RADIO BROADCAST

VOLUME X

NOVEMBER, 1926, to APRIL, 1927

GARDEN CITY NEW YORK
DOUBLEDAY, PAGE & COMPANY
1927

INDEX

(*Illustrated Articles. Editorials in Italics)

AUTHORS

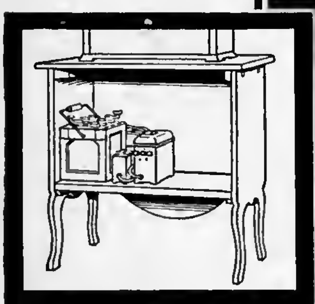
PORTRAITS

(*Portraits in "The March of Radio")

$29.00

Console with Cone Loudspeaker Ready for Your Set and Batteries

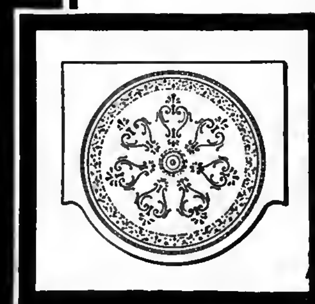
(West of the Rockies $35)



Rear view showing large compartment providing ample space for all batteries, battery charger or battery eliminator. These are entirely concealed from view. The back is open for ventilation of batteries.

MODEL 200 *with 22-inch Cone*

MODEL 200 *with 22-inch Cone*



The Cone Loudspeaker, with its Spruce sounding board, is quickly and easily removable, allowing instant access to all batteries, battery eliminator or other equipment and wiring.

A Revelation in *Radio Reproduction*

AT LAST—a cone loudspeaker that reproduces *all* the tones as they are broadcast. From the deep voiced tuba of an orchestra to the softest note of a vocal solo—*every* tone—*every* sound is reproduced in all its beauty, just as it entered the microphone.

* *

This 22-inch Windsor Cone Loudspeaker, with its *spruce* soundingboard, will reproduce the sofest crooning lullaby in a softly lighted room, or the full throated march music of a band in an auditorium—both with perfect fidelity of sound and tone.

* *

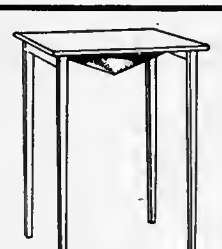
The Windsor Cone Loudspeaker Console is the greatest value in the world of radio. When compared with the average cost of cone-type loudspeakers of even smaller size, the cost of the complete Windsor—cone loudspeaker, spruce sounding board, and console—is amazingly low.

* *

As a piece of furniture, the Windsor Cone Loudspeaker Console is of such manifest high quality and attractive design as to be a welcome addition to any home. Finished in Mahogany or Walnut.

* *

The Windsor Cone and Horn Loudspeakers, combined with attractive pieces of furniture in many models, are being demonstrated by recognized dealers everywhere.



Model 600

With 16-inch Cone (*Pat. applied for*)

This 20 by 17-inch Cone Loudspeaker Table has suspended from the underside of the top a 16-inch Windsor Cone Loudspeaker. Placed in any part of a room, it fills the room with music just as an inverted electric lamp floods the room with light. Finished in Mahogany or Walnut. Price $19

(West of Rockies, $23.00)

Go to your dealer today and examine this astonishing new Cone Loudspeaker Console. If he happens not to have one, write to us and we will tell you the name of the nearest store at which you can see and hear one. ★

Note to Dealers Write or wire today for details of the highly profitable Windsor selling franchise

WINDSOR FURNITURE COMPANY

World's Largest Manufacturers and Originators of Loudspeaker Consoles

1412 Carroll Avenue Chicago, Illinois

Los Angeles Branch—917 Maple Avenue

WINDSOR FURNITURE COMPANY
Electrical Department
1412 Carroll Avenue, Chicago, Illinois

Send me FREE and without obligation circulars of the Windsor line of Cone and Horn Loudspeakers combined with pieces of furniture, and name of nearest dealer:

Name ....

Address ....

City .... *State* ....

Dealer's Name ....

RADIO BROADCAST

NOVEMBER, 1926

WILLIS K. WING, Editor

KEITH HENNEY, Director of the Laboratory — JOHN B. BRENNAN, Technical Editor

Vol. X, No. 1

CONTENTS

BEHIND EDITORIAL SCENES

THE October RADIO BROADCAST—the Metropolitan Shows number—was extremely well received at the New York and Boston radio shows and many were the sweet words of praise sung into our editorial ear. In point of content and quality, that issue is one of the most impressive of any radio magazine. And in the present number, there is a fine array of extremely interesting and valuable articles. Perhaps the one which will excite the widest interest is Mr. French Strother's, on the radio patent situation. No effort has been spared to make this series on the radio industry as accurate and correct as possible. More general uncertainty and lack of definite knowledge surrounds the radio patent question than perhaps any other branch of radio. The clarity of this article makes it extremely interesting and valuable.

SENATORE MARCONI sketches in his own words in the article beginning on page 28 how wireless and radio have altered since the day of his earliest experiments. Particularly interesting is what he has to say about the courage it required to recommend the superseding of all the elaborate and expensive long-wave equipment for the short-wave beam. . . . The long awaited constructional article on the R. B. "Lab" circuit begins on page 35 and we are confident that our readers will find here a remarkably complete constructional article on a remarkable receiver. That set we are not hailing as a positive miracle in radio design; that is not either wise or necessary. But the design and operation of th: outfit alike speak sufficiently for it. . . . A short-wave super-heterodyne has been the goal of many an amateur's designing efforts. On page 54, George J. Eltz, Jr. describes such an outfit which Major Armstrong said was to his mind about the ultimate in receiver design. The set on a small loop picked up Australian signals and while the world remains what it is, you can't go any farther than that. . . . James Millen has a helpful and complete article on how to modernize the Atwater Kent Model 20 which should interest radio service men and the many owners of that Model.

RADIO BROADCAST for December will feature the third of French Strother's radio industry articles which attempts to indicate whither radio is drifting. Also the first of a series of constructional articles will start, describing a new and completely revised model of that very popular receiver, the RADIO BROADCAST Universal. Many of the old parts can be used in this improved model. Glenn H. Browning, the co-producer of the Browning-Drake circuit, has written a highly interesting article telling something about the various Browning-Drake circuits which have been presented to the set constructing public. He hopes to give the many who are confused as to what model to build, something to guide them, for it must be admitted that some of the claims we have seen for various models of the circuit are a bit confusing. It is going to be a good December number.

—WILLIS K. WING.

Doubleday, Page & Co.
MAGAZINES
COUNTRY LIFE
WORLD'S WORK
GARDEN & HOME BUILDER
RADIO BROADCAST
SHORT STORIES
EDUCATIONAL REVIEW
LE PETIT JOURNAL
EL ECO
THE FRONTIER
WEST

Doubleday, Page & Co.
BOOK SHOPS
(Books of all Publishers)
NEW YORK: LORD & TAYLOR BOOK SHOP; PENNSYLVANIA TERMINAL (2 Shops); 38 WALL ST. AND 166 WEST 32ND ST.; GRAND CENTRAL TERMINAL
ST. LOUIS: 223 NORTH 8TH STREET; 4914 MARYLAND AVENUE
KANSAS CITY: 920 GRAND AVENUE; 206 WEST 47TH STREET
CLEVELAND: HIGBEE CO.
SPRINGFIELD, MASS.: MEEKINS, PACKARD & WHEAT

Doubleday, Page & Co.
OFFICES
GARDEN CITY, N. Y.
NEW YORK: 285 MADISON AVENUE
BOSTON: PARK SQUARE BUILDING
CHICAGO: PEOPLES GAS BUILDING
SANTA BARBARA, CAL.
LONDON: WM. HEINEMANN, LTD.
TORONTO: OXFORD UNIVERSITY PRESS

Doubleday, Page & Co.
OFFICERS
F. N. DOUBLEDAY, *President*
A. W. PAGE, *Vice-President*
NELSON DOUBLEDAY, *Vice-President*
RUSSELL DOUBLEDAY, *Secretary*
S. A. EVERITT, *Treasurer*
JOHN J. HESSIAN, *Asst. Treasurer*

DOUBLEDAY, PAGE & COMPANY, Garden City, New York

TERMS: $4.00 a year; single copies 35 cents.

RADIO BROADCAST

VOLUME X — NUMBER 1

NOVEMBER, 1926

The Radio Patent Structure and What It Means

There Are Twenty-four Hundred Radio Patents on Every Conceivable Subject—Who Owns the Basic Patents and What They Are—Radio Patents Give Non-Technical Jurists Difficulty—Does Control of Basic Patents Mean Monopoly?—The Second of a Series of Articles on the Industry

By FRENCH STROTHER

THE patent situation in radio is almost unbelievably complicated. There are twenty-four hundred American patents in force in this field, and unnumbered applications are still pending in the Patent Office. Everything that the most ingenious inventors have been able to think of to date has been covered; and every new idea, however unimportant it may seem at the moment, is at once made the basis of a new patent application, in the hope that some shift in the current of the radio art will make it more important tomorrow.

Not only are basic elements in radio patented, but the various ways in which these basic elements may be combined are also patented. Physical objects, such as tubes, are patented; methods of using physical objects, such as the various "circuits," are patented; the methods of making the physical objects, such as the ways of exhausting the air in a tube, are patented. Thus, materials, methods, ideas, combinations of ideas, combinations of methods—all are involved in a maze of conflicting patents, owned by different (often antagonistic) inventors and their licensees or vendees or heirs. On top of this complex condition rests a mountain of patent litigation—hundreds of lawsuits, by almost everybody against almost everybody else.

Nobody in the radio field today can do anything and be sure that he is not violating somebody else's legal rights. Painstaking investigation is absolutely essential. Not even the Radio Corporation of America can be sure, though it is credited with owning anywhere from 50 per cent. to 90 per cent. of the useful radio patents. A patent does not protect against another patent, which the courts may later decide really covers a certain way of doing a certain thing. No patent is of any certain value until the courts have passed upon it. The Patent Office is a bureau of technically and legally trained men who search the records of the past and certify that, in their opinion, the new device offers either a new method or a new principle. The moment the owner of such a certificate, or patent, tries to make money by operating under it, he comes into the field of the rights of property, in other patents and no property right is finally settled, against an opposing claimant, until the courts have decided which claimant owns it.

The future of radio, therefore, so far as patents affect it, is in the hands of the courts.

Now nothing that is about to be said about the courts is intended as criticism. Nobody questions for a moment the fact that the hard-working Federal judges have any thought but justice in their minds. Nevertheless, Federal judges are human beings, fallible even in their special field of law; and they are not to be blamed if they are even more likely to err in the field of complicated electrical theory that embraces radio. Thus it has more than once happened that these courts have finally awarded property rights in patents beyond appeal, when the general body of technical electrical experts did not believe these rights belonged to the successful litigant.

There is, therefore, a double uncertainty in the validity of many valuable radio patents. There is first the uncertainty whether one way of doing a thing really involves a difference in electrical theory, from another way of doing the same thing. And there is the second uncertainty whether the Federal Courts will correctly measure the truth in these cases, where even the electrical experts are still in doubt. A judge, sufficiently versed in the technique of radio to make an unquestionably fair decision would have to be twenty years a radio engineer and would therefore be biased anyhow.

In either event, however, it should be borne in mind that what the courts say will settle the matter practically. As in

TO ATTEMPT to untangle the complexities of the radio patent structure is a task almost impossible of successful accomplishment. Yet, to understand the development and the present situation in radio—particularly in the manufacture of broadcast receiving apparatus—one must have a pretty clear comprehension of who owns the important patents, how they are being used, and how that use is apt to affect the buying and selling of radio apparatus. This second article by Mr. Strother—the first appeared in RADIO BROADCAST *for October—contains no information not available to one who makes a careful study of facts open to all; it does, however, recite those facts simply and clearly. In addition, the conclusions which the author draws show whither radio is drifting. The third and concluding article of the series will appear in the December* RADIO BROADCAST.

—THE EDITOR.

the famous anecdote, "You may doubt, if you will, whether the church can damn you; but if the judge says hang, you hang." You may doubt, if you will, whether the Langmuir patent on extra-high vacuum in a tube is a true invention at all; but if the United States Circuit Court of Appeals ultimately says that it is, you will thereafter make or sell such a tube at your peril of jail for contempt of court.

ALMOST EVERY PATENT HAS ITS DAY IN COURT

THAT example is only one of the hundreds of possibilities involved in the scores of important patent cases now pending in the Federal courts. Nearly every known method of accomplishing radio reception is patented by at least two rival claimants for the exclusive use of that method; and really every article of apparatus is similarly involved in an undecided lawsuit. Most people suppose that the Armstrong regenerative principle is the most strongly intrenched invention in radio, yet De Forest has recently attacked it head-on in the Federal Courts. De Forest was once almost universally believed to have blanketed the tube situation with his patent of the three-element tube, yet to-day De Forest is in legal dfficulties in the manufacture or sale of tubes. A dozen manufacturers are making neutrodyne sets under the Hazeltine patents, yet Hazeltine is being sued by the Armstrong licensees on the theory that his neutrodyne circuit involves regeneration, while, from exactly the opposite direction, he was sued by the Radio Corporation on the theory that his neutrodyne circuit did not involve regeneration and therefore infringes Rice and Hartley's neutralizing methods. This situation is brought about by the technical complexities in the construction and use of the radio-frequency amplifier.

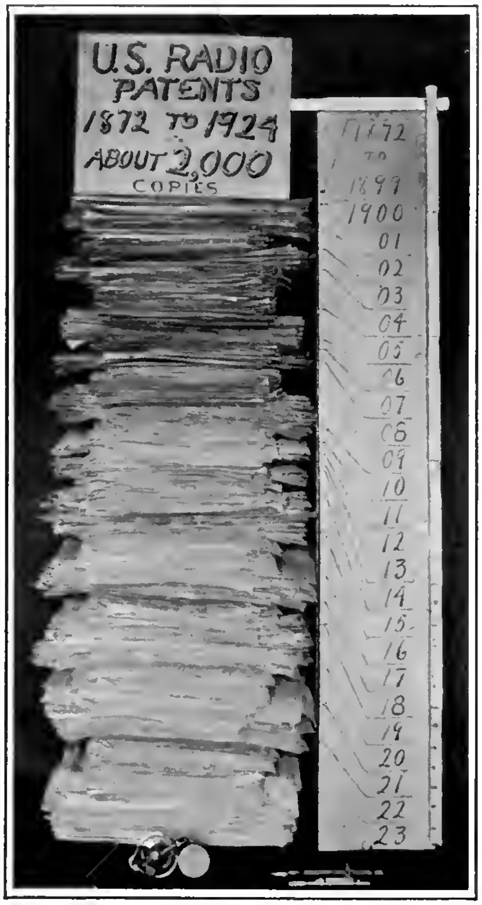
The most complicated patent situation of all surrounds the vacuum tube. There are 256 unexpired patents in this field alone covering everything from the relation of the grid to the plate, on to such details as the use of thorium in the making of a tungsten filament, and the various methods of exhausting the air and gases from the bulb.

It would be hopeless to attempt to review all the important radio patents and their tangles in an article like this. The most condensed available statement of them occupies forty-two closely printed pages of the 1923 report of the Federal Trade Commission on the "Radio Industry"—and that statement gives only one side of the story and nowhere near all the details.

A SUMMARY OF THE "KEY" RADIO PATENTS

FOR present purposes, we shall have to be content with a summary view of half a dozen patents that now seem to be "key" patents, controlling various types of receiving sets.

The tube is "the heart of the set," and perhaps the biggest battles of the hour are raging around the tube. Dr. Irving Langmuir, of the General Electric Company, filed an application in the Patent Office thirteen years ago, to cover his claim that he invented the idea of using an exceptionally high vacuum to increase the efficiency and lengthen the life of the tube. H. D. Arnold, of the Western Electric Company, made a similar improvement, and these two conflicting applications have been involved in what the Patent Office calls "interferences" ever since. Independent observers insist that the idea and the practice of high vacuum tubes are as old as the tube itself, and the Western Electric Company claims that it is not an "invention" at all—but,



Photograph by R. H. Marriott

U. S. RADIO PATENTS

This stack of patents includes those which have been issued between the years of 1871 and 1924, more than two thousand in all. The picture shows, at the foot of the patents, one of DeForest's first "audions" beside a silver dollar piece. The "audion" has been the cause of some of the costly litigation in radio history. With so many patents, covering every branch of the subject, it is no wonder that decisions concerning patent rights are only arrived at after prolonged legal fray. The stack of patents illustrated is about two feet eight inches high

as noted above, the Circuit Court of Appeals will settle the question some day, and its decision will be law. It could easily put all but one tube manufacturer out of business.

Another tube patent of vital importance is the Coolidge patent, claiming to cover the thoriated tungsten filament. Ordinary tungsten filament soon crystallizes under incandescent heat, and breaks. The addition of thorium considerably lengthens the life and increases the efficiency of the filament. The Coolidge patent covers a practical method of drawing thoriated tungsten wire, and claims to cover the use of such wire. The General Electric Company, owner of the Coolidge patent, has a test case against De Forest pending in the District Federal Court in Delaware. Here, again, a court decision can put all but one manufacturer out of business.

Passing from the tube to the circuit, we come first upon Armstrong's patent covering regeneration. The courts have decided that this invention dominates the vacuum tube oscillator and the regenerative circuit. Armstrong licensed twenty concerns under this patent before selling it to the Westinghouse Electric Company. This patent is about the most securely adjudicated in the whole radio field, but, as remarked above, De Forest has recently attacked it.

The various forms of grid leaks are covered by patents issued to De Forest, and Langmuir. The last named is broad enough, if sustained by the courts, to control this feature absolutely. It is owned by the General Electric Company.

THE IMPORTANT NEUTRALIZATION PATENTS

NEUTRALIZED circuits are covered by patents issued to Hazeltine, Rice, and Hartley. Fourteen licensees are manufacturing sets under the Hazeltine patent. Rice is a General Electric inventor and Hartley an American Telephone & Telegraph (closely associated with the Western Electric Company) inventor. A battle royal is waging here between Hazeltine, independent, and the Radio Corporation as licensee under all General Electric and Western Electric radio patents. The Radio Corporation sought to affirm the Rice and Hartley patents in a suit against the Twentieth Century Company in the Federal Court for the Eastern District of New York; while Hazeltine sought to affirm his patents in a suit against the Electrical Service Engineering Corporation in the Federal Court for the Southern District of New York. The first action by R. C. A. against the Twentieth Century Company was decided in favor of Hazletine. The action by Hazletine and his licensees against the Electric Service Engineering Corporation was also won by Hazletine. Doubtless these cases will ultimately go to the Federal Circuit Court of Appeals.

The Hazeltine patents are also involved in a suit against A. H. Grebe & Company. Here, again, it is possible that the final court decision could rule out of the field all but one patentee.

There are two or three other patents of great present importance, but enough has been said above for our immediate purpose. First, it should be observed that the critical patents today are not the critical patents of a few years ago. With the rapid advance of the art, the control of a basic idea does not rest in the basic patent, but rests in the patent upon some more recent refinement of the basic idea, or upon some new method of manufacturing the device, as in the case of the tube. It thus becomes legally impossible for De Forest to manufacture his own tube unless he has access to the Coolidge method of making the filament. Or it becomes impossible for Armstrong to make a satisfactory regenerative set unless he has access to devices patented by others for controlling the oscillations set up by his system.

The second point to be observed is that, in this process of refinement, the advantage is all on the side of the big corporation as against the small independent company or as against the individual inventor. The reader may here need to be reminded of the systematic method by which invention is stimulated by the large manufacturing corporations whose business depends upon patents. The American Telephone & Telegraph Company, for example, spent nine million dollars last year upon scientific and technical research. The General Electric Company spends several millions yearly. These and similar companies hire inventors almost as they hire book-keepers, and pay them regular salaries. These men are employed to solve definite technical problems as they arise in the course of the company's business. Their work is watched and tabulated with more method and thoroughness than any casual inventor working by himself would be apt to use. Moreover, anything that was patentable would be attended to by the company's patent department, where patent lawyers constantly study the work of the research departments. It may be only a new way of sealing the glass of a vacuum tube into its socket, or something even less related to radio than that; but this patented refinement may eventually become the commercially decisive thing about radio, either because it may reduce the cost of production vitally or it may produce an article that especially appeals to the public taste.

LITTLE HOPE FOR THE SMALL INVENTOR

IT WILL be deduced, from the foregoing, that the small inventor is scarcely apt to have a controlling power in the present radio situation. His invention is valuable only as it fits in with one, or perhaps a whole chain, of other inventions controlled by big corporations. He can hardly hope to become an independent manufacturer of anything beyond subsidiary appliances. His market is the corporations already holding numerous other patents. The only exception to this general statement would be the inventor who should devise some method of reception so different in principle from anything now known that he would at once take rank with Hertz plus Marconi or De Forest. Such an invention would revolutionize radio. Also, it should be added, it is extremely unlikely to appear.

Equally to be deduced from what has been said about patent structures, is the fact that even the large independent radio manufacturing companies are at a distinct disadvantage as against the Radio Corporation. Few of the independents have research staffs at all, and none has a staff comparable in size or facilities with those of the main constituent members of the Radio Corporation group, namely, General Electric, American Telephone & Telegraph, Westinghouse, and Wireless Specialty Apparatus Company. As the development of the radio art is now chiefly in the refinement of design and of manufacture of devices already patented, the race for control is a race to invent and patent these refinements. This statement would hold, even if Hazeltine were held by the courts not to infringe Rice and Hartley, for example, or even if De Forest were held not to infringe Armstrong.

Highlights from this Article

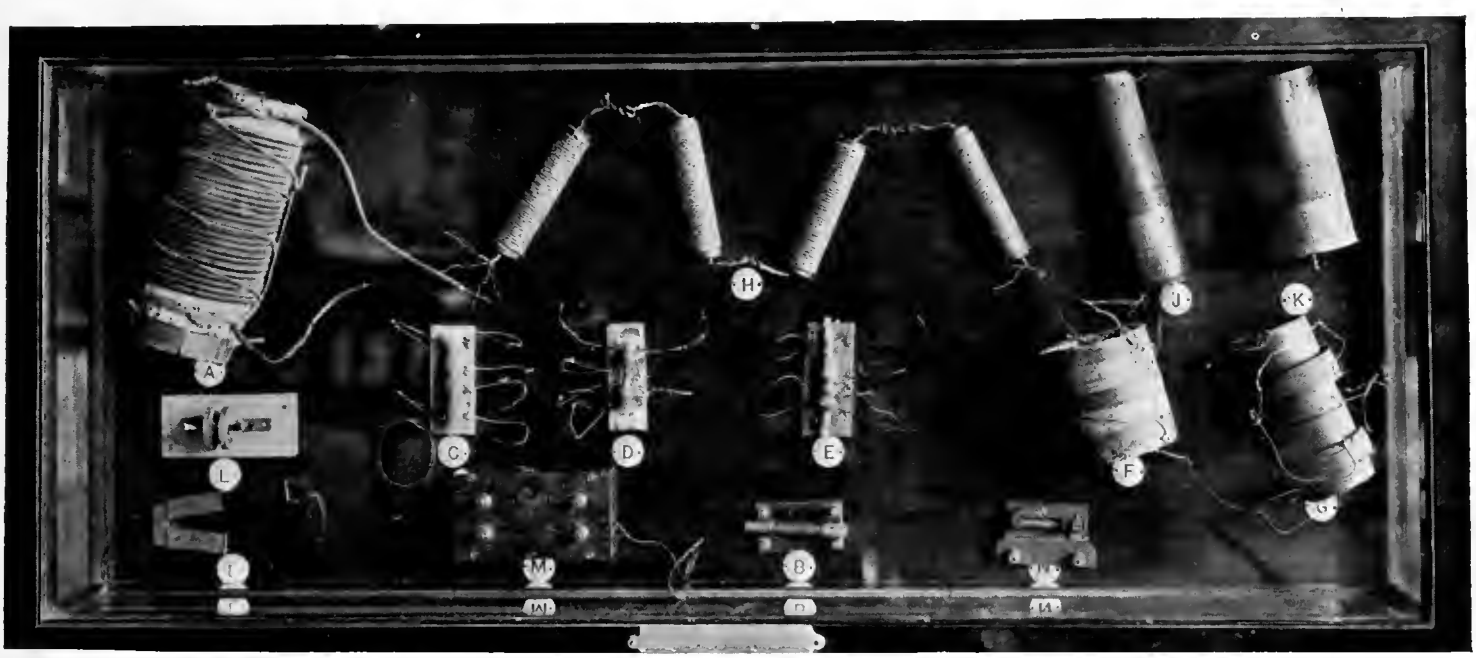
"THE future of radio, so far as patents affect it, is in the hands of the courts."

"The most complicated patent situation of all surrounds the vacuum tube. There are 256 unexpired patents in this field alone, covering everything from the relation of the grid to the plate, on to such details as the use of thorium in the making of a tungsten filament, and the various methods of exhausting the air and gases from the bulb."

"The critical radio patents of to-day are not the critical patents of a few years ago. With the rapid advance of the art, the control of a basic idea does not rest in the basic patent, but rests in the patent upon some more recent refinement of the basic idea, or upon some new method of manufacturing the device, as in the case of the tube."

