two binding posts. The dimensions of the unit are 4¾" x 5⅜" x 4½".

The type 527A Rectifier filter is mounted in the same size container as the 565B Transformer and consists of two heavy duty chokes with an inductance of approximately 13 henrys each and a continuous current rating of 100 milliamperes. The direct current resistance of each choke is 175

General Radio 565A Half-Wave Transformer.

ohms. The condenser assembly consists of a 4-2-4 mfd. combination which are rated at 1,000 volts D.C.

Acme Volume Control and Speaker Filter

The Acme Electric and Manufacturing Company, of Cleveland, O.,

Acme Volume Control and Speaker Filter.

have developed a very unique product in the form of a combined output transformer and filter control compactly in one case, as shown in the accompanying illustration. When connected between the output of any audio amplifier and the speaker this unit prevents the passage of direct current through the speaker windings and also permits a close adjustment of the speaker's volume and tonal quality. Adjustment to meet the requirements of the set owner is made by the small knob on top of the unit.

Dongan A.C. Transformer for Wiring Harnesses

Equipped with terminals designed for use with the new wiring harnesses, the Dongan Electric Manufacturing Company offers to the set manufacturer and Custom-set builder No. 6570 transformer.

Dongan No. 6570 A.C. Transformer.

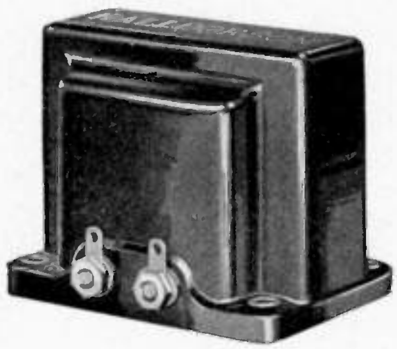
This newest addition to the Dongan line is designed for operation with 4 UX-226, 1 UY-227 and 1 UX-171 tubes.

Mounted substantially in a crystallized lacquered case, it is equipped with lamp cord and plug outlet for B eliminator, also tap for control switch.

In addition to this model No. 6570 there are 15 other Dongan types of A.C. transformers and complete A.C. and A-B-C units to operate with all the approved A.C. tubes.

Halldorson Overtone Audio Transformer

The Halldorson Company, of 4745 North Western Avenue, Chicago, Ill., have introduced an improved audio transformer having excellent frequency characteristics obtained through the use of high impedance primary and secondary windings and efficient core material.



Halldorson Overtone Audio Transformer.

The transformers are mounted in a brown polished Bakelite case and can be mounted on any form of sub-base. The soldering lugs are situated low on the casing for convenience in wiring.

The Halldorson Company are also manufacturing an output transformer the same in appearance and size as their Overtone Audio Transformer. This output transformer is designed to be used as an impedance adjusting unit between the output of the audio amplifier and the loud speaker.

Acme ABC Dry Power Unit

The Acme ABC Dry Power Unit manufactured by the Acme Electric & Manufacturing Co., 1444 Hamilton Ave., Cleveland, O., uses the dry copper oxide plates and dry condensers for the rectification of the "A" current and delivers 2½ amperes at 6

Acme ABC Dry Power Unit.

volts. The "B" power delivers 40 milliamperes at 180 volts, has 6 taps and uses the new 280 tube. "C" voltage of 4½ and 45 volts can be obtained. The unit is very compact and presents a neat and attractive appearance. This ABC Unit is 9½" in height, 12" long, and 9½" in width and weighs about 35 pounds.

New Atwater Kent Receiver

A new radio receiver, designed to overcome the handicaps of indoor aerials and of proximity to powerful local stations, is announced by the Atwater Kent Manufacturing Company. The set, Model 38, closely resembles its immediate predecessor, the Model 37, being slightly larger, however, due to its electrical assembly.

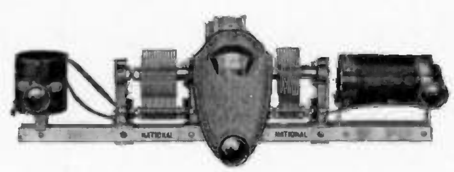
The range of this receiver makes it of unusual value for distant reception, while its improved selectivity makes it desirable for use in metropolitan areas in which are located one or more high-powered broadcasters.

Mechanically it comprises three stages of tuned radio frequency amplification in conjunction with the Atwater Kent coupling circuit, a detector and two stages of audio frequency amplification. It is designed to use seven A.C. tubes and a rectifying tube for the power supply.

The exterior of the cabinet, which is about 21 inches long, is treated with the new satin finish, with color combinations of gold with either dark brown or golden bronze.

National Type 222 Tuning Unit

The National Company, Inc., of Malden, Mass., are marketing a new type single drum dial tuning unit made expressly for the new UX-222, screen-grid tube.



National Type 222 Tuning Unit.

This tuning unit is similar in construction and appearance to the standard Browning-Drake unit made by the National Company but differs in electrical design. A variable inductance is included in the antenna circuit, to compensate for different lengths of antenna. The primary winding of the R.F. transformer has a high impedance, to match the high output impedance of the 222 tube.

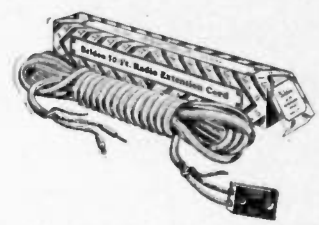
A variable tickler inductance is incorporated so that the advantages of regeneration in the detector circuit may be realized.

A Calibrated Variable Power Resistance

Mr. H. G. Richter, Chief Engineer of Electrad, Inc., announces that the Truvolt line of power resistances can be considered as calibrated power resistances, since each effective turn between the end contacts, is equal in resistance to the total resistance divided by the number of turns. This information should be of great interest to those who desire to obtain various resistance values, but have no means of measuring the exact resistance. An example of the above is the following: The 25 watt Truvolt has 30 effective turns, and assuming a 3,000 ohm resistance unit, each turn would be equal to 100 ohms. The 50 watt units have 66 effective turns and the 75 watt units have 98 effective turns.

Belden 50-Ft. Speaker Extension Cord

A recent addition to the complete radio wire accessory line of the Belden



Belden Speaker Extension Cord.

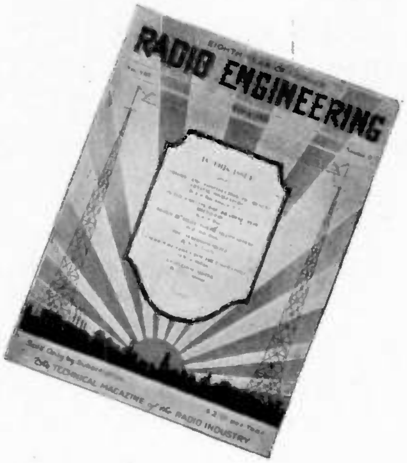
Manufacturing Company, 2300 South Western Avenue, Chicago, is a 50-ft. Loud Speaker Extension Cord. This new cord consists of two rubber-insulated conductors inside a neat brown cotton braid. It is equipped with pin tip terminals on each end. A handy bakelite connector is provided for connecting to speaker cord terminals. The rubber insulation prevents leakage in the long cord, a very important feature in a loud speaker extension cord of such great length.

Braxton-King Plug-In I.F. Transformer and Oscillator Coil

The Mississippi Valley Radio Company have also placed on the market a very neat form of shielded intermediate frequency transformer, also of the plug-in type, together with a

Braxton-King Plug-In I.F. Transformer and Oscillator Coil.

plug-in type oscillator coil. These units are designed primarily for use in connection with superheterodyne circuits. Both the I.F. transformers and oscillator coils will fit a standard UX socket.



THE Radio Manufacturer's Association Convention and Trade Show is held the week of June 11th.

The mailing date of Radio Engineering is the tenth of the month of publication.

This means that hundreds of our subscribers who are attending the show, will not receive the June issue of Radio Engineering until they have returned to their homes after the show is over.

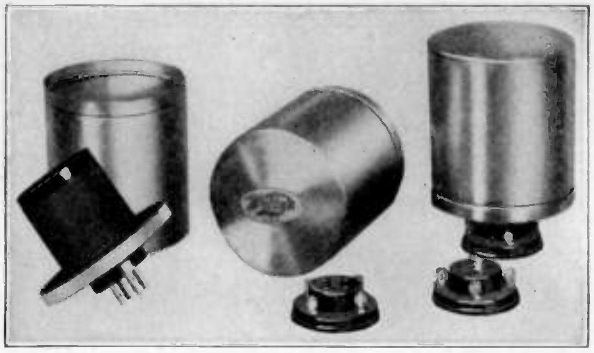
There will, however, be several thousand additional copies of the June issue **at the show.** Visit the Radio Engineering booth (No. 33) and a June copy will be yours for the asking.