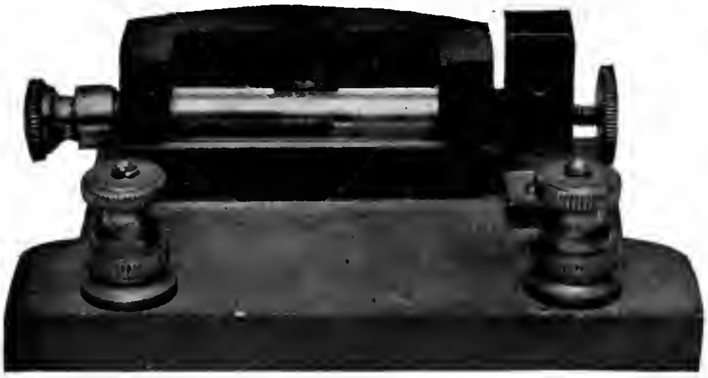
"In the process of refinement, the advantage is all on the side of the big corporation as against the small independent company or as against the individual inventor."

"If patents are the decisive element in the radio situation, the logic of events points to an eventual leadership of the field by the Radio Corporation, with only a possible one or two much smaller groups operating independently under fewer patents. Whether patents are necessarily the decisive element is another question, too broad for discussion here. It will be treated in the next article of this series."



HERE IS SOME OF THE APPARATUS MARCONI PATENTED IN ENGLAND

The various parts in this show case are lettered and identified as follows: (A) Transmitting Jigger, 1900. (B, C, D, E, F, G,) Receiving Jiggers of the years 1898, 1899, 1899, 1899, 1900, 1901, various forms. (H) Antenna Tuning Inductance, 1900. (I, J) Aerial Tuning Condensers, 1898. (K) Magnetic Detector, moving magnet, 1902. (L) Magnetic Detector, moving core, 1902. (M) Mercury Iron Detector used for transatlantic reception in Newfoundland, 1901



A MARCONI MERCURY AND IRON DETECTOR

Unless, again, that revolutionary new principle of radio reception is discovered. But such a discovery has never been made in any other developing art, so far as the writer can recall. All kinds of steam engines have been devised since Watt first put steam to work, but they all operate on the principle of the expansion of steam. Numerous kinds of internal combustion engines have been devised, but the principle of the expansion of gases is still the key. An art tends to build up from the foundation of the first discovery, and radio has followed the historical precedent of other inventions. It probably will continue to do so.

Finally, it will be observed that the so-called basic patents in radio soon cease to be the controlling factor in the patent structure. Fleming and De Forest are both still living, and their work in tubes made possible everything we mean by the word "radio." The basic De Forest and Fleming patents have expired and yet neither can unrestrictedly manufacture a tube commercially to-day. Two hundred and more patents upon mere details of design and manufacture have taken all commercial value out of their fundamental ideas.

This sapping effect of the smaller patents is at once an aid and an obstacle to monopoly. It tends to monopoly because it gives the advantage to the big corporation with a scientific and legal staff. It tends, on the other hand, to prolong the battle in the Patent Office and the battle in the courts, which must be fought to a finish before property rights are finally established. If smaller companies can set up enough interferences in the Patent Office, they can frequently delay the issue of an opposing patent for a long time; and if the contestants are equally matched, as the General Electric Company and the Western Electric Company, in the Langmuir-Arnold "high vacuum" question, the struggle may be prolonged for half a generation. The battle in the courts is likely to be shorter, though two years is about the minimum for a decision in a district court, and five years is not unusual for the whole course of a case carried on through appeal.

Even at the risk of covering familiar ground, it may be well to locate briefly the control of those patents that at the moment seem to be the most important. The General Electric Company owns the patents by Coolidge and Langmuir on tubes, by Langmuir on the grid leak, and by Rice on neutralization. The American Telephone & Telegraph Company (including Western Electric) owns the patents by Arnold on tubes, Hartley on neutralization, and Lowenstein on the C battery. The Westinghouse Electric & Manufacturing Company owns the patents by Armstrong on regeneration and by Fessenden on the heterodyne principle. The Hammond patents on inventions involved in super-heterodyne sets are licensed exclusively to the R. C. A. and the A. T. & T. Company, but Hammond reserved certain rights in military and naval fields as well as the right to license the United States Government.

The Radio Corporation has exclusive licenses under the Telephone Company, Westinghouse, and General Electric patents to sell and use apparatus in certain fields of use, among which is broadcast reception. The apparatus sold by the R. C. A. is made by Westinghouse and General Electric and some by the Wireless Specialty Apparatus Company.

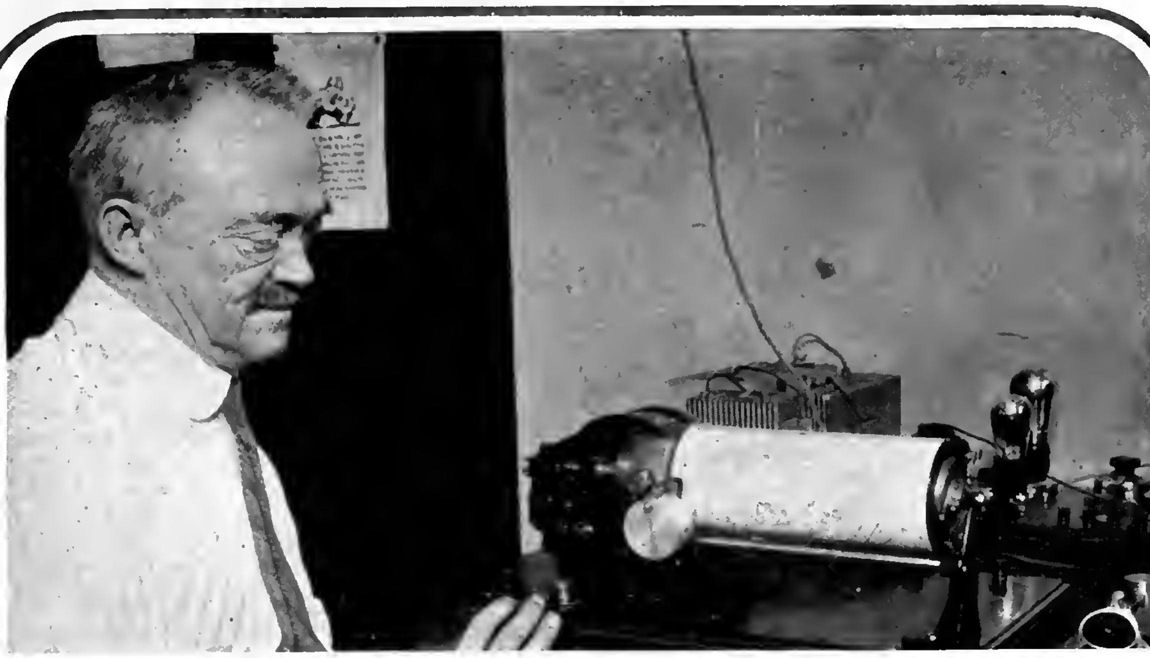
Of essential radio patents at the moment, only two are held outside the Radio Corporation. These are Hazeltine's patents on neutralization and Latour's on the common B battery also held in this country by Hazeltine. The R. C. A., however, holds a non-exclusive license under the Latour patents. Perhaps a third might be reckoned in the Schloemilch and Van Bronck (German) patent on the reflex circuit, seized by the Government as alien property during the war and now free to the general public.

From all that has been said above, it seems reasonable to conclude that within five years all the essential patents in radio will have been adjudicated in the courts. Under the law of averages, probably five out of six of them will be vested by court order in the Radio Corporation. And as time goes on, the probabilities are that the unrivalled research facilities of the Radio Corporation's constituent companies will place that group in an unapproachable position so far as technical, patented refinements of the essential devices are concerned.

If, then, patents are the decisive element in the radio situation, the logic of events points to an eventual leadership of the field by the Radio Corporation, with only a possible one or two much smaller groups operating independently under fewer patents. Whether patents are necessarily the decisive element is another question, too broad for discussion here. It will be treated in the next, and concluding article of this series.

AN EARLY EXPERIMENTAL TUNED CIRCUIT

Much of the commonly used apparatus of to-day depends in operation on the principles discovered by scientists of many years ago who worked with such crude apparatus as that depicted above. In fact, some people are inclined to believe that many of the comparatively recently granted patents were really covered in all of their essentials by the patents of earlier inventors whose ideas have been somewhat duplicated



THE MARCH OF RADIO

News and Interpretation of Current Radio Events

Critical Hours for the Broadcasting Industry

BROADCASTING now enters the most critical season of its brief history. It has muddled through many a minor crisis successfully in the past and, undoubtedly, it will be rescued from its present predicament, the outcome of legislative neglect of the last Congress, without any serious mishap.

During the summer, the reception of programs from local stations has not been seriously affected by the offences of wavelength excursionists. The coming of the fall season marks a new phase of the situation. If long distance reception is a factor of any importance in the popularity of radio, the industry is faced by a problem of fairly serious proportions.

At our listening post in one of the ideal receiving locations of the East, we have been able to gain some preview of the kind of receiving conditions which we will face during the early fall season. We have been accustomed for some time to heterodyning of carrier waves at the high frequency end of the broadcast band, but it was of no particular importance so long as the other two thirds of the band was practically free from that disturbance.

As a result of the procession of self-seeking broadcasters from their proper place in the insignificant end of the band to the heretofore orderly low frequency end, heterodyning has now been distributed over the entire wavelength scale. Although still impeded by summer atmospherics and weak signals from stations more than one thousand miles distant, we found, in a single evening, no less than nineteen points on the dial where heterodyning exists, between 1500 and 500 kilocycles. We may expect a substantial increase of this number as receiving conditions improve. Wavelength jumpers have used some care to avoid interfering with nearby stations, but they have not, in most instances, been able to avoid heterodyning or blanketing distant stations. Fortunately, the enjoyment of local programs is practically unaffected. On the other hand, many favorite long distance stations in all parts of the country are obscured by annoying whistles.

The radio industry at this season of the year makes its annual bid for public favor. Its engineers have, this year, brought forward products of a quality, from the standpoint of selectivity, tone quality, and simplicity of control, representing great forward strides. These constructive developments are deserving of liberal public support. But, for an industry which boasts of its powers of capable self-government, it has played a lamentably weak hand in dealing with the obstreperous broadcaster. We observe, for instance, a statement issued by the Radio Manufacturers' Association, ridiculing, on the grounds that all is well with radio, a most constructive editorial in *Collier's Weekly*, urging sensible federal legislation and a "Judge Landis" to rule over broadcasting. The R. M. A.'s comment, in its bulletin, is headed "No Cause for Alarm over Broadcasting" and its argument is based upon the philosophy of the proverbial ostrich.

With such an attitude, we cannot hope for much constructive assistance from the quarter which should be most aggressive in remedying the situation. At a meeting in New York on September 15, a "Radio Coördinating Committee" was formed with power to enforce the provisions of a resolution to self-regulate broadcasting until legislation shall be passed. The group represented The National Association of Broadcasters, The American Radio Relay League, The R. M. A., The Federated Radio Trade Association, The

---

The photograph forming the heading this month shows C. Francis Jenkins who has developed a method of transmitting weather maps to ships at sea, at his transmitter. Signals are being sent on a wave of 8250 meters from NAA to several naval ships as an experiment

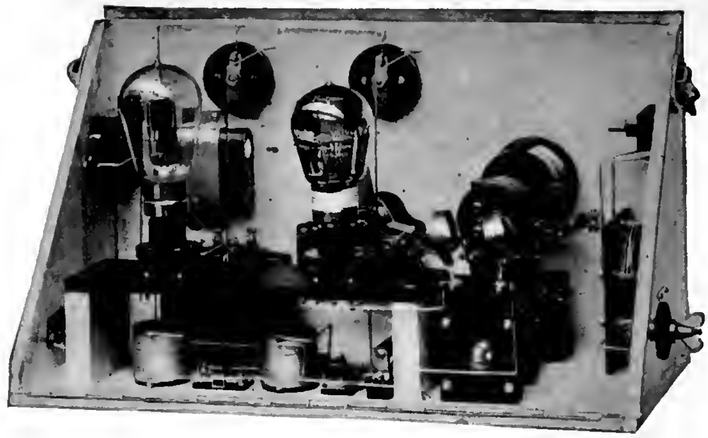
American Newspaper Publishers Association, and The National Electrical Manufacturers Association. It is not certain that this impressive group actually will do anything constructive.

High quality local reception is still the paramount factor in broadcasting and this is not seriously threatened by the present situation. But we would lament, with a large percentage of radio's most enthusiastic and valued following, the permanent impairment of long distance reception by continued operation of an excessive number of broadcasting stations.

We have, in these columns, outlined, at some length, the salient features which we believe forthcoming legislation should embody. Included in those recommendations was a suggestion that length of continued service of a station on its assigned frequency should be a paramount consideration in the granting of a license under the new law. This sound principle should be established because it would automatically exclude from the broadcast tangle all those stations which took it upon themselves to select their own channels without regard to the good of broadcasting as a whole. These stations, by abandoning their assigned frequencies when the Department of Commerce's regulatory power was disrupted, also surrendered all priority rights to their original frequencies. More conservative and considerate broadcasters decided to hold to their regular frequencies, however undesirable, rather than confuse the situation. Their commendable policy deserves reward at the expense of more selfish broadcasters. Newly licensed stations do not present a serious problem because they have no priority rights to the frequencies which they have adopted.

No official information is available as to the changes in frequency which have been made during the last two months. From the best sources which we could consult, we have compiled a list of such changes. It is as accurate and complete as we can make it, but here and there, we have found stations which have not carried out announced shifts in frequency. Others have tried shifting for an evening or two, seen the light of reason and had the good sense to return to their proper channels. Perhaps one or two such stations are included in the list which follows:

CALL LETTERS	CITY	ASSIGNED FREQUENCY		ADOPTED WAVE-LENGTH
		METERS	KILO-CYCLES	METERS
WBBR	Rossville, N. Y.	272.6	1100	416.4
WHAP	New York, N. Y.	239.9	1250	431.0
WBNY	New York, N. Y.	212.6	1410	302.8
WMSG	New York, N. Y.	212.6	1410	302.8
WODA	Paterson, N. J.	223.7	1340	390.9
WJAR	Providence, R. I.	303.9	980	485.0
WEAN	Providence, R. I.	270.1	1110	367.0
WTAG	Worcester, Mass.	280.2	1070	430.1
WKBE	Webster, Mass.	230.6	1300	270.1
WIBX	Utica, N. Y.	205.4	1460	234.2
WKBB	Joliet, Ill.	214.2	1400	282.8
WCMA	Culver, Md.	222.1	1350	258.5
WCRW	Chicago, Ill.	239.9	1250	416.4
WSBC	Chicago, Ill.	209.7	1430	288.3



AN ENGLISH SHORT-WAVE RECEIVER

This outfit is made by Marconi's Wireless Telegraph Company, Ltd., London and is designed to receive continuous wave signals from 19,990 to 2998 kc. (15 to 100 meters). Note the openness of construction, a feature of short-wave outfits everywhere

CALL LETTERS	CITY	ASSIGNED FREQUENCY		ADOPTED WAVE-LENGTH
		METERS	KILO-CYCLES	METERS
WAMD	Minneapolis, Minn.	243.8	1230	296.9
WEW	St. Louis, Mo.	247.8	1210	360.0
WQAM	Miami, Fla.	263.0	1140	285.5
KTNT	Muscatine, Ia.	256.3	1170	333.1
KFNF	Shenandoah, Ia.	263.0	1140	461.3
KFDY	Brookins, So. Dak.	272.6	1100	303.9
KFDD	Boise, Idaho.	277.6	1080	275.1
KFBU	Laramie, Wyo.	277.1	1110	374.8
KGY	Lacey, Wash.	245.8	1120	277.6
KOWW	Walla Walla, Wash.	256.3	1170	285.0
KQW	San Jose, Calif.	230.6	1300	333.1

A particularly annoying offense which a number of stations have committed is to adopt frequencies midway between two of the existing ten-kilocycle channels so that they effectively interfere with two or more stations rather than just one.

There has been some noise made about a listeners' boycott of the stations which have jumped their wavelengths. Since so many stations already broadcast without audiences and, seemingly, don't know the difference, this is obviously an ineffective weapon. Broadcast listeners will continue to tune their receiving sets to stations transmitting the programs suited to their individual tastes.

Changes in the Regulation of British Broadcasting

THE British Broadcasting Company will, next year, be replaced by the British Government Broadcasting Commission. Suggestions have been made for a system of inter-Empire broadcasting with the Daventry station in England as its starting point. The first relay station is projected for Moncton, New Brunswick, a distance of 2440 miles. From this point, the programs will be distributed via land lines to Canadian broadcasting stations throughout the Dominion. From Vancouver, a distance of 2300 miles of wire line, the programs would again take the ether route to Australia, a distance of 5000 miles. This offers the greatest distance barrier but, by the use of high power and high frequencies, it is feasible, at least during favorable seasons.

An alternative route would be through a relay station at the Fanning Islands, 3885 miles from Vancouver and 3710 miles from Sidney, Australia. Sidney would be the distributing center for the Australian continent. At Perth, a radio link would be established with New Zealand and Ceylon and, from the latter point, to Cape Town and India. The jump from Cape Town to Malta would complete the system, involving a total of eight radio relays.

Stupendous as the plan is in its conception, its estimated cost is only three million dollars. Owing to time differences, it would be of practical value only on special occasions of tremendous importance, once the novelty of inter-Empire programs had worn off. As a feat of radio technique, it would be a wonderful demonstration of radio's possibilities. As for its sociological and political aspects, in uniting the Empire, the plan represents an entirely new development in the application of radio communication.

Can a Law Prevent News From Being Heard by Radio?

AT THE Press Association Conference, recently held at Geneva, under the auspices of the League of Nations, a resolution was adopted, asking the League to induce governments to regulate radio receiving stations. Special emphasis was placed upon the importance of forbidding the listening public to pick up telegrams or messages of press or economic service, directed to paid subscribers and providing further that, if such communications are received by mistake, they must not be reproduced in writing, communicated to a third person nor used for commercial purposes. The use for commercial purposes of news issued by broadcasting stations is to be prohibited.

In other words, broadcast listeners are asked not to listen to news intended for subscribers to news services and, should they violate this request, they are asked not to communicate such news to others or use it in any way—a rather absurd proposition at best. It is perfectly feasible to send private dispatches in code or by secrecy systems which require special knowledge and equipment for interpretation. The use of intercepted private news dispatches can readily be made illegal, but listening to them cannot be stopped by merely writing a law to that effect.

General J. G. Harbord, President of the Radio Corporation of America, called the attention of the conference to the efforts of his company to lower the press rates between Japan and the United States from twenty-seven to ten cents a word. The Japanese Government has refused to sanction this proposal which would do much to foster better relations between the two countries.

Unfortunate Radio Publicity in the Press

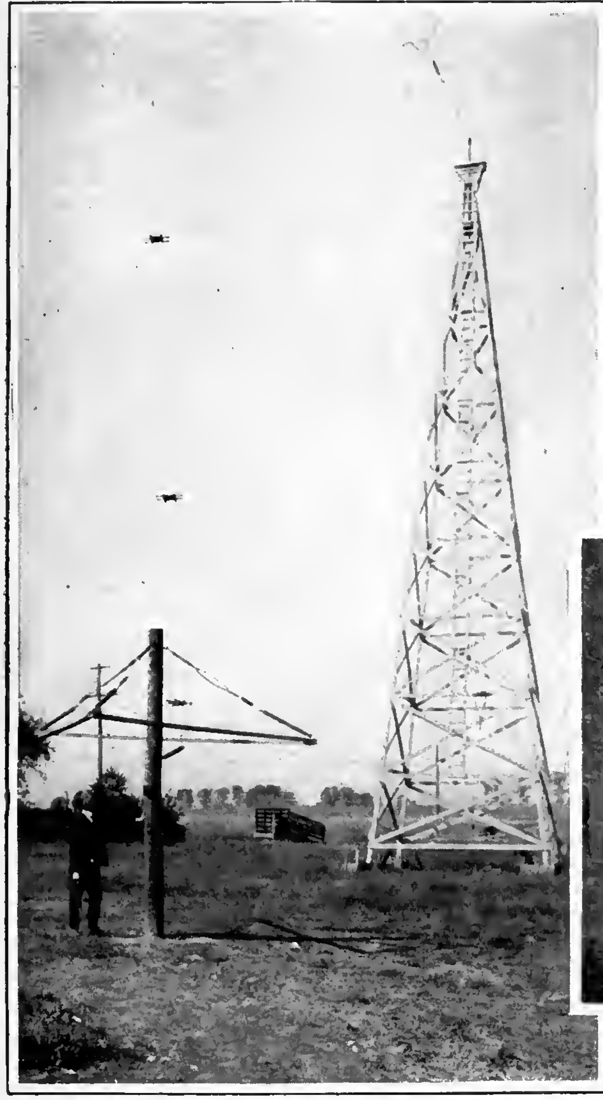
THE press is frequently the victim of publicity exaggerations propagated by zealous radio enthusiasts. Newspaper city editors cannot be expected to be radio engineers. Stories frequently appear in the news sections which a competent radio editor would delegate to the waste basket. We noted, some weeks ago, a front page story in the New York *Times*, urging all broadcast listeners to listen-in carefully for the effect of meteors on radio reception. August is the big month for meteors and scientists have, for the last two decades, made observations as to their effect on radio reception. Broadcast listeners were exhorted to listen-in and report any unusual phenomena in reception to Mr. Hugo Gernsback, editor of *Radio News*. The story may have also appeared elsewhere. If the effect of meteors is so obvious as to be easily detected by the average radio listener, it would certainly cast a reflection upon the scientists who have been engaged for twenty years or more in the investigation of radio phenomena.

At about the same time, a zealous correspondent in Cumberland, Maryland, reported to his newspaper that a local amateur established communication with the *Bowdoin*, MacMillan's ship in the Arctic, a feat which has been duplicated nightly by many an amateur in all parts of the United States.

The business of editing radio news requires the assistance of specialists. This is particularly obvious when some of the radio items are clipped from small newspapers which do not have radio editors. Frequently they fall for the rawest kind of publicity and free advertising statements, not having the necessary technical qualifications for the selection of items which might enlighten their readers on radio subjects. To counteract this situation, a number of special radio syndicate services are available to smaller newspapers at low cost, the use of which would be a decided improvement over some of the radio items now appearing.

Radio Strides in Australia

RAPID strides are being made in Australia in extending the broadcasting service of that country. A new, high power station, with call letters 2 BL, has recently begun operations in Sidney, using a normal power of five kilowatts and a maximum of ten. In coöperation with 2 FC, also located in Sydney, it maintains continuous service from 7 A.M. to midnight. 4 QG, at Brisbane, 3 LO, Melbourne, 5 CL, Adelaide, and 6 WF at Perth constitute the balance of the broadcasting stations. These are soon to be supplemented by 3 AR at Melbourne and 7 CM at Hobart, Tasmania. Thus the Australian continent has thorough radio coverage which has stimulated the radio business tremendously. KFI, and KGO of our Pacific Coast are frequently heard on the eastern side of Australia. There are still some wavelength difficulties to be adjusted, for some stations, such as 2 FC and 6 WF, are on wavelengths far out of the beaten track—over 1100 meters (272.6 kc.).



STATION WPSC, PENNSYLVANIA STATE COLLEGE

The illustration at the left shows the antenna lead-ins from an antenna supported from three towers. The buildings of the engineering college are shown in the illustration directly above. The two buildings in the foreground are devoted to the Electrical Engineering department

Should News be Broadcast?

NEWS gathering agencies, including the Associated Press and the United Press, have been asked by the Publishers' Association of New York City to refrain from broadcasting any but news of transcendent importance, such as the illness of a president or the results of an election.

Newspapers which support the various news services are entitled to this protection. News is a highly perishable product which loses its value by dissemination. Broadcasting has demonstrated that it is, in no sense, a competitor of newspapers, because it is not adapted to the distribution of anything but the most abbreviated kind of news summary. It would require some thirty-six hours to broadcast the contents of a sixteen-page newspaper.

Interesting Naval Radio Tests

THE airship *Los Angeles* has been engaged for a period of weeks in checking the calibration of naval radio compasses along the coast between Boston and Norfolk, Virginia. An airship is much better adapted to doing this work because of its steadier and slower motion as compared with airplanes. During such tests, the airship flies in a circular course of fifteen miles radius about the compass under test. The transmitter on the airship is operated continuously and an observer at the compass station records the exact time and radio bearing. At the same time, a second observer with magnetic compass and telescope, records its direction from the compass at regular intervals. By checking the visual and radio observations, the directional errors of the radio compass are recorded for future reference.

Utilizing the picture transmission apparatus developed by C. Francis Jenkins, the naval radio station NAA at Arlington, Virginia, is transmitting weather charts for the use of ships at sea. Two naval vessels have been fitted with the necessary receiving equipment for reproducing the charts. This is the beginning of what will ultimately be an invaluable radio aid to navigation on the sea and in the air.

"Cross Talk" in British Telephone Circuits

IT MUST give British radio listeners considerable distress or amusement to hear their private telephone conversations broadcast as a result of cross talk into circuits furnished the radio stations of the British Broadcasting Company. Judging from newspaper items, this has occurred on a number of occasions.

Cross talk requires most elaborate precautions to avoid, but the radiation of cross talk by a broadcasting system is nothing less than mere carelessness in operation. By constantly monitoring the program of each radio station, broadcasting of cross talk can be prevented by shutting down the radio transmitter until the line is cleared or shifting to another line.

When chain broadcasting was first undertaken in the United States, involving lines many times longer than those used in England, cross talk difficulties were encountered but they were avoided by setting up two parallel telephone circuits, offering an alternative path, should one become noisy, without more than an instant's interruption of the program. As routine tests became perfected and the reliability of telephone circuits established by long practice, the necessity for alternate circuits for ordinary interchange of programs has disappeared.