Those who are not so fortunate as to be able to attend the show, will receive their June issue during the week of June 11th, while the show is in progress.

Every effort is being made to bring to our readers as much of the show and its attendant developments as is physically possible in the pages of a magazine—to reflect the years' developments as they culminate in the displays at the show—to present all of the facts, much of the competent opinion—possibly even a little of the atmosphere.

If you are not at the show Radio Engineering will do its best to bring it to you. If you attend (and by all means do so if possible) stop in at

BOOTH NUMBER 33.



The Braxton-King shielded radio frequency impedance, of the plug-in type, designed to fit a standard UX tube socket, which can be used effectively with screen-grid tubes in a superheterodyne circuit. The impedance is a single layer winding.

Braxton-King Plug-In R.F. Impedances

The Mississippi Valley Radio Company, of 914 Pine Street, St. Louis, Mo., have introduced a well-designed radio frequency impedance for use in connection with the new screen-grid tubes. This impedance, which is of the plug-in type, and will fit a standard UX tube socket, is entirely shielded by a metal case. The grid lead of the coil, which is taken out from the top of the metal shield, is likewise protected, by a flexible metal braiding.

These R.F. impedances are designed for superheterodyne circuits and are sold in sets of three accurately matched at 350 K.C. Each unit contains the plate coil, the fixed tuning condenser, the filament resistance, blocking condenser and grid resistor.

Sonatron 201-B Tube

The Sonatron Tube Company, of 108 West Lake Street, Chicago, Ill., have just introduced a very interesting form of vacuum tube known as the 201-B.

This new tube draws only ⅛ of an ampere as compared to the ¼ ampere drain of the 201-A type tube. Since the filament voltage of this new tube is 3.3 volts, it can be operated from dry cells if desired.

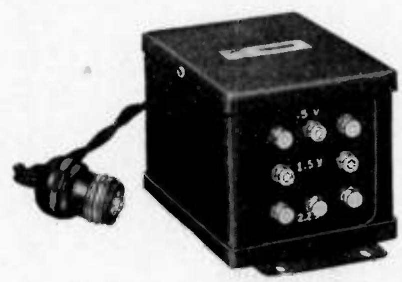
Sonatron 201-B Tube.

Probably its greatest application is in connection with the new screen-grid tubes which have identical filament characteristics. It is possible, therefore, to use screen-grid tubes in connection with the Sonatron 201-B tubes in a series filament connection and supply the filament current directly from a high current rectifier.

Aside from the filament requirements, the characteristics of the 201-B are the same as the 201-A tube.

T. C. A. Filament Transformer

The Transformer Corporation of America, Chicago, announce a new addition to their line of transformers, chokes and reactors in the form of an A.C. Filament Transformer.



T.C.A. Filament Transformer.

The coils of this transformer are impregnated in a vacuum. It will be seen from the illustration that a cord and plug are provided for making connection to the lighting circuit, and binding posts supplying 2.5 volts, for -27 type tubes, 1.5 volts for -26 type tubes and 5 volts for a power tube. The 2.5 and 5 volts windings are center-tapped.

The dimensions of the transformer are, 6¼" x 3¾" x 5" and the weight is 10¾ lbs. It is capable of handling 75 to 80 milliamperes in the primary winding without saturation.

Harfield Universal Voltage Dividers

Hardwick-Field, Inc., of 215 Emmett Street, Newark, N. J., have placed on the market two Universal Voltage Dividers for "B" eliminators. The voltage divider designed for an eliminator delivering the required voltage to a receiver employing a 171 tube, is composed of two resistor units mounted on a single iron bracket. The Universal Voltage Divider designed for eliminators supplying voltage for a receiver employing a 210 amplifier, is composed of three resistance units mounted on a single iron bracket.

Both types of dividers consist of a fixed resistor for connection between the negative "B" and 90-volt positive "B" terminals, with a tap for the 45-volt supply and an adjustable resistor for connection between the 90-volt terminal and the "B" maximum terminal. The resistances are wound with a special resistance wire of practically zero temperature co-efficient. The wire is coated with a refractory material which expands and contracts to the same degree as the wire.