Praiseworthy Work by the Victoria B. C. Radio Club

THE Radio Club of Victoria, British Columbia, we learn from W. J. M. Griffin of that city, has tackled the problem of power line radiation in a most commendable manner. Mercury arc transformers are used to step down the high voltage used in distribution and these, in some districts, cause destructive interference to radio programs. Loyal members of the radio club personally expended some four hundred dollars to equip the transformers with choke coils so as to rid the populace of this pest to radio reception. When radio listeners actually reach into their pockets to alleviate conditions of radiation, they are aided by the coöperation of the power companies and rewarded by a considerable improvement in reception.

More About Toll Broadcasting

WE HAVE received many letters commenting favorably on the article by Austin C. Lescarboura, "What Does it Cost to Broadcast?" in this magazine for September, 1926. Every care for accuracy was observed in the preparation and editing of the story, but several inaccurate statements crept in. We have been asked to call attention to several statements which may appear misleading. John Shepard 3rd, of the Shepard Stores of Boston and Providence, writes to say that the two broadcasting stations operated by his company, WNAC at Boston, and WEAN, Providence, have been connected by wire lines for nearly three years. The connection is not occasional as might have been gathered from the phraseology of the article.

In referring to another Connecticut station, WTIC of Hartford was represented as a commercial station in the sense that broadcasting for hire was a practise. In the map of the present WEAF "chain" appearing on page 368 of RADIO BROADCAST for September, WTIC was shown as one of the links, and the caption conveyed the impression that WTIC accepted payment for commercial programs. Mr. W. G. Cowles, vice-president in charge of broadcasting, of the Travelers Insurance Company informs us that his station has never received a penny of income from any source. The programs from WEAF, heard through WTIC are the so-called "sustaining programs" such as the Goldman Band concerts, the grand opera hour, and national events of various kinds for which WEAF is paid by WTIC.

THE FIRST DEMONSTRATION OF WIRED RADIO

A scene in the office of the Chief Signal Officer of the Army when Major General George O. Squier was Chief Signal Officer. Major General Squier has many patents on systems for "wired radio" or "broadcasting" over electric light lines. This photograph was taken on March 24, 1922. In the photograph, left to right: Samuel Isler, assistant radio engineer, Signal Corps; C. E. Bohner, assistant electrical engineer, Signal Corps; R. D. Duncan, Jr., radio engineer, Signal Corps; Louis Cohen, consulting radio engineer; Lieutenant Colonel C. A. Sloane, Signal Corps, U. S Army; Donald Wilhelm; Major General George O. Squier, Chief Signal Officer of the Army; Sergeant E. D. Latta, Signal Corps; Lieutenant Colonel F. J. Griffin, Signal Corps

The Month In Radio

LIEUT. E. H. KINCAID, navigator of the Navy transport *Kittery*, succeeded in plotting the course of a West Indian hurricane by observing, with his radio compass, the direction in which the heaviest static was heard. This ingenious observation suggests a new service for the radio compass which may be of value in our meteorological service.

THE Bureau of Standards is conducting experiments at College Park, Maryland, with improved radio beacon systems for the guidance of aircraft. Radio compasses and beacons are used for this purpose on most of the European commercial routes.

THE intensity of radio signals is affected by temperature conditions, according to conclusions reached by Dr. L. W. Austin and Miss Wymore of the Bureau of Standards. In order to eliminate as far as possible the influence of meteorological phenomena, stations between 125 and 190 miles distant were chosen for the experiments. A greater distance would be subject to the influence of other conditions which would complicate the analysis, while a shorter distance, on the other hand, woud not show the influence of weather changes to a sufficient degree to make for reliable observation. A study of extensive data reveals that, when the temperature rises along the signal path, there is a tendency for the signal strength to fall and, conversely, a falling temperature produces a stronger signal. It should be recognized, however, that this is only one of the many influences which determine signal strength.

SIR HARRY LAUDER
London

From an article by the Scotch comedian in the *Radio Times*, London:

"Let us (the concert and radio program managers) work smoothly together. The importance of maintaining British prestige demands it, because, in the days to come, if broadcasting maintains its present rate of development, other nations will judge us by what they hear as well as by what they see. We must, therefore, take care that what is sent out from our broadcast stations is the very best we have to offer. I think the time has already arrived when we should be making plans with this end in view. The time is coming when Paris, Rome, New York, and other parts of the world will regularly listen to the radio programs of London and Daventry. When that time comes, the London station should have the finest orchestra in the British Isles, no matter what the cost.

"Time will prove the accuracy of my vision. Henceforth, British prestige among the nations will depend largely on how we develop our radio. Let us now make certain that the foundation shall be built on harmony among ourselves."

IN THE second issue of the *Lightning Jerker,* a new publication devoted to the interests of the commercial radio operator, an article describes the activities of the Chicago Federation of Labor in attempting to unionize the technical personnel of broadcasting stations in that city. Considering the fact that engineers and technical men are of an order of skill which does not lend itself readily to standardization of laboring conditions and wage scales, it is unlikely that the result will be successful. It would be unfortunate to force commercial operators on ships to obey the dictates of labor unionism because the temptation to use their essential service as a strike weapon would not long be resisted. It is against the law for an ocean-going ship with a personnel of more than fifty to sail without its proper quota of radio operators. By calling out a few hundred radio men, a complete tie-up of shipping could be effected. A radio operators' union would soon find itself concerned in the bickerings of every class of marine worker, to the discredit of the former and for the benefit of the latter. That enviable prestige for loyalty and self-sacrifice, which heroic radio operators have built up for the profession, would eventually be clouded, were it to become an accessory to union labor embroilments.

ABOUT 100 broadcasting stations are coöperating with the Department of Agriculture's radio service, according to an announcement by Sam Pickard, its head. The dissemination of farm information by radio has frequently resulted in great profit to farmers. It is interesting to note that several questionnaires on what the farmer most prefers in radio programs place musical entertainment first and information pertaining to his trade second or third. Shop talk is just as tiresome to the farmer as it is to any other kind of worker. By selecting suitable hours for broadcasting farm information, however, so that it does not interfere with entertainment programs, an interested and appreciative audience is assured.

FROM time to time, rumors reach us that various class organizations, such as the American Federation of Labor and the Ku Klux Klan, are considering the erection of broadcasting stations in order to address their members by radio and to disseminate their propaganda. Sooner or later we will recognize that the ether is a universal medium which should be used primarily for broadcasting to the whole public and not for the special interests of any particular group.

Interesting Things Said Interestingly

DAVID SARNOFF (New York; Vice-president, general manager, Radio Corporation of America): "The development of radio sets which dispense with batteries and use house lighting current, together with the fact that radio keeps people at home, is resulting in larger consumption of electricity.

"The types of broadcast receivers which now operate completely from the lighting circuit require up to 200 watts for their operation. The numerous power accessories on the market require from seven to fifty watts. It is reasonable to assume that within the next three to five years, by far the larger percentage of broadcast receivers will draw their local source of energy from the lighting socket. It is estimated that the average of such receivers will consume energy at the rate of eight kilowatt hours per month."

E. H. ANDERSON (New York; director, the New York Public Library): "It is sometimes asserted that the movies, the radio, the automobile, and other diversions, have lessened the reading habit.

"The exact opposite is the truth; the desire for books is constantly increasing in New York. There are many libraries other than the public libraries and many sources of book supply beside the libraries in this city. There is a very large use of books within the buildings of the public libraries, that is to say, a reference use. Over and above all this, the public libraries of Greater New York lent for home use last year 16,781,679 books. The New York Public Library lent 9,018,339; the Brooklyn Public Library, 5,786,774, and the Queens Borough Public Library, 1,976,566 books. This does not wholly represent the demand for books; it merely indicates how far the public libraries were able to satisfy the demand."

J. RAMSAY MACDONALD, M. P.
London

In a statement he made after listening to the broadcasting of speeches of the Assembly of the League of Nations:

"I doubt if any discovery of our time is more marvelous in its effects, or is destined to have more influence on the human mind than wireless. The broadcasting of Geneva has brought this mighty assembly of the world States into the homes of thousands of our people and of millions like them in other parts of the world. It could not have meant so much to them as it did to me because I have been there. and, consequently, my ears awakened a responsive vision. But to be behind a curtain and to hear, even if seeing be forbidden, the business of such a gathering must enliven interest and quicken intelligence. The League of Nations must be more real to every listener after that morning than ever it was before.

"How appropriate it has been that a landmark has been set in this marvelous development in human contact by the broadcasting of speeches delivered at an Assembly of the League of Nations. I see in it not only a promotion of peace and enlightenment, but a vast extension of the rare opportunities which the mass of mankind have of judging the qualities and the capacities of those set to rule over them.

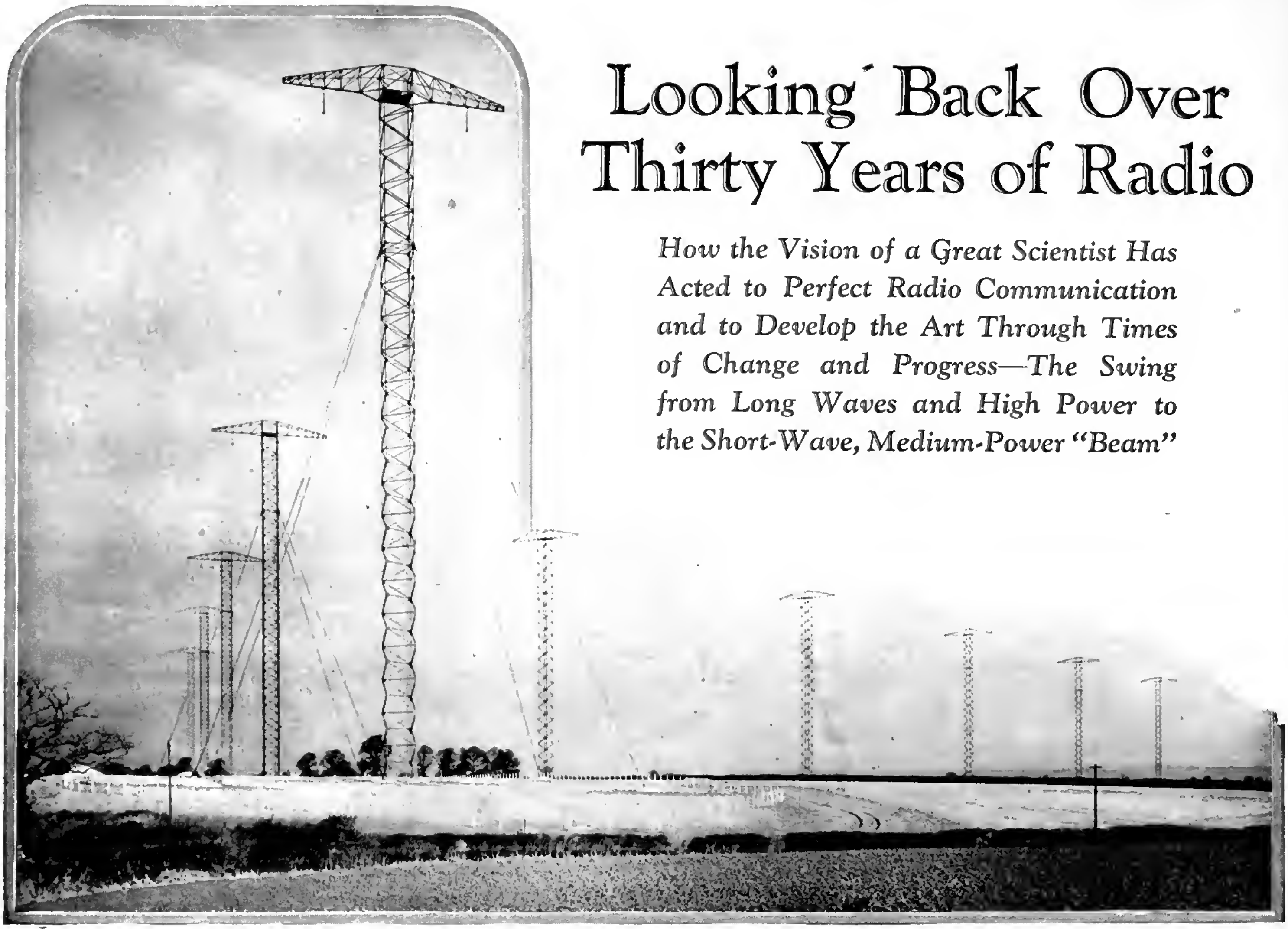
"Something like a new sense has been added to the citizens of the world."

ARTHUR BURROWS (Geneva; manager of the International Radiophone Bureau writing in *Popular Wireless*, London):

"Broadcasting is actually changing the outlook in the lives of many persons. Its value to the blind is already so freely recognized that the German Government has not hesitated to pay for 2000 sets of receiving apparatus for the afflicted within its frontiers, and the recent British Governmental Committee has recommended exemption from license fees for the sightless living in the British Isles. I hope that this proposal may be carried a stage further and that all blind persons in Britain without the necessary means will sooner or later be given a suitable receiving set."

Looking Back Over Thirty Years of Radio

How the Vision of a Great Scientist Has Acted to Perfect Radio Communication and to Develop the Art Through Times of Change and Progress—The Swing from Long Waves and High Power to the Short-Wave, Medium-Power "Beam"



AT THE BRIDGWATER, ENGLAND, "SISTEMA A FASCIO" STATION
"Sistema a Fascio," as some are well aware, being the Italian for "Beam System." The five masts to the left are for reception from Canada, while the five to the right are for receiving signals from South Africa

NOT since the July, 1925, RADIO BROADCAST have we been privileged to present an article by Senatore Marconi. In the issue referred to, the article, "Will Beam Stations Revolutionize Radio?" described in the great scientist's own words his experiments with beam transmission, and his feeling of the future of radio transmission along these lines. In the present article, which is in part an address delivered by Senatore Marconi in Bologna, Italy, at the commemoration exercises of the thirtieth anniversary of his first patent in wireless telegraphy, Mr. Marconi describes how wireless has progressed since the earliest days and tells more about his own part in the recent development of beam transmission. He pays, it will be noted, graceful tribute to other investigators in this field, to whom much is owing.—THE EDITOR.

By GUGLIELMO MARCONI

SINCE February, 1896, the date of my departure from Bologna after the first experiments in wireless telegraphy I carried out at the Villa di Pontecchio, my life has been spent far from that city. My absence has been caused by the force of events, which has been greater than that of my will.

Radio telegraphy, which appeared to me destined to connect the thought of all the peoples of the world, required for its development a very great space, and I chose for my first laboratory, the Atlantic Ocean.

From my youth, I would almost say from my boyhood, the experimental discovery of electric waves made by Hertz, in confirmation of the mathematical hypothesis of Maxwell regarding the electromagnetic theory of light, and the brilliant pursuit of such researches made by our great Bolognese physicist, Augusto Righi (to whose memory I always bow with devout admiration) had fascinated my mind, and I soon had the idea, I might almost say the intuition, that these waves might in a not distant future furnish mankind with a new and powerful means of communication which could be utilized not only across continents and seas, but also on ships with a vast diminution of the dangers of navigation and with the abolition of the isolation of anyone crossing the sea.

The happy results obtained over noteworthy distances by means of electric waves have been, in my opinion, due in great part to the discovery made by me in 1895 of the effect of the so-called "antennas" or "raised aerials" connected with both transmitting and receiving apparatus. Such a device was naturally the consequence of a happy inspiration and our mind never forgets, however great the absence, the place where a first happy inspiration was born.

But during my forced absence from Bologna the nostalgia of my native city often invaded my mind; often enough during the eighty-six times I crossed the Atlantic, during the long periods of time spent in the solitudes of Canada and of Ireland, my thoughts which to many seemed fixed on the study of the apparatus which I had before me, flew far away instead, flew to my dear Bologna, to which I am bound by the most sacred affections and the dearest memories.

Since I left Bologna in 1896 and obtained my first Patent of Invention on the 2nd of June in that year, what immense difficulties have had to be surmounted to attain the purpose which I had set myself, and in which my faith was never shaken, even when illustrious scientists had to express the most discouraging opinions!

It had been objected that the curvature

of the earth would inexorably hinder communications over distances greater than a few tens of kilometres, but I did not believe this and I was soon able to prove by my experiments conducted between the Lizard and the Isle of Wight off the coast of England, across a distance of 300 kilometres, in which the curvature of the earth intervenes rather considerably, that it did not offer any obstacle to radio telegraphic transmission.

LONG DISTANCE "WIRELESS" A DREAM?

IT WAS then affirmed that transmissions over still greater distances were the dream of a visionary but after the experiments which I carried out in December, 1901, between England and Newfoundland in North America, during which I succeeded in communicating for the first time across the Atlantic Ocean, everyone began to be convinced that very probably there would no longer be any distance in the world which could obstruct the propagation of electric waves.

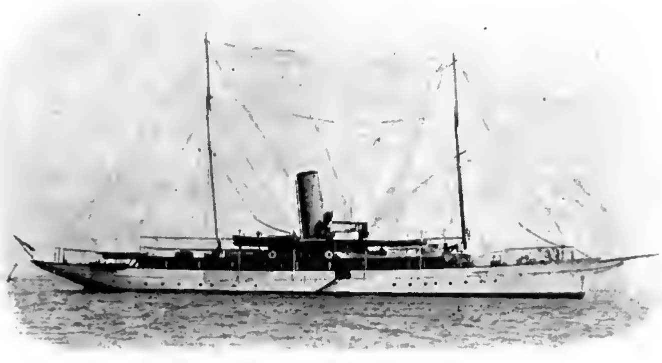
The happy result obtained by those first experiments of mine between Europe and America encouraged me in the prosecution of my studies to face the solution of a difficult problem—commercial radio telegraph communication between Europe and America, and with so many other distant countries where the practical object to be reached would justify the risk of the expenditure of a huge capital for the execution of experiments which, in Italy, were qualified as of rather doubtful success.

In my experiments conducted on the Atlantic during the winter of 1902 I found myself impeded by an unforeseen difficulty caused by the effect of solar light on radio telegraphic transmissions, a phenomenon which I discovered during a voyage made on board the ship *Philadelphia*; on account of the effect of the light, at a distance of more than 700 miles all reception became impossible when the sun rose. But with the increase of the wavelength I found that this difficulty also could be overcome.

Then all students of radio telegraphy devoted themselves to the use of longer and longer waves and thus from those of 1000 and 2000 meters there was a gradual transition to the use of waves which reached the length of over 30 kilometres.

Other difficulties presented themselves as a result of interference between neighboring stations, a difficulty which, it seemed, would cause a very great limitation in the practical applications of radio telegraphy. But with new tuned circuits, which I patented in 1898 and 1900 and experimented with on the south coast of England, such difficulties also disappeared for the greater part. It was then proved for the first time that many neighboring stations among those tuned on different waves could communicate simultaneously without interfering with each other.

Following my first long-distance experiments over the sea, it was affirmed that communications across mountainous continents would be impossible. But with the wireless telegraph experiments on the Royal Vessel *Carlo Alberto*, which, by the will of H. M. the King of Italy, was placed



THE "ELETTRA"

Marconi's private radio yacht. Very many of the Senatore's experiments have been carried out from the middle of the ocean aboard the well appointed *Elettra*

at my disposal, I was able to demonstrate that the Alps and Pyrenees were easily surmounted by the electric waves I was using.

But there always remained inexplicable periods of interruption; there also always remained great difficulties occasioned by the low sensitiveness of the receivers then used; there also always remained the enormous obstacles produced by atmospheric electric discharges.

It was then said that at that point the development of radio telegraphy wa finished; that its employment might be useful at sea for the safety of human life during navigation, but that its employment would be rather limited and rather difficult between distant continents.

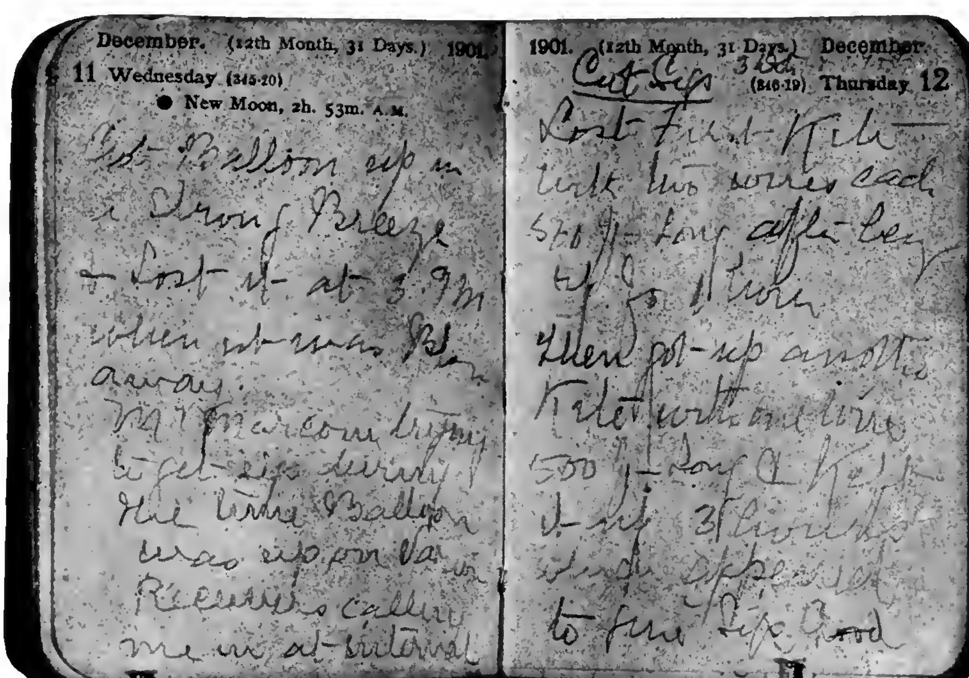
It was stated that radio telegraphy would never be in a position to compete with other rapid means of communication over long distances, such as that carried on by cables.

But even in the face of such observations often made officially in the parliaments of great nations, I was never discouraged. We Bolognese often smile in the face of the most difficult situations.

PROGRESS AIDS PROGRESS

IN FACT, by means of the use of thermionic valves—a brilliant conception of Fleming, perfected by DeForest, Langmuir, and Armstrong in America, by Meissner in Germany, and by Round and Franklin in England —and by means of the use of balanced tuned circuits, of electric filters, of power amplifiers and finally of directional radiators, I succeeded in obtaining results such as to ensure a regular radio telegraphic service by day and night between Europe and America; thus also, in 1918, I could for the first time in history communicate from England to Australia, i. e., almost as far as the antipodes, over a distance of about 20,000 kilometres (12,500 miles).

But to obtain such results, huge and very costly installations were required, based on the use of many hundreds of kilo-



December. (12th Month, 31 Days.) 1901.
11 Wednesday (345-20)
● New Moon, 2h. 53m. A.M.

[illegible] Balloon up in a Strong Breeze & Lost it at 3 PM when it was [illegible] away. Mr Marconi trying to get sigs during the time Balloon was up on the Receivers calling me in at interval

1901. (12th Month, 31 Days.) December.
Cut Sigs 3rd
(346-19) Thursday 12

Lost First Kite with two wires each [illegible] long after being up [illegible] Then got up another Kite with one wire 500 ft long & kept it up 3 hours wind appeared to [illegible]

AN HISTORICAL DOCUMENT

Pages from the diary of Mr. S. S. Kemp, Marconi's assistant at Signal Hill, Newfoundland, just about twenty-five years ago (December 12th, 1901), when wireless signals were first transmitted across the Atlantic from Poldhu, England, and received at the Newfoundland station. This was the occasion of the transmission of the famous letter "S" watts of electrical energy radiated almost circularly; so that the object I had set myself of finding, a means of rapid communication more economical than that afforded by the ordinary wire or cable telegraph, seemed to a great extent frustrated.

I then thought again of my first experiments at Pontecchio. I again remembered all I had then proposed to pursue by means of the radiation of electric waves concentrated in a beam by means of suitable reflectors.

Thus in 1917, at Genoa, where I devoted myself to particular studies for military purposes, I made numerous distance experiments with the first beam (the Italian is "*a fascio*") apparatus, using short waves, that is of two or three meters length. Yes! "Beam System" ("*Sistema a Fascio*").

I do not now use any of these words because I am a Fascist and because Fascismo, for the fortunes of Italy, is triumphant. I always claim for myself the honor of having been the first Fascist in radio telegraphy, the first to recognize the desirability of uniting in a beam (*fascio*) the electric rays, as the Honorable Mussolini has first recognized in the political field the necessity of uniting in a "*fascio*" all the best energies of the country for the greater greatness of Italy.

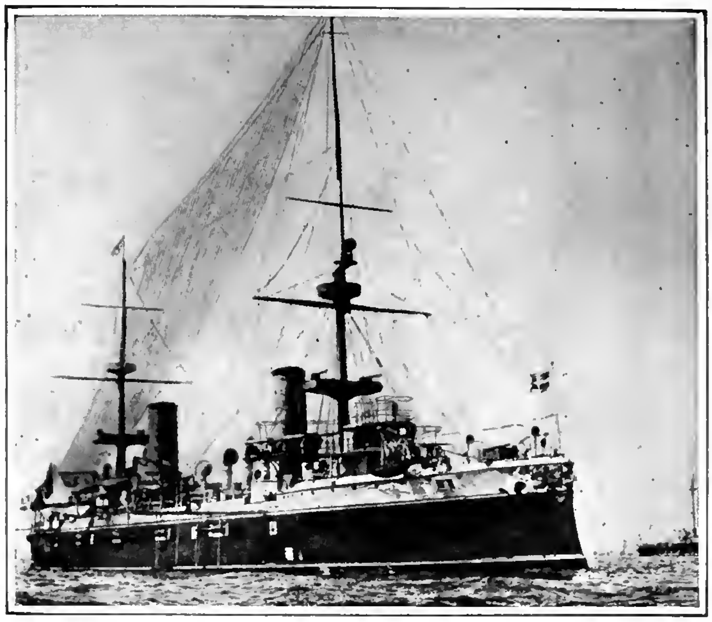
But long waves were no longer suitable owing to the use of my Beam System. This system, instead of radiating the waves in all directions, concentrates them in the desired direction almost like a beam of light projected from a reflector. The British Government has officially decided to use this Beam System on the greatest scale for direct communications between the most important Dominions and the Mother Country. And yet I was responsible for having caused the expenditure of hundreds of millions on long-wave stations.