The Harfield Universal Voltage Dividers may be adjusted for a specified design of "B" eliminator so as to comply with the load requirements. These adjustments can be made either by preliminary calculations or by trial after assembly.

It is obvious that with the variable taps provided on both types of the Harfield Universal Divider that most any desirable values of "B" and "C" voltages can be secured by making the proper adjustments.

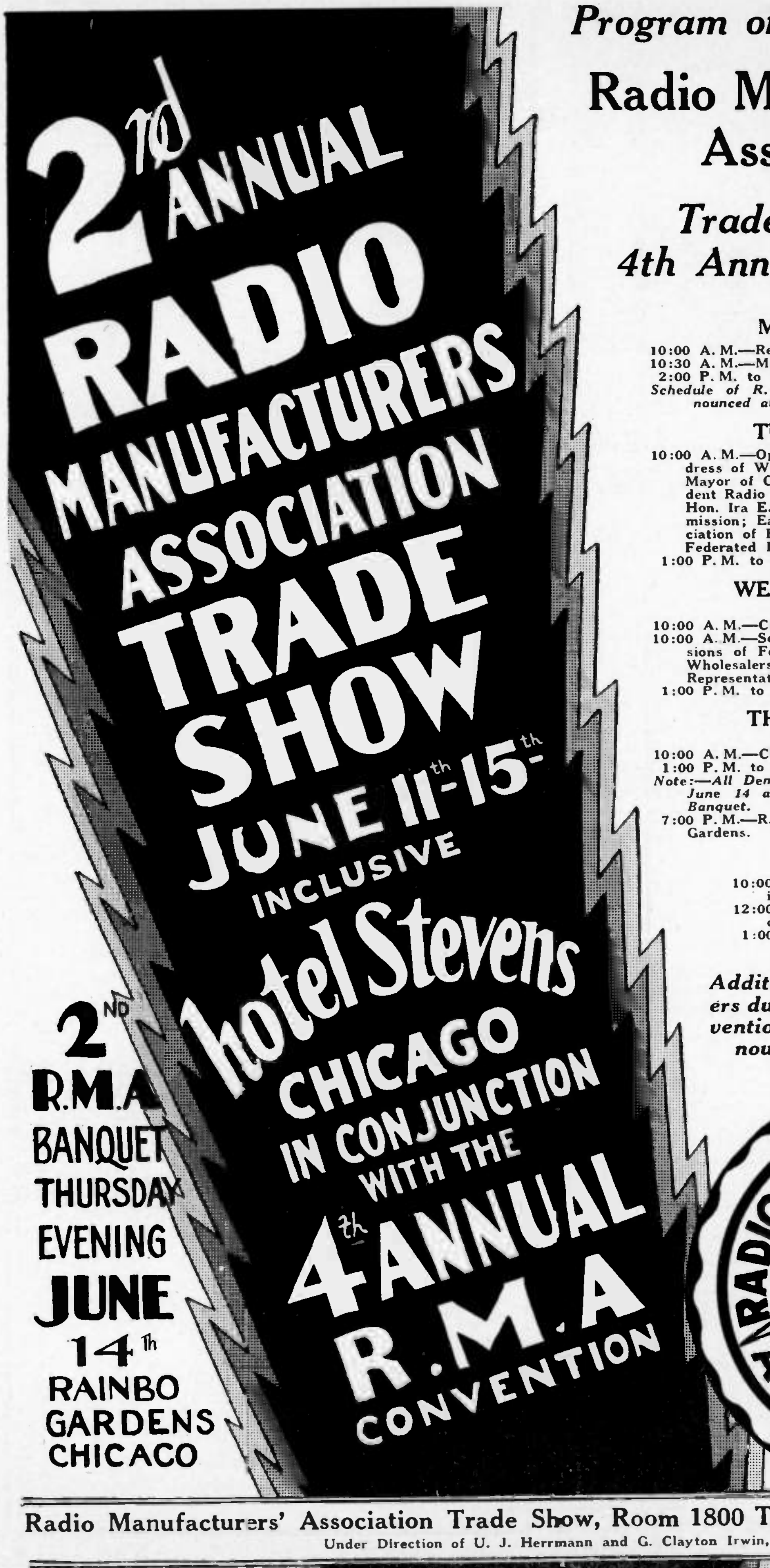
These dividers are designed for use only with voltage regulator tubes such as the Raytheon "R" or the UX-874.