A certain courage was therefore necessary to say "Let us turn back."

TURNING BACK PAGES OF RADIO HISTORY

BUT the Bolognese, after building at Bologna one of the highest towers in Italy, did not hesitate to build near it another much lower one.

Near the longest wave stations I was the first to have had constructed, I did not hesitate placing beam stations using very short waves.



THE ITALIAN WARSHIP "CARLO ALBERTO"

When Senatore Marconi had made his first long-distance experiments across sea, it was generally opined that communication across mountainous country would not be feasible. The King of Italy placed at Marconi's disposal the *Carlo Alberto* from which experiments were conducted, and these proved conclusively that the above supposition was incorrect, for communication across the Alps and Pyrenees was effected without difficulty

In my practical study on the ranges of transmission of such waves, while cruising on the Atlantic for several months aboard my yacht *Elettra* in 1923, I was able to discover some of their very valuable properties unknown to science before that time.

I thus gathered that by using short waves in installations of very low power with a suitable reflector it was possible to carry on the most regular, rapid, and economical service by day and night between the antipodes of the globe, that is between England and Australia.

With such short-wave installations I was able in May, 1924, for the first time in history, to cause the human voice transmitted from England to be heard and understood in distant Australia.

IN HIS SEA-GOING LABORATORY

Senatore Marconi is here shown amongst some of the experimental apparatus on board his famous yacht *Elettra*. He has crossed the Atlantic eighty-six times, many times in his own yacht

RADIO—ALMOST UNIVERSAL TO-DAY

TO-DAY there are thousands of ships equipped with radio telegraphy for the safety of human life at sea and to maintain alive the daily activity of the countless persons who cross the oceans; to-day radio communications between Europe and America, the Far East and South America handle a huge traffic to the advantage of the growing demands of civilization; to-day millions of radio telephonic receivers scattered in the most distant countries carry on continuous communication with the greatest centers radiating news of everything of interest to mankind; to-day, by means of circular radio telephonic diffusion (so-called "broadcasting"), public opinion can be kept calm during any popular disturbance which interferes with the peace-making work of the press, as was proved on the occasion of the recent general strike in England; to-day many hundreds of thousands of people find occupation, study, and work in the new industry created by radio telegraphy; to-day aërial navigation is possible and safe up to the farthest bounds by means of radio communication, as has been recently demonstrated by the great triumph of Italian boldness and technical training obtained in the glorious *Norge* expedition.

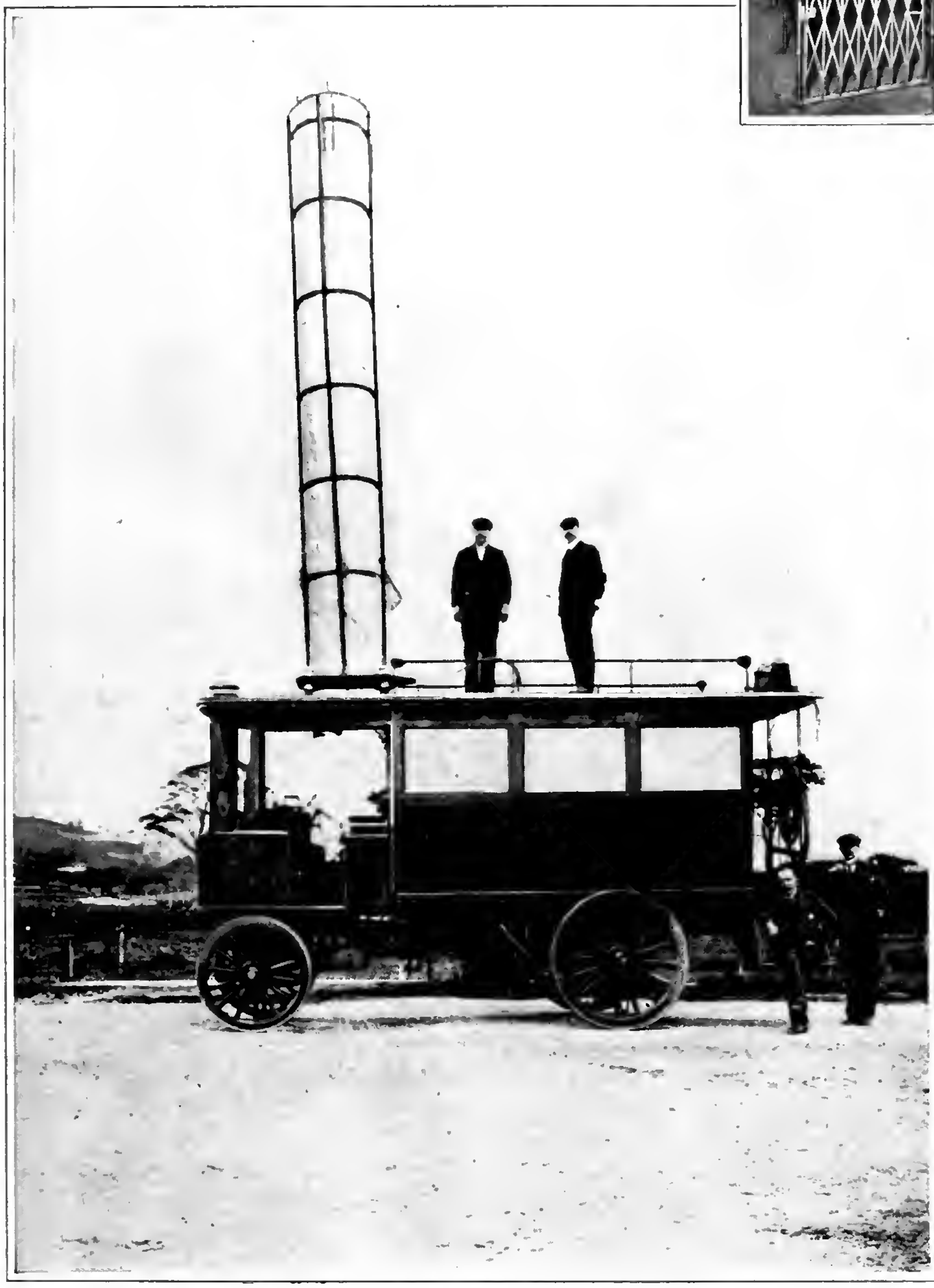
The field of radio transmissions is continually getting wider, thus the radio transmission of photographs to a distance is already an accomplished fact and even now the practical solution of the great problem of television is seen to be possible in the near future.

Before concluding, I would like to send a respectful greeting to the numerous band of efficient scientists, seekers after the truth, and humble workers scattered all over the globe whose work has contributed to make possible the progress obtained; I wish once more to record with deep admiration and reverent affection the great figure of Augusto Righi who, with his genius and his indefatigable effort, did so much for the study of electric waves.

The clever and classical work on the Optics of Electrical Oscillations accomplished here at Bologna by Augusto Righi led to results which, from the walls of his laboratory, became the admiration of the students of physical sciences throughout the world.

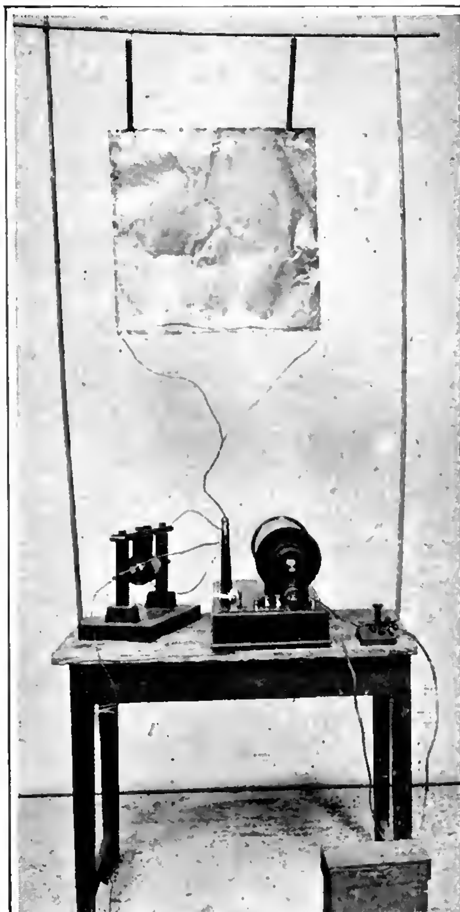
BEAM STATION EQUIPMENT

"I was responsible for having caused the expenditure of hundreds of millions on long-wave stations. A certain courage was therefore necessary to say let us turn back," says Marconi with reference to the development of the short-wave beam station. The above picture shows the tube rectifier panels of the Bodmin, England, beam station



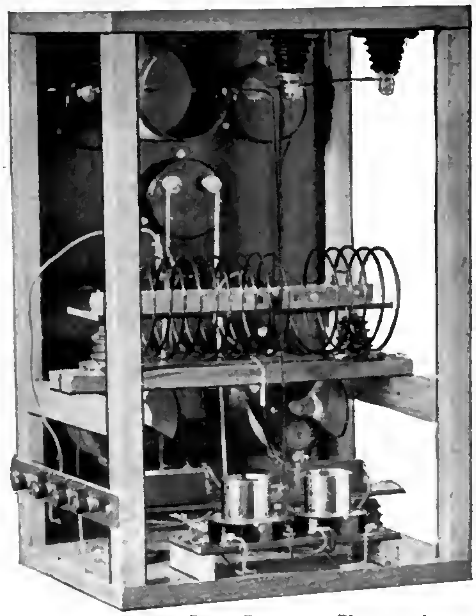
COMPARISON IS ODIOUS, SO THEY SAY

Yet let us turn to page 39 of the May, 1926, RADIO BROADCAST, and see how Warner Bros. modern 250-watt portable outfit, 6 XBR, compares with the somewhat antiquated mobile affair illustrated above. Those of you who have seen 6 XBR on the road will be in an even better position to contrast, though it is hardly possible that the "puffing billy" depicted will ever be seen on Main Street again. It is a twenty-year old contraption used by Senatore Marconi in one of his first attempts at a portable field station. A cylinder of copper forms the antenna. To the extreme right stands the Senatore



MARCONI'S FIRST TRANSMITTER

Was fashioned after the model in this picture. The apparatus includes the induction coil for obtaining a high voltage with a multiple coil spark gap, one side of which is connected to the antenna, which is in the form of a copper sheet slung, by means of insulators, between two posts. The other side of the spark gap is connected to ground



Radio Broadcast Photograph

FIG. 1

It is not difficult to see why 1 BD at Plainfield, Vermont, "steps out." Maple boiled in paraffin forms the framework of this efficient transmitter. Note the standard equipment, General Radio condensers and other parts mentioned in this article

High Efficiency B-Battery Transmitters

Several Types of Very Inexpensive Transmitters Using 201-A Tubes Which Are Capable of Long-Range Service—How to Tune Small Transmitters

By KEITH HENNEY

Director, Radio Broadcast Laboratory

IN THE April Radio Broadcast was described the portable short-wave transmitter that enabled 2 GY (the experimental short-wave station at the Laboratory of Radio Broadcast) to carry on communication with 9 CCQ, 1000 miles away, with a plate input to a 201-A tube of 0.04 watts, a record of 25,000 miles per watt. So many requests have come to the Radio Broadcast Laboratory for more complete directions for building this efficient set and so many readers have desired rules for tuning and operating it that the present article has been prepared.

The portable transmitter, however, was one of those "long geared" affairs that, "placed end to end," would reach from the cellar to the garret, and truthfully was not a beautiful object. For transporting about the country in the rear of an automobile—for which it was designed—it was quite the thing, but for one's den, that is a different matter.

Several of the readers of Radio Broadcast, however, have made a much better looking job of the small transmitters than that used at 2 GY and some of these are described in this article. For example, Mr. Roy L. Gale of Plainfield, Vermont, 1 BD, wrote:

> This is to inform you that I have constructed a dry-battery transmitter after the description of the one in Radio Broadcast for April. As a starter I worked Holland, Michigan, Brookville, Ontario, and at 5-45 A.M. day before yesterday I worked Fredonia, Kansas, and a little later, a station at Cambridge, Illinois. I don't think this bad considering that I was using only about 350 volts on a five-watt tube. All report me as "strong and steady." Moreover, I haven't really learned to tune the thing yet, so I am expecting big success with it a little later. Old discarded BCL B batteries work fine on this rig.

Again on April 9, Mr. Gale wrote:

> On Easter morning in broad daylight I worked 6 BIL at Pomona, California. My input was about 25 watts to a VT2 so maybe this wasn't a very alarming record considering that I was using quite a bit of power, but there are two fifty watters near here who haven't done any better than this at any time of day or night. I attribute my good results to perfect insulation. Am using Pyrex insulators for the antenna.

Several weeks after his first letter, Mr. Gale sent photographs of his set which appear in Figs. 1 and 2, and a description of his apparatus follows:

> The panel is Radion Mahoganite and the layout somewhat resembles that of Mr. Dixon's of Montana, a description of which appeared in Radio Broadcast some time ago. You will notice that the coils are well insulated, being supported by maple strips boiled in paraffin, mounted on a hard rubber strip, and this in turn supported by two General Radio insulators. The plate and grid condensers, leak, and sockets, are also supported in the same way. The choke is a Browning-Drake antenna coil. Weston meters are used throughout. General Radio 0.0005-mfd. tuning condensers, and sockets. Dubilier 2000-volt plate and grid condensers, 0.002 mfd. in size. I use a 12 x 24 drilled window pane for lead-in and Pyrex antenna insulators. The antenna is a two-wire inverted L, 60 feet long, the counterpoise being a single wire 60 feet long, both rather high. A single VT 2 is used usually, but I have used two C-301-A's in parallel with good success. Was reported R5 DC in California when using about 25 watts. This in daylight, but not sunlight. I worked 6 BIL at this time for 30 minutes.

With a similar outfit using two 201-A tubes in parallel, Mr. Vincent Fertitta, 5 LE, of New Orleans, has had excellent luck and the accompanying log shows what can be done with small power inputs. Note particularly that with an input of 13.5 watts he worked Italian 1 NO. The average miles per watt of plate power expended for these transmissions is 84.5. Unfortunately Mr. Fertitta's photographs would not reproduce properly but the layout practically duplicates that of Mr. Gale, except that a transformer furnishes plate power instead of Mr. Gales's device of employing discarded B batteries.

A SIMPLE MODEL

JUST to show how simply one can build a similar transmitter, Figs. 3, 4, and the picture on page 34 give an idea of a 201-A transmitter built by Ferdinand Mann, an operator at 2 GY. This outfit, working from a DeWitt LaFrance power supply unit designed for broadcast receivers, and putting out about 200 volts at 30 milliamperes, puts 0.15 amperes into an average 40-meter antenna.

This set, as well as those used by 1 BD and 5 LE, use the Hartley circuit loosely coupled to the antenna. Fig. 5 is the circuit diagram of Mr. Mann's affair. The parts used in this small transmitter follow:

1 Benjamin Socket
2 13-Plate, G. I. Condensers
2 Dials

Radio Broadcast Photograph

FIG. 2

A front view of Mr. Roy Gale's transmitter which has communicated nearly 3000 miles using about 25 watts input. Mr. Gale operates station 1 BD at Plainfield, Vermont

DATE	TIME	STATION	DIS-TANCE MILES	WATTS INPUT	MILES PER WATT	AUDI-BILITY
12- 5-25	6:30 P	3 HS	930	12.5	76	R-3
12- 5-25	9:55 P	1 YB	1340	12.5	107.2	R-4
12- 8-25	12:05 P	5 HE	504	13.75	36.7	R-4
12-15-25	11:30 P	3 AUV	1073	15.0	71.5	R-3
12-26-25	12:45 A	8 AFQ	1126	13.75	81.1	R-4
1- 1-26	2:40 A	8 AFM	925	16.25	59.6	R-3
1- 2-26	11:30 P	8 GZ	787	15.0	52.5	R-6
1- 4-26	8:30 P	8 BTH	888	12.0	74.0	R-2
1- 5-26	10:00 P	2 CFT	1075	13.75	78.1	R-5
1- 6-26	12:15 A	2 ACO	1150	15.0	76.6	R-3
1-10-26	12:16 A	1 HJ	1240	15.0	80.2	R-5
1-10-26	2:15 A	2 HH	1155	16.25	71.1	R-7
1-10-26	5:20 A	1 ADI	1430	15.0	95.3	R-4
1-15-26	8:20 A	9 BME	700	13.75	50.9	R-5
1-15-26	10:30 P	8 AH	925	12.5	74.0	R-5
1-17-26	11:45 P	1 UW	1314	13.75	95.5	R-5
1-18-26	12:40 A	1 YB	1340	15.0	89.3	R-6
1-21-26	8:15 P	9 DUD	590	12.5	47.2	R-4
1-25-26	5:40 A	2 AEV	1155	15.0	73.3	R-4
2- 1-26	6:58 A	8 BFH	1000	12.5	80.0	R-6
2- 2-26	5:30 A	1 BKP	1340	13.75	97.4	R-6
2- 2-26	5:53 P	9 DMZ	675	12.5	54.0	R-5
2- 2-26	11:00 P	9 WO	1070	15.0	71.3	R-3
2- 6-26	7:30 P	3 BUV	1083	12.5	86.6	R-5
2- 9-26	12:10 A	8 FP	1075	16.25	66.0	R-5
2- 9-26	11:35 P	2 AMJ	1155	13.75	84.0	R-3
2- 9-26	12:00	8 BQ	1075	13.75	78.0	R-4
2-12-26	11:15 P	2 RM	1155	15.0	77.0	R-4
2-28-26	4:30 A	PR-4 SA	1625	15.0	108.3	R-4
3- 1-26	12:05 A	C-3 QS	1096	13.75	79.0	R-5
3-21-26	4:25 A	8 XE	1073	12.5	85.84	R-6
3-28-26	12:15 A	1-INO	5291	13.5	391.9	R-2
3-29-26	11:36 P	M-JH	920	13.75	66.9	R-4
4- 5-26	12:30 A	2 KG	1155	15.0	73.3	R-5
4-14-26	10:50 P	M-IN	920	13.75	66.9	R-5

Average miles per watt, 84.5

A PAGE FROM THE LOG OF MR. VINCENT FERTITTA

1 Yaxley Filament Lighting Jack
1 General Radio 127A 0-.5 Radiation Meter
1 Choke Coil 100 turns, -1 inch diameter No. 28 d.c.c.
2 Cardwell Inductances
2 Sangamo 0.002 Condensers
1 Sangamo 0.001 Condenser
1 Lynch 5000-Ohm Resistance
1 Elkay Ballast No. 2 with Mounting
2 Radion Brackets
7 Binding Posts

TUNING THE HARTLEY CIRCUIT

IT IS due to its simplicity that the Hartley gets its popularity. One coil, two condensers, and the tube make up the oscillating circuit. And due to this simplicity, tuning it is not difficult, although there are several processes that must be gone through before one is certain that the circuit is putting out the maximum power with the minimum of input energy.

Once the set is put together, the first thing to do is to test the filament circuit. If it is properly connected, one should then proceed with the plate circuit and if batteries are used for power, about a hundred volts should be used to determine whether the circuit is properly wired. The plate current at 100 volts using a 201-A or a 210 tube will be about ten milliamperes, and as the tuning condenser is varied, the plate current will probably have "bumps" in it due to resonance with the plate choke coil or the antenna circuit.

The filament tap on the tuning inductance should be at about the center of the coil and varying this tap toward the grid end—that is, including more turns in the plate circuit—will decrease the plate current and power drawn from the B batteries. With the tap on the fourth turn from the plate on Mr. Mann's transmitter built at the RADIO BROADCAST Laboratory, and the tuning condenser across the whole coil, the closed circuit tunes as shown in Fig. 6, from about 15,000 to 5000 kc. (20 to 60 meters). An Ureco 112 tube with 100 volts on the plate was used when taking this data. The antenna was 38 feet long and the counterpoise 24 feet, both consisting of single wires, horizontal and 8 feet apart.

Having determined that both filament and plate circuits are properly connected and operating, it is desirable to know whether the antenna will tune to all frequencies in the amateur band. Fig. 7 shows what happens as the antenna series condenser is varied and the closed circuit retuned for maximum antenna current at each setting of the series condenser. It shows that the antenna-counterpoise system described above tuned from 29 to 48 meters. It will be noted that the plate current is practically constant through this range.

It must be remembered that antenna current is little indication of how a set "gets out." So much depends upon surrounding physical conditions, upon the relation of the natural wavelength of the antenna to the wavelength actually used, that antenna current is only useful in indicating when the greatest amount of power is being transferred to a given antenna at a given wavelength. It is probable that greater range may be obtained by operating the antenna below its fundamental wavelength, although the current actually pushed into it is less.

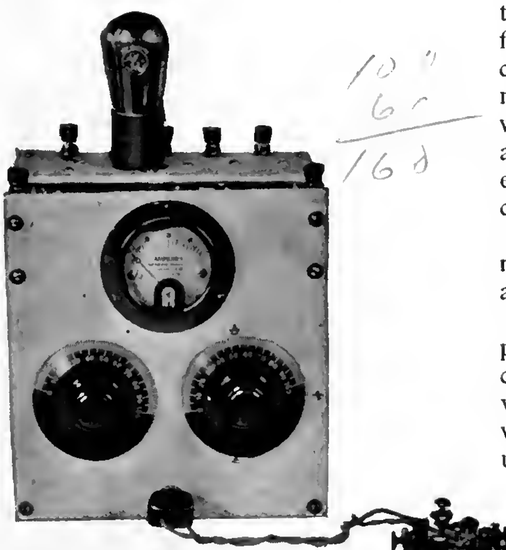
Having determined that the given antenna-counterpoise will operate within the amateur band it is only necessary to pick out some wavelength, say 40 meters, and retune both closed and antenna circuits to get the maximum current into the antenna.

Fig. 8 shows the effect of varying the filament tap. When there are five turns in the grid circuit, the greatest efficiency is attained, and when there are four turns, the greatest antenna current results. The figures representing efficiency are antenna current milliamperes divided by plate milliamperes but are not true efficiencies which should be the ratio between output and input power. They do show, however, the adjustment for maximum antenna current consistent with low plate current.

With the closed circuit adjusted for maximum efficiency, the antenna tunes about as Fig. 9 shows.

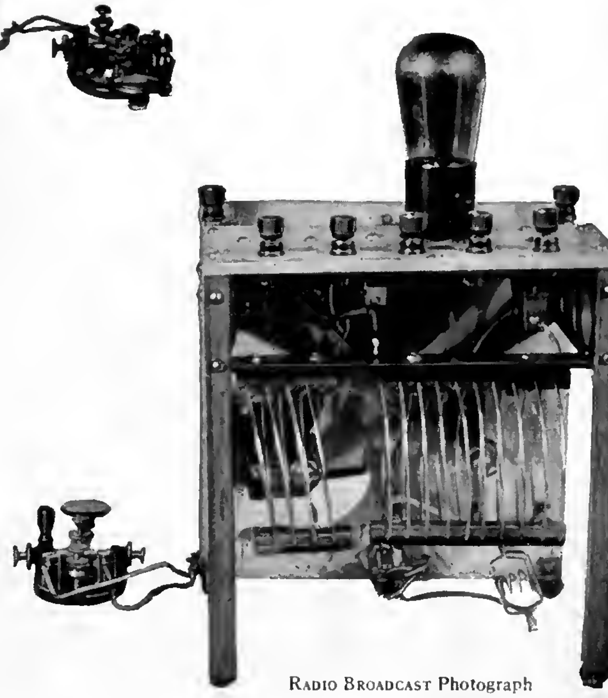
The final adjustment is to place full power on the tube. All of the data for curves in this article have been with 100 volts on the plate but Fig. 10 shows what happens when higher voltages are used.