Dubilier Interference Prevention Devices

Two simple and inexpensive devices for the prevention of inductive interference are now announced by the Dubilier Condenser Corporation, 437 Bronx Boulevard, New York City. The devices, each comprising a pair of condensers of ample capacity and working voltage for use across 110-volt of 220-volt lines, with a center tap for the ground connection, will be found entirely satisfactory for most cases of inductive interference. Where the trouble is of a serious nature, a more elaborate Dubilier interference device, which includes choke coils as well as condensers, will be required.

Dubilier Interference Device No. 1 has a pair of condensers of sufficient capacity for the usual minor causes of inductive interference, while Dubilier Interference Device No. 2 has condensers of a larger capacity for taking care of greater inductive interference. Either type may be employed on 110 or 220 volts. The devices are provided with two pigtail leads, for connecting with each side of the line, and a binding post for the center tap to ground. Mounting feet facilitate the permanent installation of the devices.

There are many ways in which these interference devices may be applied. Usually, the practice is to connect an interference device across the line, and to ground the center tap. This takes care of inductive interference coming through the electric line, sparking brushes of a motor, oil-burner spark transformer, electric refrigerators, arcing contacts, and so on.



Program of the 2nd Annual

Radio Manufacturers' Association

Trade Show and 4th Annual Convention

MONDAY, JUNE 11

10:00 A. M.—Registration.
10:30 A. M.—Meeting R. M. A. Board of Directors.
2:00 P. M. to 10:00 P. M.—Trade Show open.
Schedule of R. M. A. Committee Meetings will be announced at the Convention Monday, June 11.

TUESDAY, JUNE 12

10:00 A. M.—Open Meeting R. M. A. Convention. Address of Welcome by Hon. William Hale Thompson, Mayor of Chicago; Response by C. C. Colby, President Radio Manufacturers' Association; Addresses by Hon. Ira E. Robinson, Chairman Federal Radio Commission; Earl C. Anthony, President National Association of Broadcasters; Harold J. Wrape, President Federated Radio Trades Association.
1:00 P. M. to 10:00 P. M.—Trade Show open.

WEDNESDAY, JUNE 13

Chicago Trade Day

10:00 A. M.—Closed R. M. A. Membership Meeting.
10:00 A. M.—Sectional meetings of the following divisions of Federated Radio Trade Association—Radio Wholesalers, Radio Dealers and Radio Manufacturers' Representatives.
1:00 P. M. to 10:00 P. M.—Trade Show open.

THURSDAY, JUNE 14

Flag Day

10:00 A. M.—Closed R. M. A. Membership Meeting.
1:00 P. M. to 5:00 P. M.—Trade Show open.
Note:—All Demonstration Rooms will be closed Thurs-June 14 at 5:00 P. M. on account of R. M. A. Banquet.
7:00 P. M.—R. M. A. 4th Annual Banquet at Rainbo Gardens.

FRIDAY, JUNE 15

10:00 A. M.—R. M. A. Board of Directors Meeting.
12:00 A. M.—Joint Meeting Board of Directors of the R. M. A.—N. A. B.—F. R. T. A.
1:00 P. M. to 10:00 P. M.—Trade Show open.

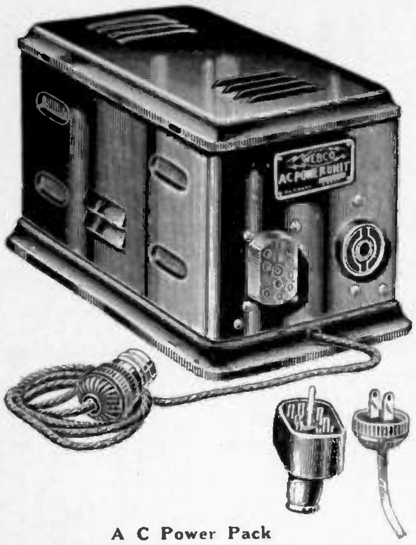
Additional speakers during the Convention will be announced later.

Radio Manufacturers' Association Trade Show, Room 1800 Times Bldg., New York City

Under Direction of U. J. Herrmann and G. Clayton Irwin, Jr.