10"
6"
16"



RADIO BROADCAST Photograph

FIG. 3
A front view of one of the transmitting sets operated by batteries and used at 2 GY. Note the extreme simplicity. It uses the Hartley circuit—the same as Mr. Gale's receiver



HERE IS SHOWN
Another view of the 2 GY set. It was made by Ferdinand Mann

RADIO BROADCAST Photograph

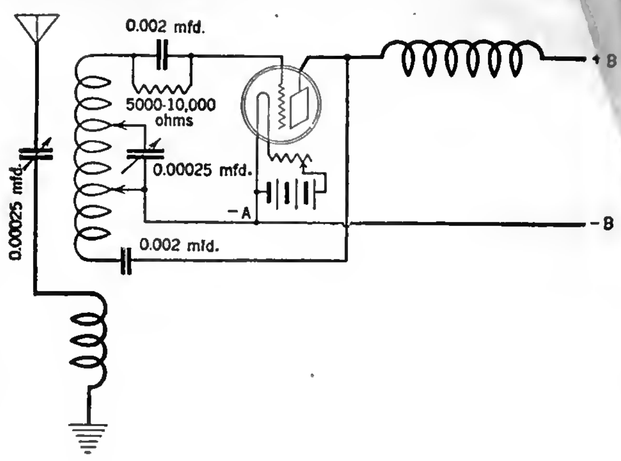


FIG. 5
The well known Hartley circuit. The key may be inserted in the minus B lead. In Mr. Mann's set, the inductance consisted of ten turns of No. 14 gauge antenna wire. The condensers must be well insulated since they have to stand the full d. c.. voltage applied to the plate

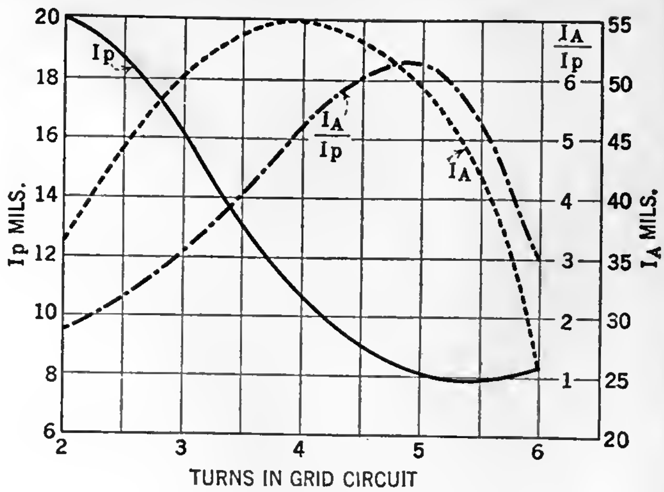


FIG. 8
The effect upon antenna and plate currents of varying the filament tap. The greatest ratio of antenna current to plate current is secured when there are five turns in the grid circuit

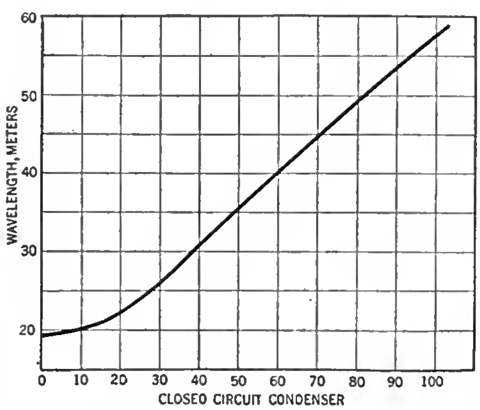
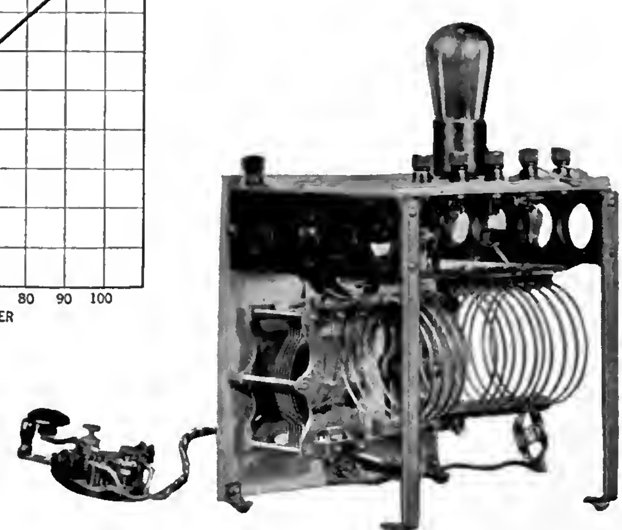


FIG. 6
The closed circuit of the Hartley transmitter at 2 GY tunes from 15,000 to 5260 kc. (20 to 57 meters), as this chart shows



RADIO BROADCAST Photograph

FIG. 4
A side view of the small 2 GY transmitter. It is operated entirely from dry batteries

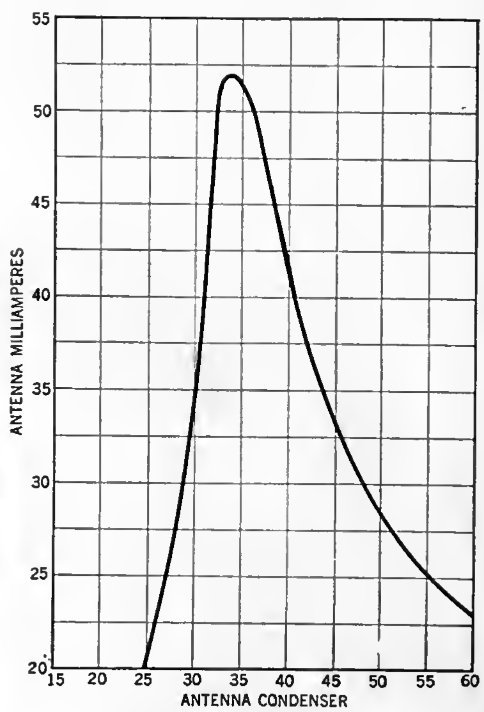


FIG. 9
With the closed circuit adjusted for maximum efficiency, the antenna tunes according to this curve. This is a typical resonance curve. The wavelength is approximately 38.8 meters

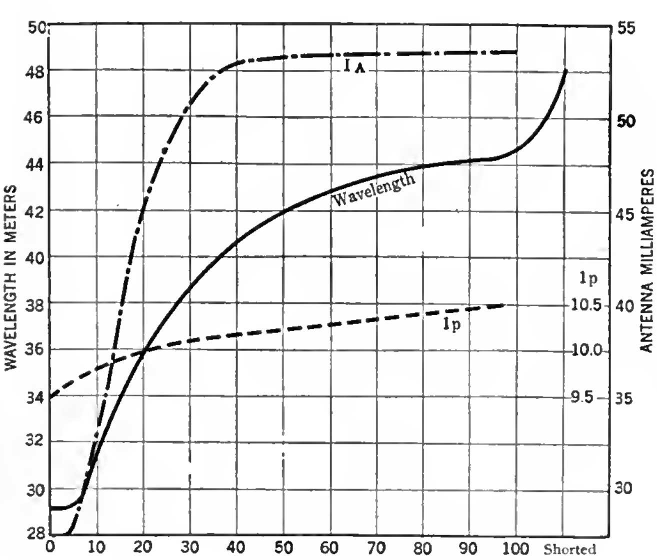


FIG. 7
As the antenna series condenser is varied, the transmitter tunes as this chart shows. It also gives an idea of how the particular antenna tunes to different wavelengths. On the longer waves, the antenna is apparently of lower resistance since more current can be fed into it

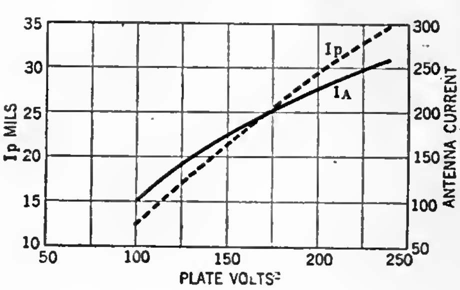
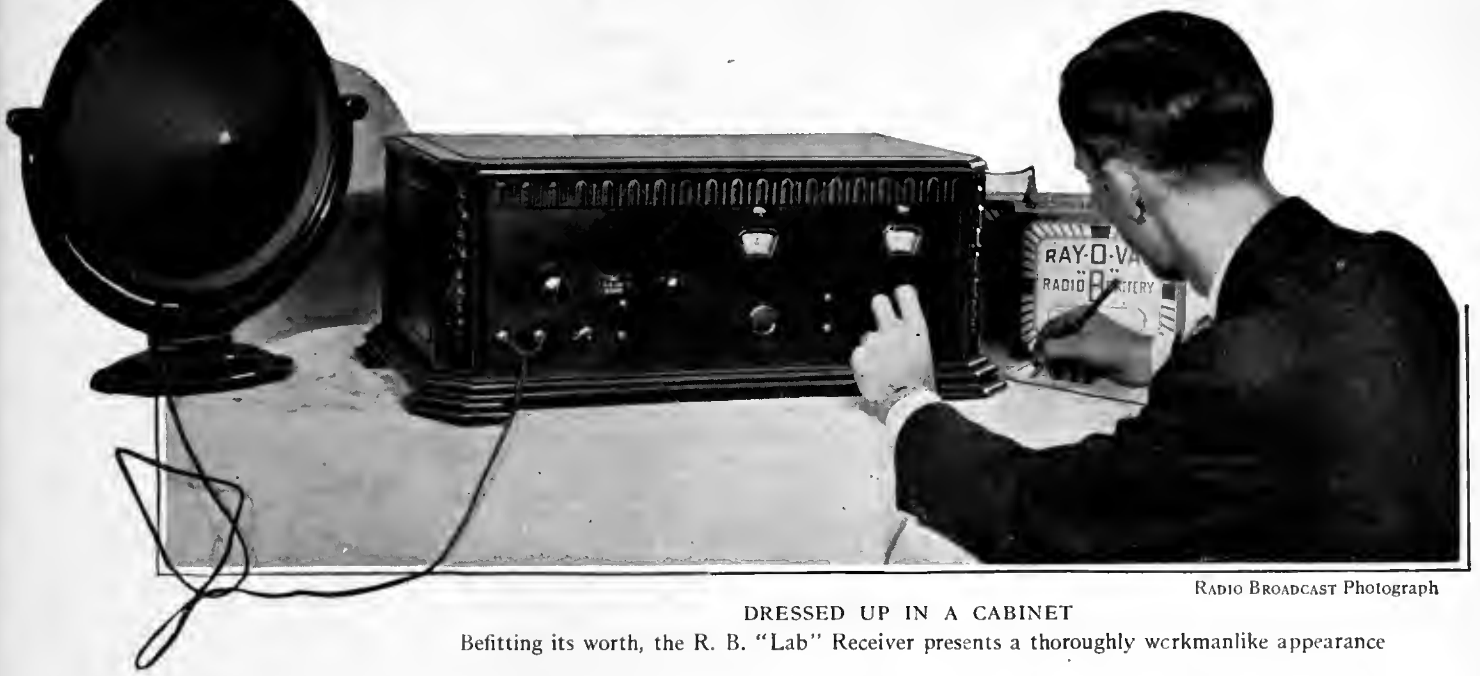


FIG. 10
The relation between power input and antenna current is shown here. The greater the plate voltage the greater the antenna current and naturally the plate current increases too



Radio Broadcast Photograph

DRESSED UP IN A CABINET

Befitting its worth, the R. B. "Lab" Receiver presents a thoroughly workmanlike appearance

Constructing the R. B. "Lab" Receiver

Four Tubes, in a Circuit Employing Rice Neutralization, Provide Sufficient Volume for Loud Speaker Operation—Short Leads Made Possible by Novel Layout—Shielded Panel, Output Device, Cabled Wiring, and Illuminated Dials Are Featured

By JOHN B. BRENNAN

Technical Editor, Radio Broadcast

FOLLOWING Keith Henney's articles in the June and September issues of Radio Broadcast on the R. B. "Lab" circuit, this third article is published with the intention of placing before the reader constructional data which will enable him to duplicate such a receiver with a minimum of trouble.

The design does not follow orthodox paths but incorporates an unconventional feature not attempted in many receivers. It will be noticed, from both the circuit diagram and panel view photograph accompanying this article, that unlike most receivers, the progression of the signal as it enters the antenna circuit follows from right to left instead of from left to right. In other words, the antenna and detector tuning units are situated at the right-hand end of the receiver instead of, as is more usual, at the left side. There are several good reasons for following this procedure. First, the connections from socket to coil, from socket to transformer, etc., are extremely short; in fact, in the audio channel no wire is used for connecting the sockets and transformers because these units are close enough so that the lugs on the terminals of each may be soldered together. Secondly, practically all of the A, B, and C battery wires are located behind the sockets and at the rear of the base board so that it is possible to arrange these wires in the form of a many-wired cable. Thirdly, the fact that this cabling is possible insures against feed-back between units comprising the receiver.

The worth of the circuit has been established previously, and this constructional article makes it possible to make use of the circuit at its utmost efficiency, simply because time, energy, and thought have been expended in devising for the circuit the best possible layout.

In the model described here, a panel shield has been used which completely eliminates any hand capacity effects which ordinarily would be noticed when Rice neutralization is used without any shielding. The photographs show how the home-made shield is installed with cut out places to fit around the apparatus on the panel. A piece of sheet copper, quite thin, is best for the shield.

Neutralization in the Rice circuit is practically independent of frequency, or, said in another way, one adjustment of neutralization will be sufficient no matter whether the receiver is tuned to the longer or shorter waves within the band covered. This is obviously an advantage because the satisfactory performance and successful operation of a tuned radio-frequency amplifier at its highest point of efficiency depends entirely upon the degree of perfection of neutralization.

The theory governing the proportioning of the inter-stage coil has been dealt with at length by Mr. Henney in his previous articles, and will not be repeated here. Suffice it to say that commercial coils suitable for immediate inclusion in the circuit have been made available. For those who desire to make their own coils, specifications are given in Figs. 2 and 3.

To tune the two coils, Cardwell taper plate type 169E condensers are used. Although the plates are semi-circular in shape, the tuning chart, Fig. 1, shows practically a straight frequency-line characteristic due to the special design of these plates.

The Facts About This Receiver

Name of Receiver	R. B. "Lab" Receiver.
Type of circuit	One stage tuned neutralized radio frequency amplification, regenerative detector, and two stages of transformer audio frequency amplification, followed by an output device.
Number and Kind of Tubes	Four; 201-A's for r.f. stage, detector, and first audio stage; UV-171 in last audio stage.
Volume control	500,000-ohm variable resistance shunted across the secondary of the first audio transformer.
Regeneration	Condenser feedback.
Neutralization	Rice.

Utilizing all of the high gain produced by the peculiar inter-stage coupling feature, without waste or undesirable feedback effects, it is possible with the R. B. "Lab" receiver to attain a degree of selectivity and sensitivity hard to approach with other types of circuits. By employing a most efficient audio channel, the tone quality and volume of the loud speaker signal is above reproach.

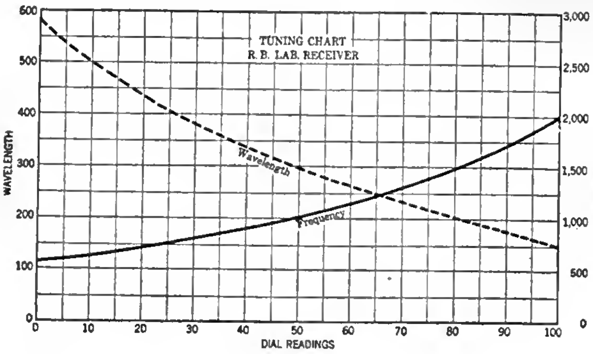


FIG. 1

Both dials of the "Lab" Receiver read alike; should they both read approximately 50 for a certain station, you may be sure that the station is transmitting on about 1000 kc. (300 meters)

EVER since Keith Henney's article in RADIO BROADCAST for June describing the fundamentals of the R. B. "Lab" Circuit appeared, a considerable stream of correspondence has come into the office asking when a constructional article would be printed on the circuit. The "Lab" Circuit is not a new circuit in the sense that it is revolutionary; such circuits do not exist. The circuit is not easy to build; it cannot be "thrown" together, but this complete article by John B. Brennan tells how to build a model embodying many features of decided interest to the home constructor who desires to put together a set which uses many circuit refinements brought forward by the manufacturers for the 1927 season. The constructor who builds this set will have a receiver of neat appearance, great sensitivity and selectivity, and one which delivers a signal of high quality—all with four tubes. Development work on the circuit was done over a period of several years, by Keith Henney, director of the RADIO BROADCAST Laboratory. We prophesy that this circuit will enjoy a wide popularity.—THE EDITOR.

Choke coils are advantageously employed in both tuned circuits. In the secondary circuit of the antenna stage, an 85 millihenry Samson choke is inserted in series with the lead connected to the center tap leading to the C battery. It is used to prevent oscillation of the circuit at the extremely high frequencies around 3750 kc. (about 80 meters). In the detector stage, a similar choke is employed to prevent the radio frequency currents from passing on through the primary of the first audio frequency transformer and through the B battery to the ground. These currents are more useful when passing through the small Precise variable condeners to cause regeneration.

Another feature — purely a mechanical one — adding to the factory-like appearance of the finished receiver, is in the use of the new Marco illuminated dials. On the front of the panel a small pie-like segment of a bezel is mounted forming the window through which may be seen the white celluloid dial-piece. Behind the dial is located a small lamp which, when lighted by the thumb switch —a part of the dial proper and located above the bezel—illuminates the figures and scale markings so that one may tune the circuit very accurately.

The full volume output of the audio amplifier may be diminished by merely turning the knob on a variable resistance unit which shunts the secondary of the first audio transformer.

OUTPUT DEVICE EMPLOYED

AS IS the custom with the many modern types of receivers, a choke coil and condenser are arranged in the output circuit so that the windings of the loud speaker may be operated free from the excessive drag exerted by the d. c. component of the high B potential on the plate of the last tube. Also, better quality of tone is obtained with this system due to the fact that a Samson tapped output coil is employed, making possible the adjusting of the impedance of the coil to approximately match the particular characteristics of the loud speaker used. The condenser employed in this combination must possess especial qualifications, *viz.*, it must be fairly large in capacity—4 mfds.—but not large physically. Furthermore, it must be capable of withstanding approximately 350 volts. The Tobe-Deutschmann 4-mfd. bypass condenser is suitable for this purpose, and is employed in the receiver described.

Wiring throughout the receiver is accomplished with the use of Belden hook-up wire. This wire, consisting of a number of tinned twisted strands of fine copper wire, is well insulated with a rubber covering. It is obtainable in the following colors: Red, blue, green, and gray or natural. The use of this wire greatly simplifies the connecting of the various units of the receiver, and permits the A, B, and C battery leads to be twisted and cabled.

So that a power tube may be used in the last audio stage, the filament wiring to this socket includes a separate $\frac{1}{2}$-ampere filament ballast, such as a Brachstat. The other three tubes are connected with their filaments in parallel and controlled by a single $\frac{3}{4}$-ampere filament ballast.

Regeneration in the detector circuit is accomplished by means of a small variable condenser of 50 mmfd. The Precise is very satisfactory for this work and is used here.

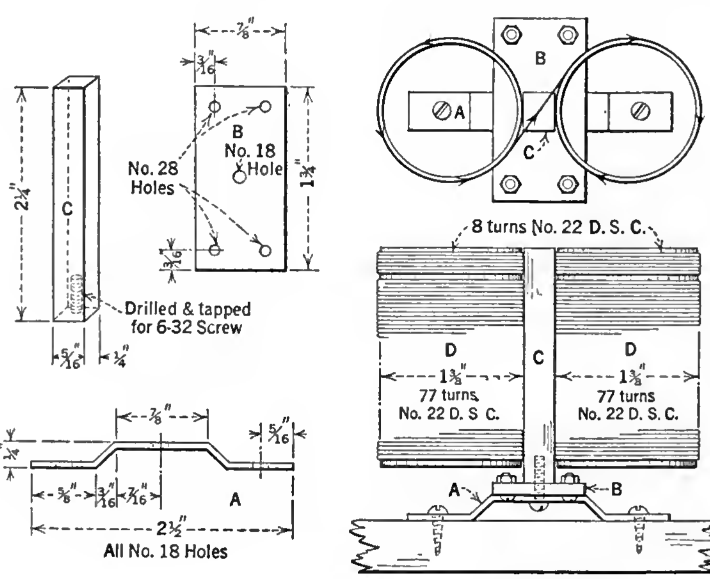


FIG. 2

Data for the construction of the coils and supports are given here. Reference to the text on page 37 and Fig. 3, will simplify the making of the coil units

LAYOUT IMPORTANT

TO CONSTRUCT a receiver similar to the one described, detailed layouts, wiring diagrams, and explanatory sketches are furnished so that there need be no great difficulty in this respect.

Only when actual duplication of the layout and wiring of the receiver as herein described is attempted, can successful operation be assured. This point cannot be stressed too greatly. Mr. Henney, in his previous articles, dealt at length with the advisability of placing parts and wiring correctly to prevent objectionable feedback effects. The use of Airgap sockets, which introduce a minimum of grid-plate capacity, aids in reducing this feedback. The receiver described in this article is the result of much experiment, and it is doubtful whether with the apparatus employed a more successful arrangement can be obtained. It is for this reason that constructors are urged to follow closely the design as given.

To begin actual construction of the receiver, the following parts are required:

- 2 Cardwell 0.00035-mfd. Variable Condensers, type 169E.
- 2 "Lab" Circuit Tuning Coils, General Winding.
- 2 Marco Illuminated Dials.
- 4 Sockets, Airgap.
- 2 Amertran Audio Frequency Transformers, 1st and 2nd stages.
- 1 XL Neutralizing Condenser, type N.
- 2 Samson Choke Coils—85 millihenries.
- 1 Samson Output Impedance, type O.
- 1 Tobe-Deutschmann Bypass Condenser, 1-mfd.
- 1 Tobe-Deutschmann Output Condenser, 4-mfd.
- 1 Electrad Royalty Variable Resistance, 500,000 ohms.
- 1 Electrad Filament Switch.
- 1 Electrad Grid Condenser, 0.00025-mfd.
- 1 Electrad Fused Metallic Grid Leak, 4 megohms.
- 2 Brachstats, $\frac{1}{2}$-ampere and $\frac{3}{4}$-ampere.
- 2 Frost Pin Jacks.
- 1 Precise Microdenser, type 940, 50-mmf.
- 9 X L Binding Posts.
- 1 Radion Binding Post Strip.
- 1 Panel 7 x 21 x $\frac{3}{16}$ inches, Formica.
- 1 5-wire fused Belden battery cable cord.
- 1 Fritz Cabinet.

Having obtained the necessary parts, we now lay out and drill the panel in accordance with the panel sketch, Fig. 4. Each Marco dial is furnished with a steel template which enables the builder to drill the holes in the panel necessary to mount the window.

Now cut and prepare a base board, details of which are shown in Fig. 11. Brackets, to fasten the panel to the base board and the C batteries to the rear wall of the cabinet, are shown in Fig. 10. Brass strip, $\frac{1}{2}$-inch wide and $\frac{1}{16}$-inch thick is used for this purpose. Also in this diagram are shown the details necessary to prepare the binding post terminal strip.

The next thing to do is to fasten

the metal panel shield to the panel proper by means of four screws which pass through the brass brackets holding the panel in place. The copper should be laid flat on the panel and holes located at the various points where the instruments must project through to the front of the panel. The holes must be made sufficiently large so that no part of the instruments will come in contact with the shield itself.

Assemble the Precise regeneration condenser, Electrad Royalty 500,000-ohm variable resistance, Frost pin jacks, and Electrad filament switch on the panel in their respective mounting holes. Then set the panel aside and assemble the parts on the base board. A layout of these parts is shown in Fig. 5.

Without fastening the panel to the base board, much of the wiring can be done, as shown in Fig. 8. It is better to do the simpler and shorter connections first. For instance, the audio transformers and sockets are close enough together so that with the aid of a lug on the terminal of the socket, direct connection, without the use of wire, can be made from the grid and plate posts of the sockets to their respective grid and plate transformer terminals. After this is done, the filament wiring may receive attention. Here is where cabling of the leads is beneficial. First, with a piece of gray (natural) hook-up wire, connect the minus F terminals of all the sockets together, leaving about $\frac{3}{4}$-inch of slack wire between the terminals. Next, beginning at the minus A binding post, run a piece of the same colored wire along the

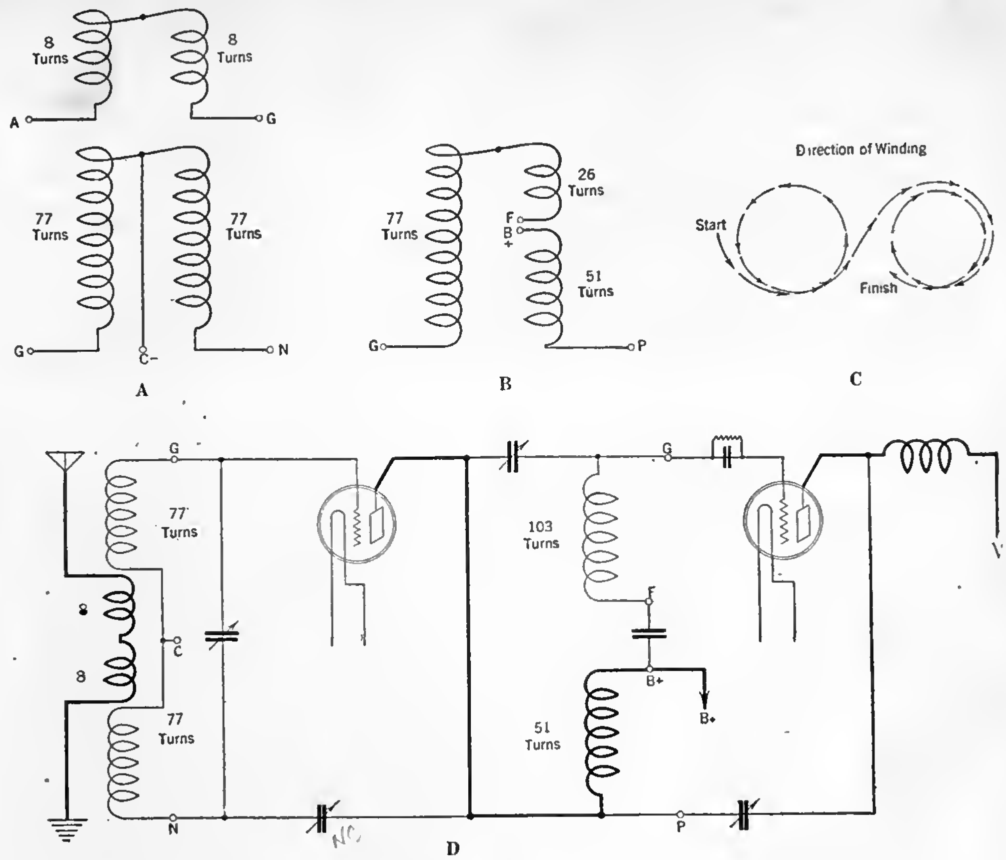


FIG. 3

The diagram above, together with that on page 36 and the text in the article will enable the veriest of home constructors to satisfactorily produce the "Lab" circuit coils. The connections of these coils in the circuit are explained by the diagram given here

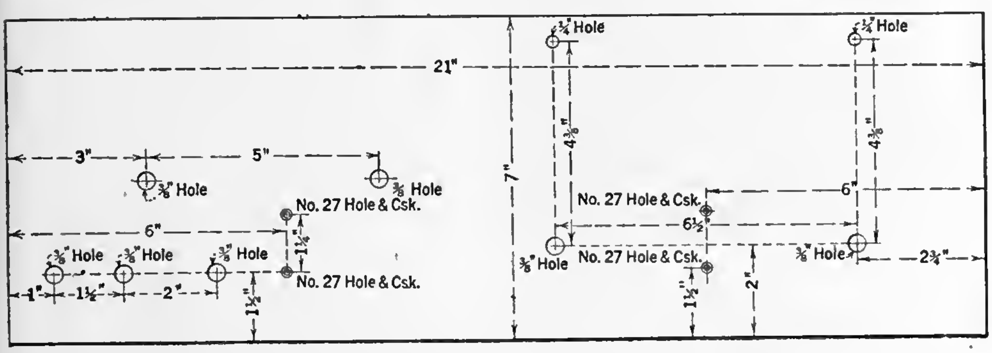


FIG. 4

The panel for the "Lab" receiver should be drilled in accordance with the directions on the diagram above. A steel template furnished with the Marco illuminated dials enables accurate drilling of holes for the windows on the panel to be accomplished

back of the base board and down the left-hand side, and cut it when it is long enough to reach the position the filament switch on the main panel will take. This piece of wire is run parallel to the back edge of the base board and, as it advances, it is wound over the previous socket wiring threading it under and over, etc. From the second approximately estimated position of the contact on the filament switch a similar piece of wire is run back to the minus F post on the last audio socket. It also is twisted with the other lead emanating from the filament switch.

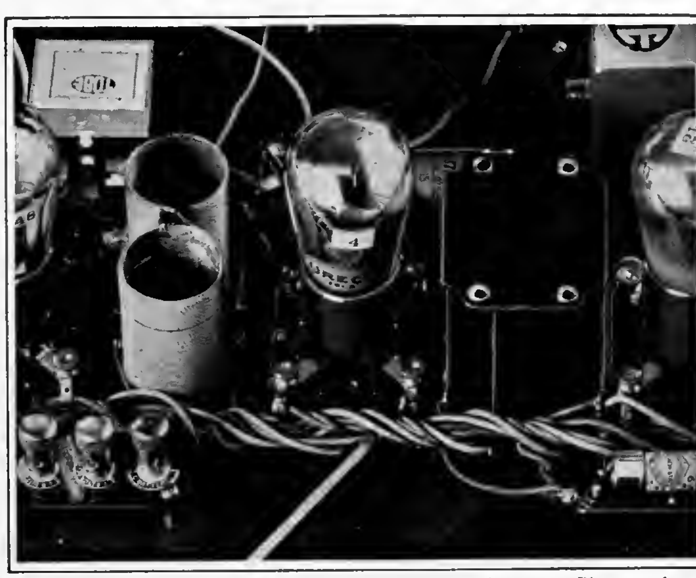
Continuing the filament wiring, a piece of green wire is started from the plus A binding post, wound or twisted around the gray wires, and attaches to the right-hand end of each filament ballast. In the radio frequency, detector, and first audio stages, the plus F posts are connected together with more green wire, which is twisted over the rest of the wires. At this time, it is not well to connect the remaining contacts on the Brachstats to their respective terminals on the sockets because the presence of these wires will impede the completion of the wiring of the B battery and C battery leads. From both audio transformers, connection must be made to the B and C binding posts on the terminal strip. As these connections are made, the wire is twisted around the mass already forming a formidable cable. The B battery leads are done in red wire, the C battery leads in blue.

COIL DATA

THE tuning coils may be directly wired into place without difficulty.

Winding and assembling the coils for the "Lab" circuit is not as complicated as a first glance at the sketch in Figs. 2 and 3 would make one believe.

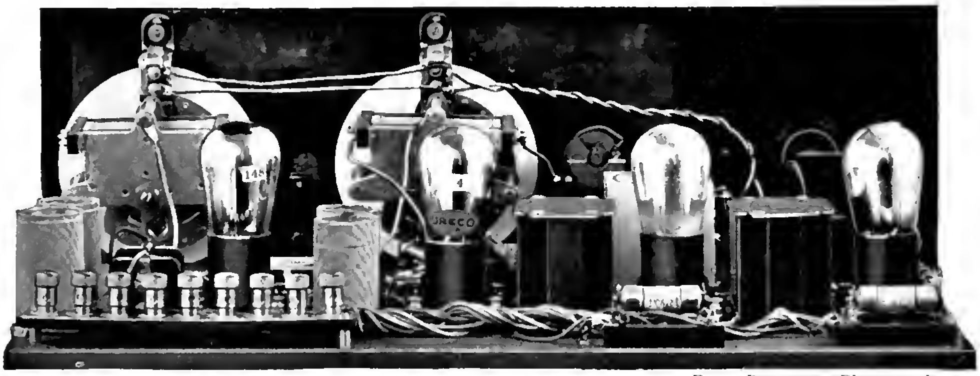
First procure the material, namely: A $\frac{1}{4}$-lb. spool of No. 22 d.s.c. wire (a $\frac{1}{4}$-lb. spool is too much, but it is doubtful whether a smaller amount can be purchased); a piece of $\frac{1}{8}$-inch bakelite or formica; a strip of $\frac{1}{2}$ x $\frac{1}{16}$-inch brass strip; four No. 6 brass round head wood screws; a mailing tube $1\frac{3}{8}$-inches in diameter, and a sheet of celluloid, such as is used in photography. A strip of bakelite or formica is also required as a coil support. This may be obtained by cutting a strip of the desired width from a sheet of $\frac{3}{16}$-inch panel material. With this is required one $\frac{1}{2}$ x $\frac{6}{32}$ inch round head brass machine screw.



RADIO BROADCAST Photograph

A CLOSE UP OF THE CABLING

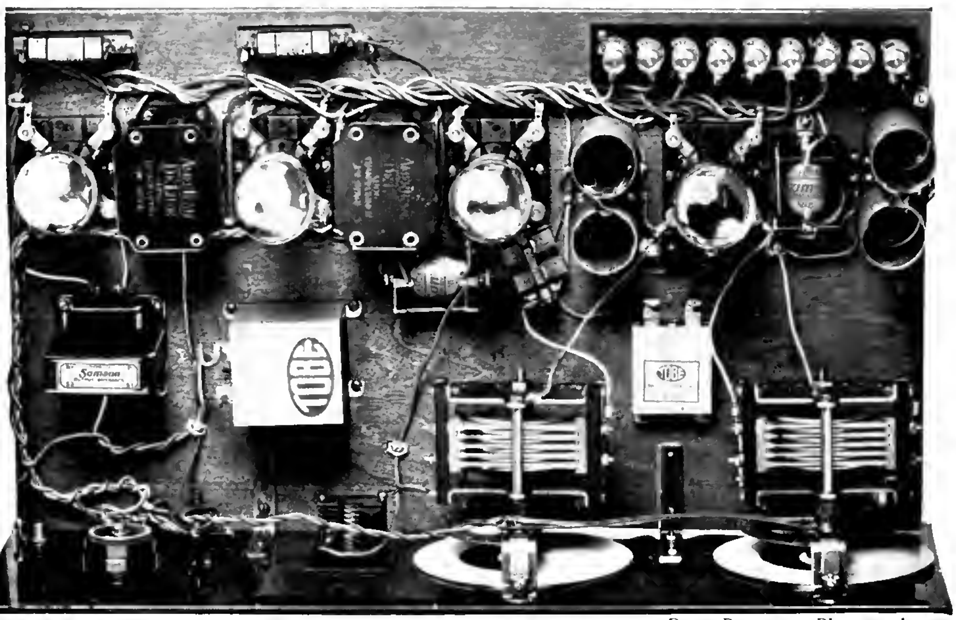
Shows how all the wires are formed into one big twist. This is accomplished by threading each wire as it progresses from terminal to terminal under and over those already there



Radio Broadcast Photograph

THE SHIELD

Against the rear of the main panel as illustrated here is beneficial since it eliminates the hand capacity effects so detrimental to accurate tuning



Radio Broadcast Photograph

FOR CROSS REFERENCE

This from-above-the-baseboard view should be studied in conjunction with the diagram Fig. 5. This picture shows very clearly how well spaced the various units are, and gives an excellent idea of the cabled filament wiring

Remove the chemical coating from the celluloid film by washing in hot water. Then wrap this sheet around the mailing tube to form just one layer, cutting away the surplus. By applying acetone along the seam formed by the celluloid edges a complete cylinder of celluloid will result.

From this point on it is better if two people do the job, one to turn the cylinder, the other to guide the wire. However, before the wire is started on the form, lightly coat the entire surface of the celluloid with acetone. This will produce a sticky surface in which the wire will find a substantial hold. From time to time as the wire advances along the form, it may be found necessary to freshen the surface by additional coatings of acetone.

Wind about seven inches of wire on the form and set it aside until the celluloid has become hardened again. Then, starting at one end, count seventy-nine turns and lift up the wire at the 79th turn with a knife blade and cut it. Then, unwind back toward the starting point, two turns, so that there are exactly seventy-seven turns in this one section. Beginning again where the wire was cut unwind two more turns. This produces a space four turns wide. Count out ten more turns and cut the wire. Unwind two turns to form a lead, leaving eight turns in the second section. With a pen knife cut the celluloid form at the eighth turn and you have a coil form upon which are wound two sections, one of seventy-seven turns and one of eight turns. These sections are separated by a space equalling the width of four turns. Now duplicate this process, making another identical coil unit. These two units constitute the antenna circuit inductance.

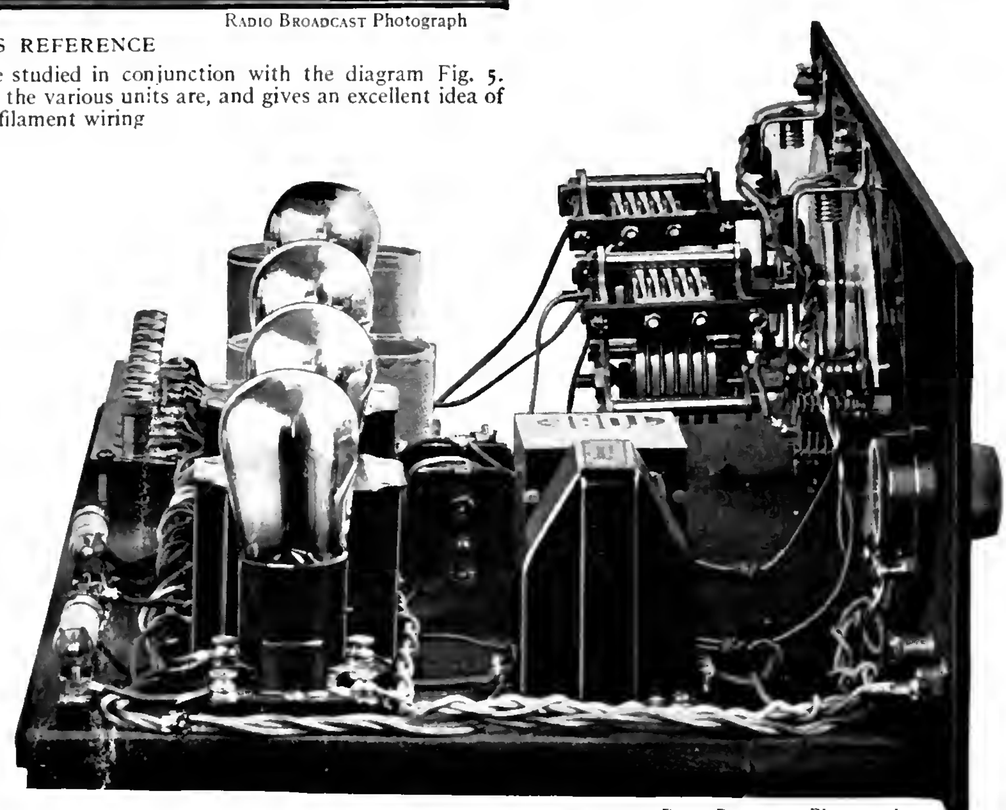
By dissolving strips of celluloid in acetone, a cement may be made with which the coils may be fastened to the central support, C, as in Fig. 2. The leads from each coil are terminated as shown in Fig. 3.

For the interstage coil system, the proceedure is somewhat the same excepting that the first coil unit has a single winding of seventy-seven turns on it. The second coil unit is wound first with twenty-six turns, then a space equal to two turns, and finally a section of fifty-one turns. The correct connections for the interstage form are shown in B, Fig. 3. It is essential that the turns in each form of a completed coil assembly run in the same direction, as in C, Fig. 3. The manner in which the coils fit into the circuit is illustrated in D, Fig. 3.

Returning to the wiring, we note that the grid condenser is mounted directly on the detector socket. This insures the shortest possible connection.

Reference to the wiring diagram and circuit diagram, Figs. 8 and 7, will show that very simple connections are made to the radio frequency choke coils. Also, the neutralizing condenser is so positioned that short leads are all that are necessary to wire it correctly into the circuit.

Three blue wires are twisted together and connected, one to the G post of the first audio transformer, another to the F post of the same transformer, and the third to the G post of the first audio socket. These wires, in the form of a separate cable, are passed along the front of the transformers to the left hand edge of the base board, thence along it to a position at the



Radio Broadcast Photograph

ATTENTION TO THE LAYOUT

Is an important factor that is often overlooked in construction of a new receiver. The wide baseboard of the "Lab" Receiver enables all the apparatus to be placed to best advantage. Note the cabled filament wiring which runs right around the base board to the switch and rheostat

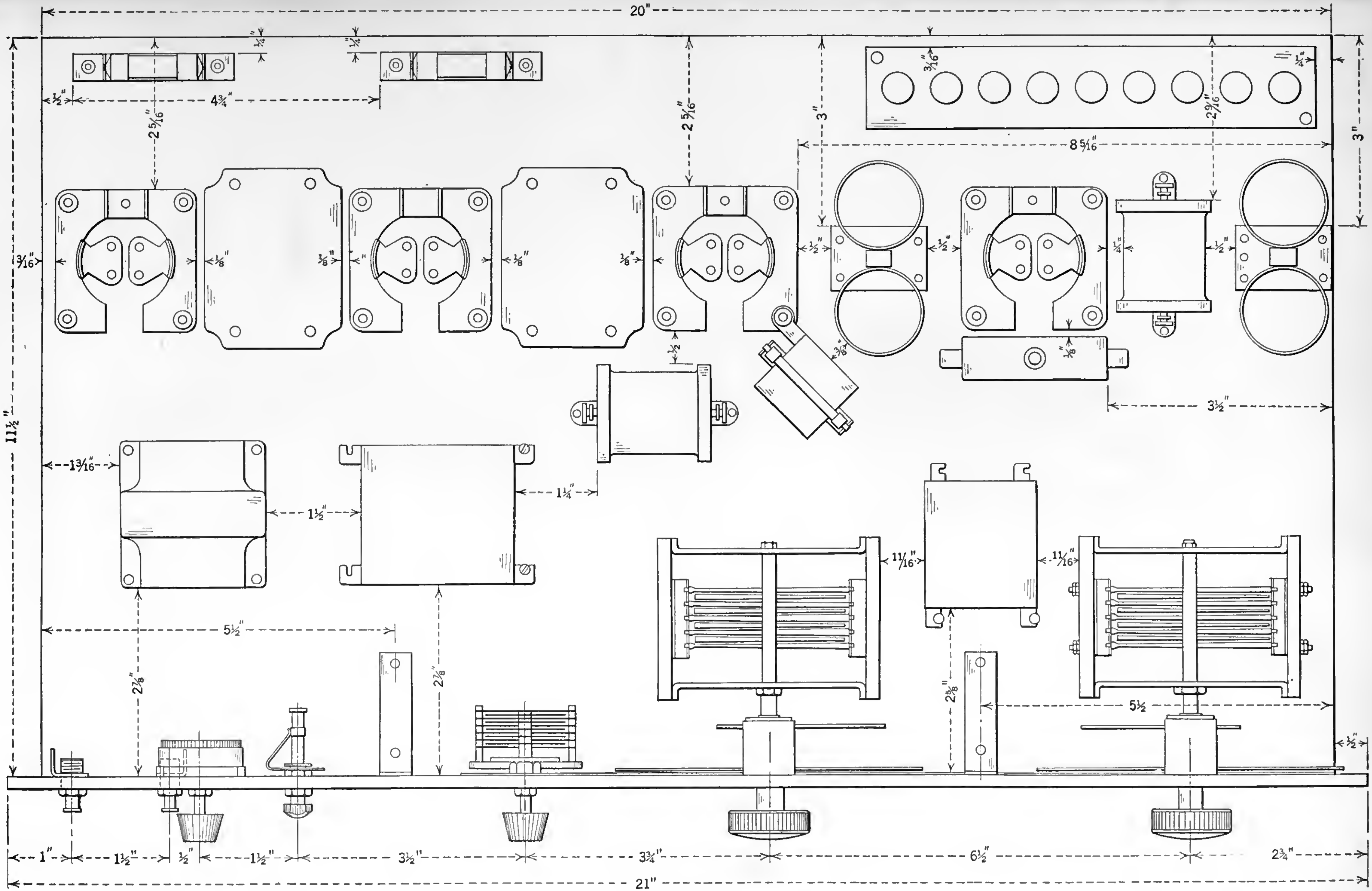

20"
11½"
3"
3"
3"
2 5/16"
2 5/16"
4¾"
½"
¼"
¼"
3/16"
¼"
2 9/16"
8 5/16"
3/16"
⅛"
⅛"
⅛"
⅛"
½"
½"
½"
¼"
½"
3/8"
⅛"
3½"
1 3/16"
1½"
1¼"
11/16"
11/16"
5½"
2⅞"
2⅞"
2⅝"
5½
½"
1"
1½"
½"
1½"
3½"
3¾"
6½"
2¾"
21"

FIG. 5

Radio Broadcast Photograph

THE TUNING CONTROLS

Are clearly shown in this side view of the R. B. "Lab" Receiver. The two nearest tubes are the r. f. and detector ones, and not the audio stages, as one would be apt to suppose

front approximately in line with the 500,000-ohm volume control on the panel.

At this point the base board assembly may be laid aside and further work on the panel continued.

First examine the Marco dials; two types are available on the market. The new style is recognized by the fact that the lamp receptacle holding the pilot light is completely isolated from the metal frame of the dial whereas, in the old style, one side of the lamp receptacle was connected to the frame. The new style dials can be used without any alterations, but it will be necessary to change slightly the construction if the old dials have been purchased.

In this latter instance, it is necessary to cut away the upper part of the frame supporting the dial light, removing a $\frac{3}{32}$-inch section. By means of a small piece of fibre, rubber, or other insulating material, these two parts are joined together again. The insulating strip insures against short circuits, etc., and, in the circuit employed, prevents blown out tubes. Detailed sketches showing how these changes are made, are contained in Fig. 10.

After the dials have been satisfactorily altered, the condensers are mounted on them, and the whole assembly is mounted on the panel. When this is completed, the panel may be fast-

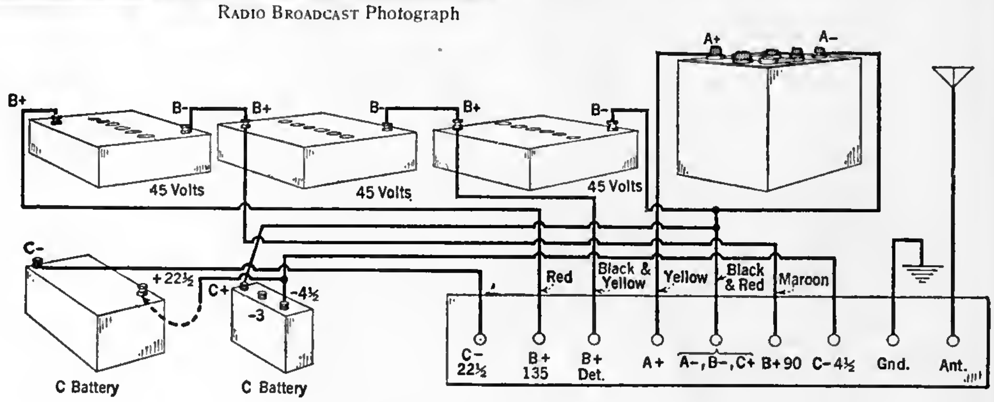


FIG. 6

To the right a plan of the battery connections to the binding post strip is given. A Belden cable is employed for all but the C battery leads

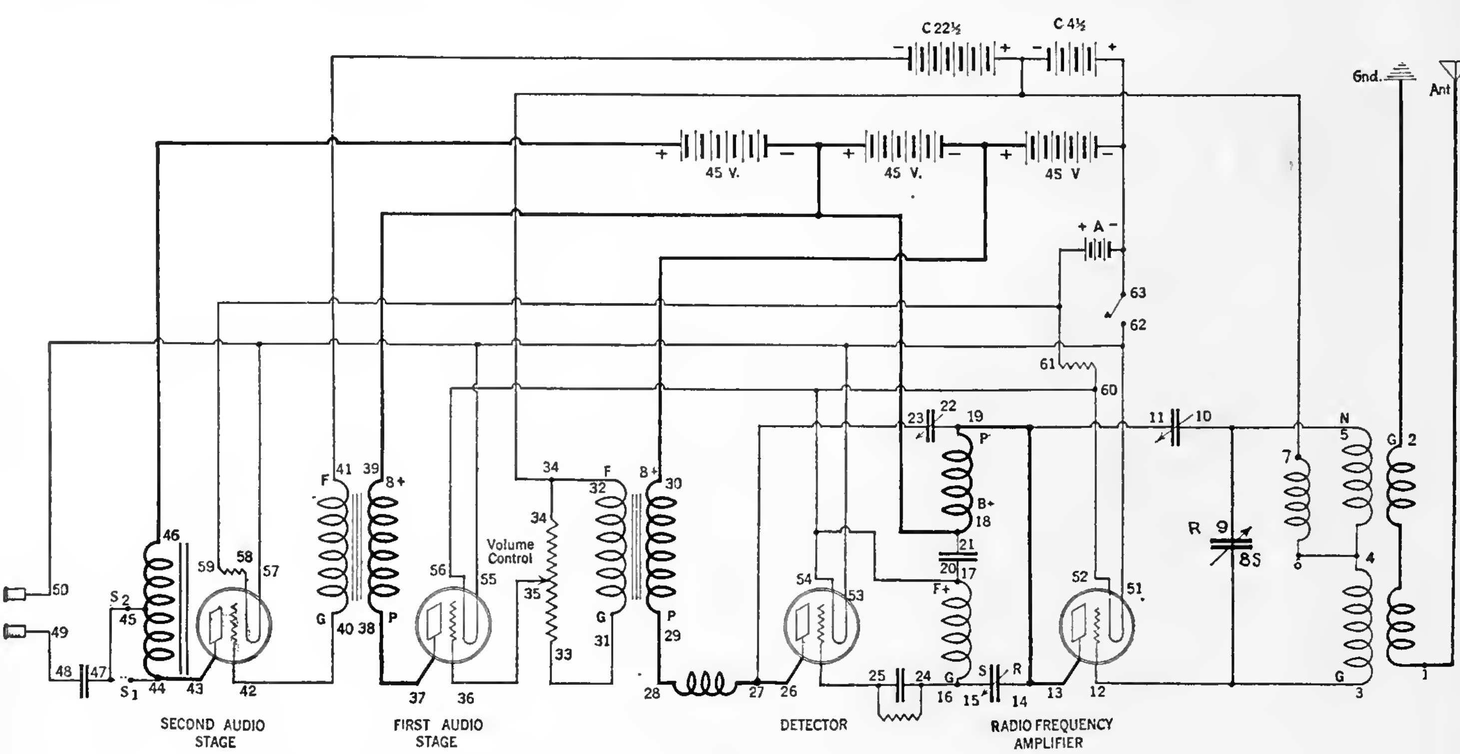


FIG. 7

Here is given the circuit diagram of the four-tube Radio Broadcast "Lab" Receiver. Note that the progress of the incoming signals is from left to right, and not vice versa, as is usually the case. The coil unit at the extreme left, between the terminal numerals 44-46 is a Samson type O audio output impedance coil designed to protect the windings of the loud speaker. Its impedance is variable in two steps which approximately match existing types of loud speakers