POWER WEBSTER UNITS

BONE-DRY



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A Complete Line of A & B Power Units and Power Packs, also Amplifiers for Electric Phonograph Pick-ups. All Webster Products are made of the highest quality materials procurable, a line that should interest both manufacturers and jobbers in their efforts to supply their trade with quality merchandise. Write us your requirements.

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Webster A C Power Packs provide all A C and D C voltages as well as all grid biases for all receivers employing A C Tubes. They can be supplied with any filament winding combinations and are made in various types to suit manufacturers' requirements.

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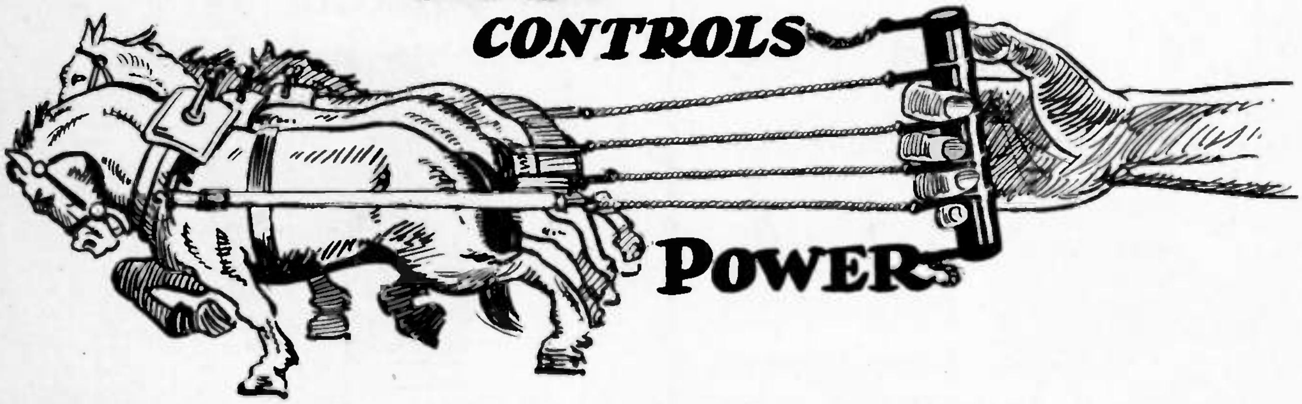

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We are prepared to furnish samples and quotations on resistors of any value, size and mechanical measurements

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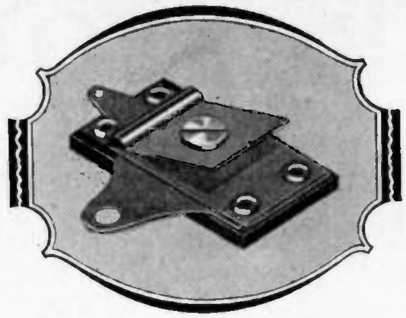

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The AmerTran Equalizer, with its three taps will almost exactly match the impedance of any pick-up with the primary of good audio transformers.

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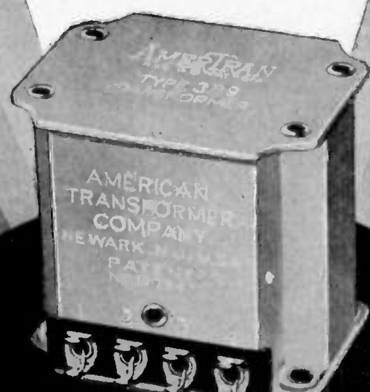

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Cover every radio requirement. Built to the highest standards. Tested to 1,000 volts throughout.

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MAGNET (Cotton or Silk).

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See Page 64

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Powerizer A—for filament supply and "C" bias 226, 227 and 171 tubes.

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Direct Tube Powerizer for UX-199 and UX-222 Shielded Grid Tubes designed where AC Tubes cannot be used.

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If you are thoroughly familiar with modern methods and equipment used in making electrical equipment for radio-receiving sets; if you are competent to analyze designs and determine the most modern manufacturing processes, tell us all about yourself in a letter. This is a rare opportunity to connect with a leader. Write in confidence. Box No. 200, c/o RADIO ENGINEERING, 52 Vanderbilt Ave., New York City.

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JOHN F. RIDER has completed a laboratory treatise on B-Eliminator Design and Construction. 65 pages just full of data and wiring diagrams you can understand.