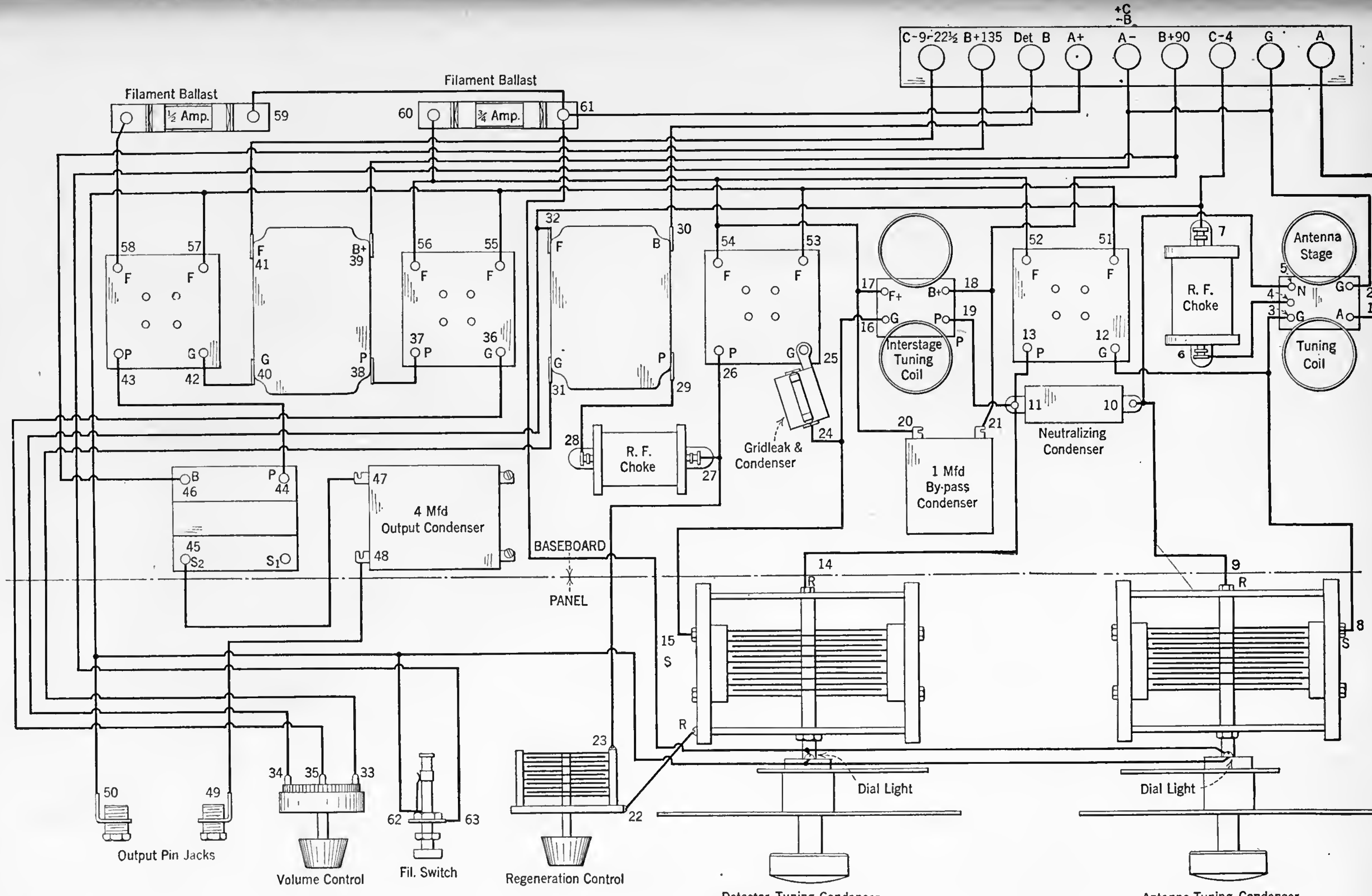

+C
-B
C-9-22½
B+135
Det B
A+
A-
B+90
C-4
G
A
Filament Ballast
½ Amp.
Filament Ballast
¾ Amp.
Antenna Stage
Tuning Coil
R. F. Choke
Interstage Tuning Coil
Neutralizing Condenser
1 Mfd By-pass Condenser
Gridleak & Condenser
R. F. Choke
4 Mfd Output Condenser
BASEBOARD
PANEL
Dial Light
Dial Light
Output Pin Jacks
Volume Control
Fil. Switch
Regeneration Control
Detector Tuning Condenser
Antenna Tuning Condenser

FIG. 8

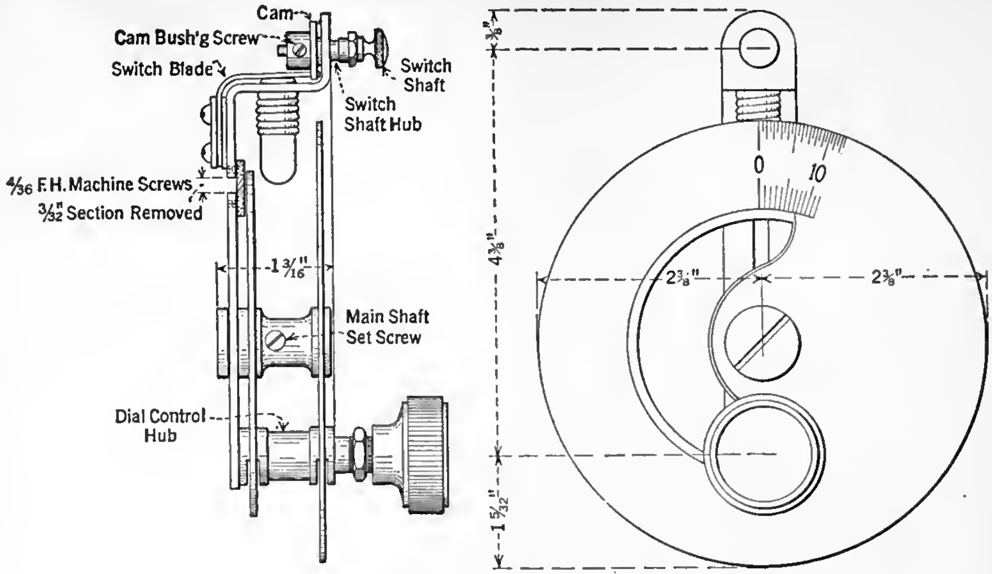


FIG. 9

There are two forms of the Marco illuminated dial on the market. If you have obtained any but the latest models, a slight alteration will have to be made. This alteration, which involves the removal of a section of the frame, is explained elsewhere, and is clearly shown in the above diagram

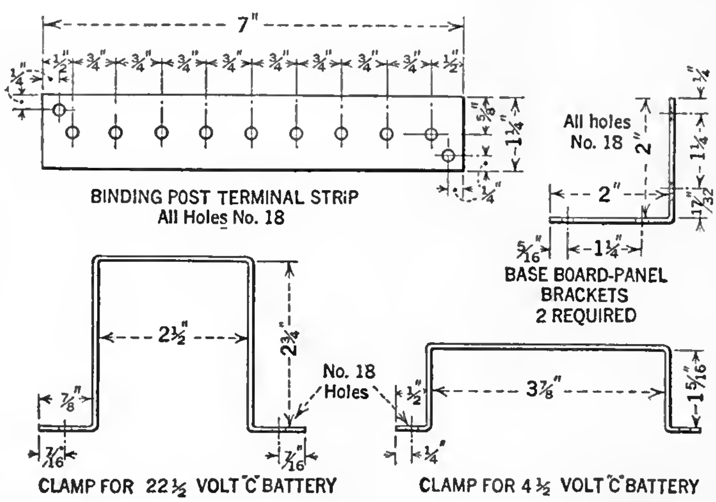


FIG. 10

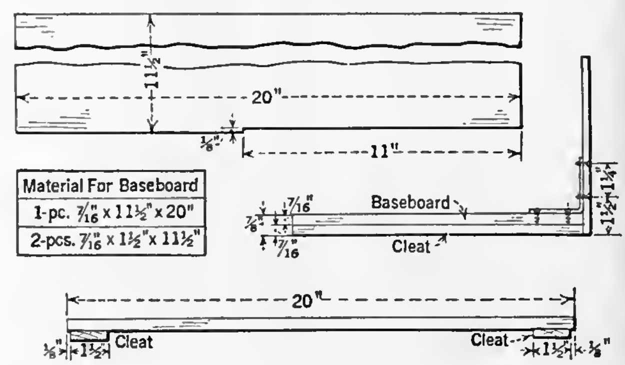


FIG. 11

For the base board it is essential that good wood be employed, thus obviating any possibility of warping. The base board of the "Lab" Receiver is exceptionally wide, and cleats are employed to strengthen it. The base board supports the front panel rather than the front panel supporting the base board, which is generally the case

ened to the base board by means of the brackets, details of which are shown in Fig. 10.

To complete the wiring of the receiver the units on the panel are wired to their correct points on the base board.

By means of a five-wire fused Belden battery cable, the batteries, with the exception of the two C batteries, may be connected to their respective binding posts. The five wires of the Belden cable are colored as follows; red, maroon, yellow, black with red tracer, and black with yellow tracer. These wires are connected to the binding post terminal strip as shown in Fig. 6. The C batteries, since they are contained inside the receiver cabinet, are connected directly to their respective binding posts, as is also shown in the same diagram.

THE CORRECT TUBES TO USE

THREE 201-A tubes may be used in the first three sockets and a 171 tube in the last audio socket. At 135 volts of B battery, this latter tube requires about 27 volts of C battery.

Now pull out the filament switch. This should light all the tubes. Turn the regeneration condenser so that its movable plates are completely meshed with the stationary plates. Then, with the aid of the tuning chart shown in Fig. 1, set the right-hand dial at an approximate setting for the station it is desired to receive, and slowly turn the knob of the detector condenser, swinging it a few degrees above and below the number on the other condenser. If the station is broadcasting, a regeneration squeal will be heard in the phones or loud speaker. Back off the regeneration condenser setting to diminish the squeal. Then slowly rotate the antenna tuning condenser. If the squeal changes in pitch, the neutralizing condenser should be adjusted until there is no such variation of the squeal pitch. The set is then properly neutralized and may be operated like any other receiver that employs the squeal method of tuning. The fact that a squeal can be heard in the loud speaker does not necessarily mean that other neighboring receivers will also pick up this squeal—providing that first you have satisfied yourself as to the proper neutralization of the receiver. This enables you to turn up the regeneration control and then vary the tuning of the detector condenser until the carrier wave of a station is picked up.

Now, from this point onwards, it is only a matter of bringing the antenna condenser setting up to the point where the loudest squeal results and then backing off the regeneration control until the squeal is eliminated. In its place ought to be the music, or speech from the broadcasting station to which the set is tuned.

Radio Broadcast Photograph

INSPECTING THE JOB

Right to left, are Willis K. Wing, editor, Keith Henney, Director of the Laboratory, and Howard E. Rhodes of the Technical Staff. Mr. Henney is pointing to the cabled leads which are distributed along the rear and side of the base board

The Listeners' Point of View

Conducted by ...... John Wallace

Who and Where the Infants Really Are In Radio

WHENEVER we begin to feel too morbid about the headway—or non-headway—that radio is making we are cheered up considerably by a happy thought which we shall make haste to share with you.

We are thoroughly sick of the phrase "in its infancy." For the last twenty years the movie industry has been assuring us that it is "in its infancy." So frequently and loudly has this phrase been repeated that it begins to take on the air of a boast rather than a well warranted apology. And, as you well know, the phrase is being constantly applied to radio with the same *double entendre.* So we shall not make ourself an accomplice in the crime by here repeating it ourself—even though it would fit in very nicely.

Instead, we shall say that the men behind the scenes, the *entrepreneurs* of radio, are in their infancy. We do not mean this facetiously but literally. Perhaps it isn't true! If so our pet spark of hope goes a glimmering. But our occasional ventures behind the scenes have disclosed that the usual radio personnel is made up of young men. Generalizing from the few studios we have visited, we guess that the same conditions obtain at the rest of the stations.

Nor is it surprising that radio should be manned principally by youths. The business "broke" all of a sudden. In its humble beginnings there was no hint of the prosperity it was to achieve. To enter the "radio game" was an out and out gamble; and a gamble is not entered into too recklessly by a middle aged, or past middle age, man. Moreover, on the technical side, there were a hundred boys interested in the mechanics of the new invention to the one adult that was similarly engaged in experiment.

The consequence was that back in the early twenties, opportunity-seeking young business men and just-out-of-college boys made a rush to enter the broadcasting profession, and succeeded pretty well in filling up all available seats. And now the older man, the conservative who hesitated to jump at such a long chance, must stick to his banking business or the Governorship, for there's no room for him.

Possibly you have yourself at some time become interested in the resonant, deep and mature voice of some favored announcer. You have pictured him as a kindly, grayed old man with dignified side whiskers. Chance, let us say, brings you to his radio studio. Curiously you ask to have him pointed out. Lo and behold! you are shown a sleek haired youth in twenty-six inch trou'.

Or mayhap you have read in the public prints the comments of Manager Bloopus of WHEW on current radio events and marveled at the paternal sageness of his pronunciamentos; only to have some disillusioning friend point him out in an ice cream parlor perched boyishly on a high stool guzzling a double choc'lit sundæ with nuts.

Yes, radio as we find it at present is in the hands of the youth of the country: it is a boy's profession. We state this in no spirit of derision but as, we believe, a fact. Far be it from us to hold against the purveyors of radio entertainment their youth. Perhaps we are in a glass house! On the contrary, we think that this factor was in a measure responsible for the wim and wigor of radio's get-away. And supposing radio were operated by a bunch of gray beards; would we be any better off? The answer is no.

For they wouldn't be any better equipped to manage a radio station for having spent forty years in the dry goods business or operating a newspaper. At the time radio came into being no one was any better fitted by previous experience to enter its ranks than anyone else. For radio was, and is, different than any previously existing sort of "art" or industry. By way of exception, people in the theatrical business had some sort of qualification for the new trade, but not much. Also, the impressarios of the musical world were specially fitted, but unfortunately for us listeners, but few of them abandoned their concert halls and lyceums for the radio studios.

And now to sound the cheerful note which we promised in the opening paragraph of this dissertation. When things look blackest we are consoled by this reassuring thought: what of ten, twenty years from now?

Ah, there you have it—the secret of our ineradicable smile! We, the listeners, will be being served by a flock of veterans. The present staff of each and every radio station, barring assassinations, and acts of God, will still be in existence, *in toto.* We cannot help but believe that this accumulation of experience will mean much. An analogous condition exists in the automobile business to-day. It is the boast of several large concerns that they have almost the identical organization with which they started twenty-odd years ago. Such an organization necessarily becomes closely knit and highly efficient.

Ten or twenty years diligently devoted to an endeavor to discover "what the public wants" should certainly result in some light being cast upon that elusive riddle. The making up of the programs and the doling out of them should by that time be reduced to a formula. The demands of the public will doubtless vary slightly from time to time, but once having determined the general trend of its likings it will be easy to introduce these gradual variations.

Take, for instance, the announcer. Ten or twenty years of announcing (if any of them stick it out that long) should completely exhaust the jests of any announcer and make him a mechanical "announcing machine"—which is just what we would have him. In the course of that time he should have experienced almost every conceivable situation, from conniption fits on the part of the tenor soloist to an explosion in the studio. (And the announcer, lest we fail to give him credit, has plenty of exacting situations to handle.) So in 1936 we may expect him to smooth over any mishap gracefully, and to deliver himself of his routine labors in a very minimum of words.

Of course there is the danger of an inbred organization going stale. But there will inevitably be some changes, some new blood entering the broadcasting profession. And all the while there

AIDAN REDMOND, OF WBZ

A new addition to the announcing staff of the Springfield station. Mr. Redmond officiates usually from the Hotel Brunswick studio of station WBZ, in Boston. Before he came to radio, Mr. Redmond was on the concert stage. He is a native of Cambridge, Massachusetts

THE PENNSYLVANIA RAILROAD "HOUR" ARTISTS

Who are regularly heard through WJZ, WGY, and WRC on Tuesday evenings from eight to nine P. M., Eastern Standard Time. The photograph forming this illustration was made in the studio of WJZ. At the extreme left is Eddie Smalle, piano; next, a quartette: Franklyn Bauer, tenor; Elliott Shaw, baritone; Lewis James, tenor; Wilfred Glenn, bass. Following the quartette is Norman Brokenshire, erstwhile announcer of WJZ, holding the cord of the locomotive bell used to give a realistic touch to the programs. The others in order are, Frank Banta, pianist; Andy Senella, saxophone and guitar; Sam Horman, xylophone; Alvin Simonds, porter at the WJZ studio. He adds realism by blowing on the railroad whistle as occasion requires

will be that nucleus of experienced veterans—the boys of today—serving as a stabilizing influence. On the whole the outlook is a happy one!

"Merchants of Glory"

TO INTRODUCE a variation on the above theme, there is one group of individuals connected with the radio business whom we fervently wish would grow up in a hurry, and they are the publicity men. Now you as a listener have little or nothing to do with the publicity men so there's really no reason why we should air our complaints to you. But we, so much the worse, are exposed to them, or rather their products, daily—and it occasions us great ire.

Perhaps you would be interested in being taken behind the scenes and informed as to their deadly activities. Every radio station maintains a publicity man, or if it is big enough, a staff of publicity men, to see that its name is kept prominent in the newspapers—a perfectly legitimate job and not an offensive one if it is done properly. These publicity men set their agile wits to working and send forth about once a week an envelope full of mimeographed drivel, tooting the horn of the station they represent. This parcel of printed matter, together with advance programs, is sent to radio editors throughout the country. It's brought to our desk in baskets.

And if ever you think that the standards of any particular department of radio are low, rest assured that they are nowhere near the rock bottom attained by the radio publicity staffs. Some of these propagandists may be adults, but their prose endeavors certainly read like the work of a backward school-boy. This is no reflection on the profession of publicity as a whole. In the ranks of the publicists are numbered some of the most able journalists in the country. In fact if you run across an especically readable and well written "story" in a newspaper you may eight times out of ten discover that a good publicity man is behind it.

Radio has simply been unfortunate in not having lured into its camp able and experienced publicity men. The puerility of efforts in this line is borne witness to by an inspection of any newspaper radio section. We find therein column after column of stories containing no whit of interesting information but only a series of wild hurrahs for this or that station and a pack of obviously manufactured yarns.

We could quote you several yards of silly statements that have crossed our desk during the last month, but fortunately for you we have already emptied our waste basket. We have at hand just one specimen. The publicity man has been touting his station for its high-brow offerings and concludes his article with the remark:

> In radio, the child gets a basic training in the *better* type of music, an acquaintance with the outstanding musicians and operas of the nation. *Little children to-day recognize selections from Brahms, Wagner, Beethoven, and others equally popular in musical circles, without trouble.* (Italics ours)

No event in the studio is too personal, insignificant, or utterly uninteresting for the publicity man to devote several hundred words to it. If the second cousin of the great aunt of one of the station's artists gives birth to a boy we are promptly informed of its weight, color of eyes, and early remarks.

There are exceptions, of course. Among the five hundred or so stations in the country there are at least ten that send out fair publicity material. And among these ten there are three stations whose publicity is as excellent as could be asked—that is: it is not "publicity" but news, news with thought, research, and painstaking writing behind it.

As for the rest of the publicity men, ten or twenty years of experience (if they stick that long—some of them ought to be fired at once) should result in a marked improvement in their output. We may even come to look forward to our daily publicity mail. Perhaps in thirty years it will be considered Literature!

Men vs. Women as Announcers

ONE of our predecessors in this department threshed out this matter pretty well; but further light has been cast upon the subject by a questionnaire conducted by WJZ. A canvass of 5000 listeners resulted in a vote of 100 to 1 in favor of men as announcers. Says Charles B. Popenoe, manager of WJZ, anent this vote:

Our previous experience had indicated that listeners preferred men as announcers, but we

Probable Football Broadcasts This Season

Here is a tentative list of scheduled football games to be broadcast during the 1926 season from some of the main stations. It is not improbable that additions and corrections will be made to this list, but such will of course be announced by the stations concerned.

WJZ, WGY

OCTOBER 16, Princeton-Navy, at Princeton.
OCTOBER 23rd, Yale-Brown, at New Haven.
OCTOBER 30, Navy-University of Michigan, at Baltimore.
NOVEMBER 6th, Harvard-Princeton, at Cambridge.
NOVEMBER 13th, Yale-Princeton, at Princeton.
NOVEMBER 20th, Harvard-Yale, at New Haven.
NOVEMBER 25th, Pennsylvania-Cornell, at Philadelphia.

WEAF
AND CHAIN STATIONS

OCTOBER 16th, Dartmouth-Yale, at New Haven.
OCTOBER 23rd, Chicago-Pennsylvania, at Philadelphia.
OCTOBER 30th, Army-Yale, at New Haven.
NOVEMBER 6th, Princeton-Harvard, at Cambridge.
NOVEMBER 13th, Yale-Princeton, at Princeton.
NOVEMBER 20th, Harvard-Yale, at New Haven.
NOVEMBER 25th, Cornell-Pennsylvania, at Philadelphia.

WBZ

OCTOBER 16th, Dartmouth-Yale, at New Haven.
OCTOBER 23rd, Harvard-Dartmouth, at Harvard.
OCTOBER 30th, Yale-Army at New Haven.
NOVEMBER 6th, Harvard-Princeton, at Harvard.
NOVEMBER 13th, Harvard-Brown, at Harvard.
NOVEMBER 20th, Yale-Harvard, at New Haven.
NOVEMBER 27th, Holy Cross-Boston College at Boston.

WCCO

OCTOBER 16th, Michigan-Minnesota, at Ann Arbor.
OCTOBER 23rd, Wabash-Minnesota, at Minneapolis.
OCTOBER 30th, Wisconsin-Minnesota, at Madison.
NOVEMBER 6th, Iowa-Minnesota, at Iowa City.
NOVEMBER 13th, Butler-Minnesota, at Minneapolis.
NOVEMBER 20th, Michigan-Minnesota, at Minneapolis.

WWJ

OCTOBER 16th, Minnesota-Michigan, at Ann Arbor.
OCTOBER 23rd, Illinois-Michigan, at Ann Arbor.
NOVEMBER 6th, Wisconsin-Michigan, at Ann Arbor.

were surprised to find that the preference was so overwhelming.

It is difficult to say why the public should be so unanimous about it. One reason may be that most receiving sets do not reproduce perfectly the higher notes. A man's voice "takes" better. It has more volume. Then, announcers cover sporting events, shows, concerts, operas and big public meetings. Men are naturally better fitted for the average assignment of the broadcast announcer.

Another reason may be that women prefer to hear the voice of a man. If that is true you would expect the converse to be the case. But the vote does not indicate that men prefer to hear women announcers.

Many soprano voices reproduce perfectly. There is no preference for the man over the woman in singing. There is no doubt of the radio popularity of women artists, but they are certainly not in demand as announcers.

But perhaps the best reason suggested for the unpopularity of the woman's voice over the radio is that it usually has too much personality. A voice that is highly individual and full of character is aggravating to the audience that cannot see the face and expression which go with the voice.

We resent a voice that is too intimate on short acquaintance, and the woman announcer has difficulty in repressing her enthusiasm and in maintaining the necessary reserve and objectivity. The bane of the radio voice is a certain patronizing quality which gives the effect of a teacher talking to children or of Columbus instructing the Indians. It is difficult for women to avoid the patronizing note in their effort to speak effectively over the radio.

The struggle to avoid being too patronizing or intimate results in the opposite vice of monotonous colorless delivery, like that of a dead man talking a dead language. Only male announcers, and only a few of them, have been able to strike the right key, equally remote from the majesty of Hamlet's father's ghost and the sweetness of a night club hostess.

Poetry Dept.

YOURS truly reprints a parody contributed to a Chicago colyum—not so much because he thinks it is very droll—but because of the remarkable fact that even his change in words hasn't succeeded in obliterating the musical beauty of the original.

The Listener's Silent Night

(With apologies to Walter De La Mare.)

"Is there anybody there?" said the Listener
Tuning-in the right hand dial
While his left hand twisted the other
By fractional hair's breadths the while;
And a squawk flew up out of the speaker
Over the Listener's head
And he moved the right hand dial another inch,
"Is there anybody there?" he said.
But no jazz band rewarded the Listener;
No voice boomed forth in reply
From the far, great, and open spaces;
"You're listening to KFI."
Only a host of phantom noises,
That dwelt in the ether then,
Taunted in cacophonous chorus
That voice from the world of men;
Cackled in a key coarse and strident
And uniting in shrill caterwaul
Mocked in a mad mélange of moaning
The lonely Listener's call.

They heard his step upon the window sill
And the sound of flesh on stone.
They use the aerial for a clothes line
Now that he is gone.

A Radio Play That Might Have Been

A PLAYWRIGHT acquaintance of ours some time ago showed us a melodramatic little one act-er, in the manner of the Grand Guignol, that ran something as follows:

The curtain rises disclosing a barren, snow covered waste in a remote part of northern Canada. A single, gaunt piece of timber toward back stage is the only object that breaks the monotonous expanse of cold whiteness. In the distant sky a sickly, greenish aurora borealis flickers weirdly. Then there staggers into the scene a lone man, tugging weakly on a pair of long traces. Behind him a gaunt husky shares the pull. A row of empty harnesses show that the other dogs have succumbed. Hardly is the sledge drawn into view when the man falls exhausted. A shrouded form on the sledge discloses itself as the body of his traveling mate.

The survivor struggles to his feet and attempts to carry on, but he is too weak. He talks brokenly to the dog, revealing the situation; he and his companion had undertaken the dangerous task of rushing medical supplies to a remote trading post which was in the grip of an epidemic. They became lost; their supplies gave out. One by one the dogs were killed and fed to the remaining ones. Then his companion had died.

He tries to keep awake, knowing that sleep will mean death. He munches a biscuit, the last of the food. Then he has an idea. He goes to the trailer sledge and, removing several blankets, discloses a radio set equipped with a small loud speaker. With numbed fingers he adjusts the dials, in hope that it will bear him "company" and help him to withstand the "terrible white silence." The audience then hears (from an off-stage phonograph) snatches of music and singing and talking and laughter. And now for the melodrama! The survivor, instead of being heartened by these voices from civilization, is made all the more conscious of his hopeless isolation. He gibbers to himself and laughs hysterically. Gradually we perceive that he is losing his mind. As he listens, his frenzy relentlessly heightens until he is completely insane. His blind fury is directed at the receiving set. He looks about for a weapon and commences tugging at a piece of timber half frozen in the ice. As, with feverish energy, he pries it loose, the audience (but not the man) hears announcement from the loud speaker that the trail of the lost expedition has been picked up by a rescue party and they should "keep up hope as help would overtake them at any hour." But the maniac had not heard; with a final burst of superhuman strength he brings the huge timber crashing down on the receiving set and falls unconscious into the snow. Curtain. (And spirits of ammonia.)