Every phase of B-Eliminator design and construction is considered. After you peruse this treatise you will understand the function of the various units comprising the eliminator; how they work, how they are designed.

You will learn how to adapt an eliminator to operate with various receivers—how to calculate the resistance values for various output voltages. You will learn how to effect economy when constructing an eliminator—just what parts are necessary and how to use these parts most economically. . . . This treatise will answer any B-eliminator questions which might arise in your mind . . . . . AND the price is only $1.00.

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The treatise contains comprehensible wiring diagrams, the list of parts required and constructional details. This treatise describes equipment which will help you service more rapidly and economically. . . . Price 50 cents.

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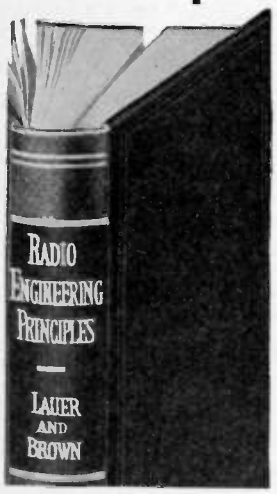

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, OF RADIO ENGINEERING.

Published monthly at Albany, N. Y., for April 1, 1928.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of RADIO ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24th, 1912, embodied in section 411, Postal Laws and Regulations, to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Radio Engineering Magazine, Inc., 52 Vanderbilt Avenue, New York; Editor, M. L. Muhleman, Bronxville, N. Y.; managing editor, M. L. Muhleman, Bronxville, N. Y.; Business Manager, B. S. Davis, Scarsdale, N. Y. 2. That the owners are: B. S. Davis, Scarsdale, N. Y.; Roy T. Atwood, Albany, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1% or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where a stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustees is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed) B. S. DAVIS, Business Manager.

Sworn to and subscribed before me this 1st day of April, 1928.
(Seal) J. A. WALKER, Notary Public.

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Kings Co., Registers No. 9100.
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Buyers Directory of Equipment and Apparatus

Readers interested in products not listed in these columns are invited to tell us of their wants, and we will inform the proper manufacturers. Address Readers' Information Bureau.

Addresses of companies listed below, can be found in their advertisements—see index on page 62.

ADAPTERS:
Carter Radio Co.

AMMETERS
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Electrad, Inc.

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BASES, VACUUM TUBE:
Formica Insulation Co.

BINDING POSTS:
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Eby, H. H., Co.
X-L Radio Labs.

BOOKS
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Ramsey, H. H.
Van Nostrand Co.
Wiley, John, Co.

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BRACKETS, ANGLE:
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BRASS:
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BUTTS:
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Crowe Nameplate Mfg. Co.

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CERIUM:
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CHARGERS:
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CHASSIS:
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HORNS, MOLDED:
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LACQUER:
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Shakeproof Lock Washer Co.

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Formica Insulation Co.
General Plastics Co.
Westinghouse Elec. & Mfg. Co.

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Scovill Mfg. Co.

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Strype, Fred C., Co.

PAPER, CONE SPEAKER:
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PHOTOELECTRIC CELLS:
(See Cells)

PLUGS:
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Saturn Mfg. Co.

POTENTIOMETERS:
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Carter Radio Co.
Central Radio Laboratories
DeJur Products Co.
Electrad, Inc.
United Scientific Laboratories

RECEIVERS, ELECTRIC:
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Carter Radio Co.
Central Radio Laboratories.
De Jud Products.
Electrad, Inc.
Hardwick, Field, Inc.
International Resistance Co.
Lautz Mfg. Co.
Ward Leonard Electric Co.

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American Mechanical Labs.
Carter Radio Co.
Central Radio Laboratories.
Electrad, Inc.
Hardwick, Field, Inc.
International Resistance Co.
Lautz Mfg. Co.
Ward Leonard Electric Co.

RHEOSTATS:
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Central Radio Laboratories.
De Jur Products.
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United Scientific Laboratories.
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Radio Institute of America

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TESTERS, TUBE:
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Transformer Co. of America.
United Radio Corp.
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General Radio Co.
Samson Electric Co.
Thordarson Electric Mfg. Co.
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Dongan Elec. Mfg. Co.
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TUBES, VACUUM:
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C. E. Mfg. Co.
Northern Mfg. Co.

UNITS, SPEAKER:
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Temple, Inc.
United Radio Corp.

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Westinghouse Elec. & Mfg. Co.

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