* * * * * *

. . . which has nothing to do with the following true happening except that the scene of both is laid in Canada.

You may recall that WBZ was broadcasting nightly during the early weeks of last November a "life and death" message as follows:

The following message is for Hudson Bay Company at Chesterfield Inlet, Repulse Bay and Wager Inlet:

The company's relief ship failed to reach Southampton Island this season. Consequently that post is insufficiently supplied with provisions. If Chesterfield Inlet or Wager Inlet receives this message, rush special courier to Repulse Bay and have forwarded from there to Southampton two sled loads of staple food, advising Southampton to draw on Repulse Bay where stocks are plentiful for further requirements. Should Repulse Bay receive this message, act on it at once without waiting to hear from Chesterfield Inlet or Wager Inlet.

Though that was almost a year ago, word has only recently been received from lonely Southampton Island, at the extreme northern end of Hudson's Bay, that the messages were successful. Another trading post in the Arctic regions, hundreds of miles away, picked up the call and rushed by dog-sled to the Hudson Bay Company post on Southampton Island the food that enabled the hunters and trappers to live through the winter.

A MILWAUKEE PROGRAM FEATURE, HEARD THROUGH WHAD
George Devine's Orchestra who, in addition to their radio "appearances," are feature performers in many theatres in and around Milwaukee

Practically two years had elapsed since anyone had gone in or come out of the Southampton Island post. As this isolated point is not equipped with a radio set, the men stationed there had no idea as to what had become of the supply ship and they were in complete ignorance that the other posts some miles south had been rationed. Chesterfield Inlet chanced to be listening-in when the appeal was broadcast and Brother Pigeon of the Oblate Fathers took down the message.

The Oblate Order labors among the scattered peoples of northern Canada and ordinarily these missionaries have few contacts with more advanced civilization, and such contacts are separated by long intervals of time. From this same Brother Pigeon, CNRO has received a letter, which tells vividly how much radio means to these isolated people:

> . . . Let me tell you now a few words about radio. A charitable person gave us a receiving apparatus so that we can better enjoy our dreadful solitude in these ice deserts. We heartily thank that person who so generously furnished the missionaries with a little bit of the joys of the civilized world. Here are a few results from the radio apparatus. We heard many a time Ottawa and Montreal. What a joy for us all in hearing of our homes. We knew the results of the last Federal elections as soon as you did yourself. We also gathered a message sent to the Hudson Bay Company asking for help for the Eskimos living in Southampton Island who were threatened by a famine because the boat could not reach them with food last summer.
>
> Could we have a few items of news from your locality we would indeed be pleased if you would broadcast them. Since we can pick up your station it is a delightful pleasure to hear "voices from home."

Good News for the Winter Season

THE pooh-poohers of radio, of whom there are still plenty, should have excellent cause to reconsider their poohs when they learn (if they learn!) that radio listeners are to have a special symphony season of their own offered by no less an organization than the New York Symphony Orchestra under the direction of Walter Damrosch.

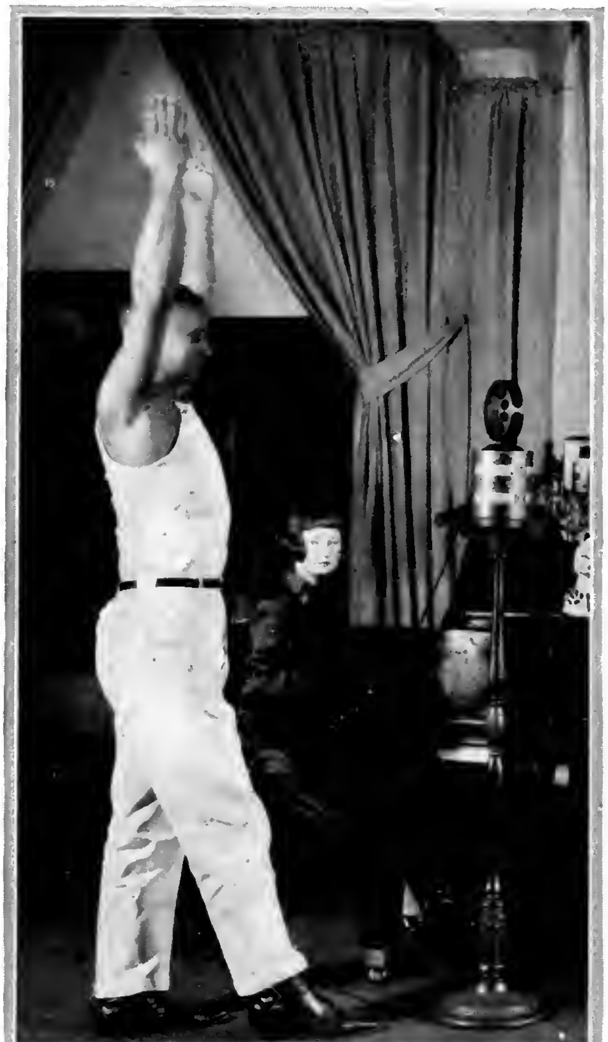
For if the engineers do a good job of microphone placing and transmitting and the listener has a first rate receiving set the concerts should be very nearly as good as if they were heard in an auditorium. (Providing also that the music is selected with regard to its adaptation to reproduction.) And there will be the added advantage that the radio audience will not be obliged to see the orchestra—which same seeing is more of a detriment to full enjoyment of music than otherwise.

The Fansteel Products Company, manufacturer of Balkite Radio Power Units, is the sponsor of the series. The concerts will be given every Saturday night at 9:00 P. M. Eastern Standard time, over WEAF, New York; WEEI, Boston; WGR, Buffalo; WFI, Philadelphia; WCAE, Pittsburgh; WSAI, Cincinnati; WTAM, Cleveland; WWJ, Detroit; WGN, Chicago; WCCO, Minneapolis-St. Paul; KSD, St. Louis; WDAF, Kansas City, and WOC, Davenport.

While Mr. Damrosch and his orchestra have been on the air before, this is the first time that any attempt has been made to broadcast a regular series of symphony concerts.

The first concert (October 23rd) will be a full symphony program by Mr. Damrosch and the orchestra. Thereafter the concerts will be arranged as far as possible in pairs. Each symphony program will be preceded by a piano recital by Mr. Damrosch alone. In these recitals he will discuss, explain and play important parts of the programs of the following week. By this method it is expected that the programs can be made not only of the greatest entertainment value, but be made to constitute a liberal education in music as well.

Mr. Damrosch is too well known to require comment. It is not surprising that he should be the pioneer in symphonic broadcasting, for he was one of the pioneer orchestra leaders in the country. Perhaps no other person has done as much as he in the development of music in America. He grew up with American music, and to many his name is synonymous with its growth.



WILLIAM N. STRADTMAN, AT WLW

Mr. Stradtman is the physical director of the Cincinnati Y. M. C. A. For the past two years he has been broadcasting morning exercises at 7:30 through WLW. Eva Carrol Roark gets up in time to play the necessary piano accompaniment for him each morning

While Mr. Damrosch is now enthusiastic about the prospects of broadcasting regularly, this has not always been so. The following story is told about him. He had been approached on several occasions on the subject of going on the air. He was very skeptical and not at all interested, fearing that orchestral music could not be broadcast with any accuracy. He was afraid it would be distorted beyond recognition, and for a long time refused to consider the proposal. Finally, however, there came an evening when one of the large Eastern symphonies was broadcasting. A member of his family had a radio set put in the room next to Mr. Damrosch's library where he was working. When the concert began the set was tuned-in. For some time Mr. Damrosch paid no attention to it. Then he came into the room to listen. For some time he sat without comment. But after a few minutes the attempt to sit idly by while an orchestra was playing proved entirely too much for him. He got up, took his position in front of the receiver, and proceeded to conduct for the remainder of the entire concert exactly as if he had had the orchestra before him. When it was over he was as spent as by an hour's work on the stage. He was asked whether he thought the music well reproduced, and he was forced to admit that he hadn't noticed, so it must have been well done. From that point his only objection to broadcasting was removed.

Broadcast Miscellany

MR. E. M. TINGLEY, Chicago, Illinois, offers the following information in a letter:

> As a bit of radio history, WOR, of Newark, New Jersey, first started to broadcast the time by voice on March 22, 1922. Can any other station claim an earlier date?
>
> It had occurred to me that as the correct time is always new and is always news, especially in the country districts, that it would be particularly suitable for a radio item. I accordingly wrote to KDKA, WJZ, and the Madison, Wisconsin, station asking that they state the time once or twice during each period they were on the air. The idea did not get across, as KDKA replied that their time service from Arlington was satisfactory and the other stations did not answer.
>
> Finally I made a personal call at WOR and their manager and his assistant immediately appreciated the value of the idea and they promised to put it into practice at once.
>
> That same afternoon I heard by the voice of their young lady announcer "the correct Eastern Standard time is now 4:16 P. M., WOR signing off."

In the good old days, all one had to do was to inquire of the telephone operator, then known as "Central," "time please?" Since that service has long been done away with, the radio check-up on the time is an occasional convenience. The trouble is that you generally have to wait for a station to sign off to glean this information. Some one station in each center might make it a point to announce the correct time on every even hour. We don't mean that it should interrupt its program to pipe out with "it is now exactly three P. M." but it could make use of the announcer's interval that nearest approximated the even hour, even though it were a few minutes earlier of later. But let the studio clock be correct itself! Graham McNamee must have made many a commuter miss his favorite train when, one day last summer, he signed WEAF off at "10:08 Eastern Daylight Time" when it was actually 10:22 in the evening. The catastrophe occurred, he later explained, because in taking his watch from his pocket he turned the stem wind, which was loose, back several minutes.

AMONG the radio programs we receive regularly is that of the Compagnie Française de Radiophonie, Paris. (The printed program we mean!) Just by way of giving this department a ritzy and cosmopolitan air, here's a typical evening program:

3321 EMISSION

20 H. Résultats des courses—cours des cafés du Hâvre — cours des Matières grasses — cours des farines — des blés de Chicago — cours des sucres — des laines — des cuivres — cours de clôture des cotons de New York — Informations Havas — cours des caout - choucs — du plomb.

20 H. 30—Radio concert de Gala, organisé par les Grands Magasins Du Printemps.

The 20:30 o'clock concert is an indirect advertising offering and is sponsored by different organizations on each successive night—such as department stores, theatres, manufacturers, newspapers, magazines, etc.

WCAP having discontinued broadcasting, WRC is now operating at full time on the wavelength it formerly shared with the other Washington station. Wire lines now connect WRC with both WEAF and WJZ, in New York, and its programs are arranged with features from both of the Metropolitan stations, together with musical and educational events of the Capital.

AN INTERESTING feature of the fall and winter schedule of WBAL will be a series of American Composer programs. The programs will not all be orchestral, but will more frequently feature a solo instrument. Frederick R. Huber, director of the station, aims to enlist the aid of the composer whose work is to be featured, requesting him to supervise the program and to perform certain of his favorite compositions on his own chosen instrument. Among those in the front rank of American musical achievement to whom invitations will be extended are: Charles W. Cadman, Deems Taylor, Henry Hadley, Walter A. Kramer, John Alden Carpenter, and Rudolf Friml.

FACTORS contributing to successful radio broadcasts are outlined in a newly published list of microphone instructions now being distributed to singers, speakers, and piano accompanists at KOA.

Programs start on the minute.

Coughing, sneezing, clearing the throat, scraping the feet and other disturbances in the studios are annoying to listeners. The microphone is so sensitive that the slightest commotion may be transmitted to the unseen audience. Therefore, when the announcer calls, 'quiet everybody!' kindly comply.

Do not begin singing or playing until the announcer gives the signal.

Unless you have memorized your music, be prepared with an extra copy, as you do not stand near the piano when singing.

Do not be perturbed if the announcer motions for you to move nearer the microphone or withdraw, while singing.

Very loud singing or playing is objectionable as it detracts from successful broadcasting, often producing a shattered effect. The best choral effects are obtained when each person sings in a subdued manner.

To pianists: Too much loud pedal spoils the rendition. The top of the piano should be left down as the best broadcasting is accomplished when the instrument is closed.

TOM McNAMARA, former gridiron star, coach, and sports writer is again broadcasting a course of radio football instruction at KOA, Denver—which must mean that last year's series attracted enough interest to justify the continuance. Lessons are broadcast every Monday, Wednesday, and Friday evening at 8:15 o'clock, mountain standard time, and are intended for college and high school players, parents, beginners and athletic instructors. McNamara is head coach of Regis college at Denver.

WBAL has added to its features a dance orchestra which is being heard on Monday and Thursday nights, and which, in keeping with WBAL's policies, is of the slightly high-brow variety. John I. Lederer, its conductor, has some original views on dance music and stoutly maintains that such does not have to be jazzy to be alluring and rhythmic.

"This idea that a lot of noise is necessary to get pep and snap into dance music is a false conception," he says. "The most alluring dance music in the world can be soft and snappy, full of rhythm and syncopation, and yet without any undue noise. I know I get the best results by using the best of the popular dance music, especially those wonderfully syncopated selections from the leading musical comedies. In fact, dance music of this sort I have found to be much more generally liked than the sort that shrieks and wails. Rhythm and syncopation do not necessarily have to be combined with mere noise; in fact, they are far more likely to be found in music that is quietly tuneful and melodious than in any other sort of music."

Mr. Lederer also decries the idea of taking the old masters and arranging their compositions to the popular idea of dance music.

"I think it's a desecration to take the lovely music of, say, 'Faust,' and produce it in dance form. One always connects that sort of music with genius, and with so much dance music being written, it seems almost sacrilegious to rearrange the works of such writers for this purpose." With his last point we do not find ourself in entire agreement. We admit it is an abuse to lift a "classical" piece in its entirety and simply butcher its time to make a dance piece of it. But we see no great harm done in lifting a theme or two from the classics and bending them to the purposes of jazz. For after all, these themes are as often as not public property, and were originally "stolen" from some previous source by the classic composer. What a jazz composer, and a master such as Brahms, can "say" with the same snatch of tune, constitute two such entirely different things that neither one can conceivably affect the virtue of the other.

THE Hazeltine Corporation reports a profit of $65,474 during the first half of 1926, after deducting Federal taxes. The total dividend per share for the current year now amounts to one dollar.

Communications

Help! Help! Tell Us Which Is Right? We Aim to Please!

Benton Harbor
Michigan.

SIR:

. . . and why don't you occasionally write something we'd like to read about? You are making the department deader than a doornail and you rarely if ever express an opinion anyone with common sense could agree with.

BERTRAM WEBER.

Rye, New York

SIR:

I have just finished reading your "Listeners Point of View" and I just want to tell you how much I always enjoy this always interesting section of the RADIO BROADCAST. It is more interesting and entertaining with every issue.

N. M. COOKE

HOW THE BASTILE FALLS FOR THE RADIO

A view in an English radio studio, the fall of the Bastile and some of the stirring events of the French Revolution were reproduced. The quaint and curious devices shown here were responsible for the successful illusion of the historic occasion

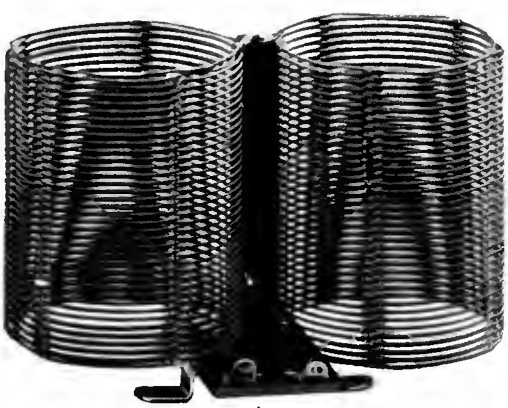
NEW APPARATUS

New Equipment of the Radio Industry Submitted to the Radio Broadcast Laboratory for Test and Approval

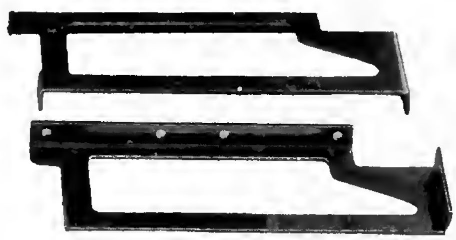
1

2

3

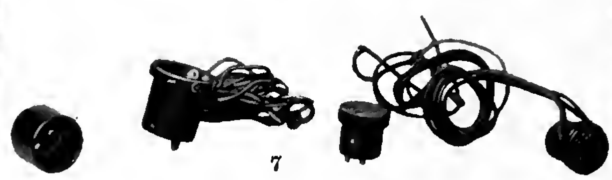


4



5

6



7

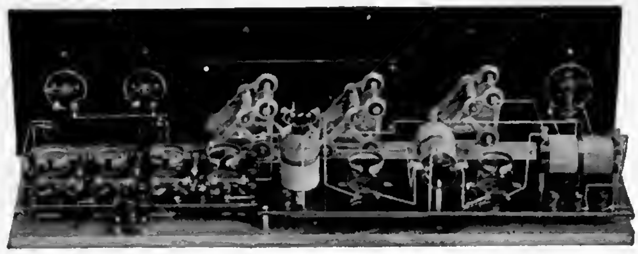
8

9

RADIO BROADCAST Photographs

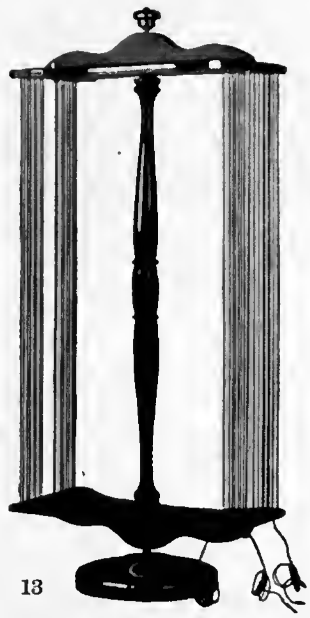
No.	Name of Apparatus	Manufacturer	Use of Product	Price	Remarks
1.	Cabinet Loud Speaker	Artcraft, Inc.	Sound reproducer for use with receiving sets.	——	The sound producing device in this loud speaker is a Miller unit having a long winding air column. This horn is suitably housed in an artistic cabinet.
2.	Cone Loud Speaker	Selector Company, Seattle, Washington.	Sound reproducer for use with receiving sets.	$30.00	A cone loud speaking device of the completely free-edge type. Artistically decorated.
3.	Drum Loud Speaker	Teletone Co. of America, 449 W. 42nd St., New York City.	Sound reproducer for use with receiving sets.	$32.50	Completely constructed of a special wood which aids in amplifying the loud speaking properties of the reproducing unit.
4.	Binocular Tuning Coil	Benjamin Electric Company, 120–28 S. Sagamon Street, Chicago, Illinois; also 247 W. 17th Street, New York City.	A tuning inductance unit for use in receiving sets.	$2.50	Because of the arrangement of the two halves of the coil in a binocular shape, the field set up by these coils in a receiving circuit is self-confined, thus aiding in preventing oscillations due to inter-coupling effects.
5.	Cardwell Sub-Panel Brackets	Cardwell Company, 81 Prospect St. Brooklyn, New York.	Supports for sub-panel	$0.75 a pair	Nickel-plated stamped brass frames which are fastened to the rear of main panel to support shelves or sub-panels.
6.	Audio Choke Coil, No. 3	Samson Electric Company, Canton, Massachusetts.	An audio frequency choke	$3.00	The Samson No. 3 choke coil serves the useful purpose of deliberately preventing the audio frequency current in an audio amplifier from passing through B batteries, where inter-coupling effects may be produced. Instead, these audio currents must necessarily return to ground through the by-pass condensers provided for that purpose.
7.	Na-ald Adapters	Alden Mfg. Co., 52 Willow St. Springfield, Massachusetts.	Tube Adapters	$0.75 to $1.25	For adapting old tubes to new sockets, etc.
8.	Rubber Socket	Moulded Products Inc., 549 W. 52nd St., New York City.	Receptacle for vacuum tube.	$0.60	Entirely shock-proof because of the resilient properties of the socket, composed of soft rubber.
9.	Dialite	Carter Radio Co., 300 S. Racine Ave., Chicago, Illinois.	Illuminate dials of receiving sets.	$1.75	The Dialite may be added to any receiver, where it is desired to illuminate the dial markings. The flashlight bulb with which it is furnished operates direct from a 6-volt source.

10



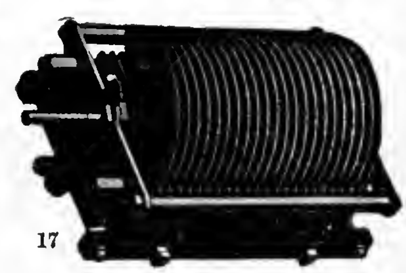
11

15



13

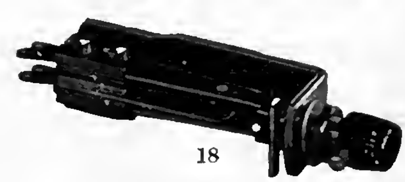
14



17

12

16



18

Radio Broadcast Photographs

No.	Name of Apparatus	Manufacturer	Use of Product	Price	Remarks
10.	Horn Loud Speaker (Burns)	American Electric Co., State & 64th St., Chicago, Illinois.	Sound reproducer for receiving sets.	$10.00	A horn loud speaker employing a unit which may be adjusted for maximum sensitivity.
11.	Six-Tube Receiver	Heath Radio & Electric Mfg. Co., 206–10 First St., Newark, New Jersey.	Broadcast reception.	$69.50	A semi-wired receiver consisting of Heath units. It is easily and simply connected together to form an efficient 6–tube receiver employing 3 stages of Heath resistance-coupled audio frequency amplification.
12.	Cone Loud Speaker.	Tower Mfg. Co., 98 Brookline Ave., Boston, Massachusetts	Sound reproducer for receiving sets.	$ 9.50	An inexpensive cone loud speaker in the lower-price field.
13.	Loop	W. I. Thomas Company, 217 N. Desplaines St., Chicago, Illinois.	Signal pick-up device.	——	A knock-down loop that may be assembled in a few seconds. To facilitate "pointing" the loop, the frame pivots on a swivel.
14.	Horn Loud Speaker (Wonderphone)	Universal High Power Tel. Co., Carlton and Eddy Sts., Seattle, Washington.	Sound reproducer for use with receiving sets.	——	A typical horn loud speaker having a curved throat and wide-flared mouth.
15.	Pedestal Cone Baffle-Board Loud Speaker	The Rola Co., 45th and Hollis Streets, Oakland, California.	Sound reproducer for use with receiving sets.	$45.00	This high-quality reproducing unit is a combination of cone and baffle-board speaker. It is substantially and handsomely constructed.
16.	A Battery Eliminator	Davey Electric Corporation, 505 Court St., Brooklyn, New York.	Replaces the usual 6-volt storage battery as a source of vacuum-tube filament supply.	$47.50 $52.00	Combining the units of transformer, rectifier, and filter, this A supply furnishes sufficient current to operate up to ten tubes. May be obtained in either 1½-ampere or 2-ampere sizes.
17.	Cardwell Transmitting Condenser	Cardwell Company, 81 Prospect St., Brooklyn, New York.	A tuning device for short-wave transmitters.	Variable $7.00–$70.00 Fixed $4.50–$15.00	To resist possible breakdown due to high voltages, the plates in this variable tuning condenser are liberally spaced.
18.	Jack Switch	Carter Radio Co., 300 S. Racine Ave., Chicago, Illinois.	For "making" and "breaking" circuit in a receiver.	$1.00 to $1.60	This switch is of the panel mounting type. It may be obtained in several models, each for a specific circuit purpose.

THE ATWATER KENT MODEL 20 COMPACT RECEIVER

Instructions are given in the article below which will enable the possessor of an Atwater-Kent Model 20 Receiver to make simple changes to improve the audio channel. Since the Model 20 first appeared, transformers for audio frequency amplification have appeared which are considerably better than those available a year or so ago. A resistance-coupled amplifier, a power amplifier, an output device—all these may easily be adapted to the Model 20

Modernizing the Atwater Kent Model 20 Receiver

Simple Instructions for the Revamping of This Popular Set to Bring It Up to Date—Improving the Quality by Putting in New Transformers, a Resistance-Coupled Amplifier, or Power Amplifier—How an Output Device Is Incorporated

By JAMES MILLEN

DURING recent years, a number of improvements have been made in radio receiving sets. Thus, while the outward appearance of many of the new sets is not greatly different from those sold two or three years ago, the performance is materially better. Perhaps the greatest advance has been made in the direction of better tone quality. A piano now really sounds like a piano; the low notes of the cello and the high notes of the piccolo are now heard just as well as the notes nearer the center of the musical scale.

The improved tone quality, or audio characteristics, of modern radio receiving sets is due to improvements made in several of the small but important component parts and accessories. Very excellent speakers of the disc or cone type are now on the market, as are also improved audio transformers, impedances, and resistors for high-quality audio amplifier construction; output transformers and chokes for keeping direct current out of the speaker; high-voltage B supply units; and a number of new tubes. B batteries have also been improved so that not only are they more economical to use than formerly, but, due to lower inherent resistance, they are no longer as likely to cause audio frequency howls and distortion.

It is quite a simple matter for any one, no matter how inexperienced they may be in handling a screw driver and pair of pliers, to add some or all of these improved accessories to their present receiver so as to bring its performance up to the same high degree of excellence as that of the neighbor's new set.

In this and other articles to follow, data and suggestions will be given on modernizing some of the receivers that in the past have been most popular. This, the first, is devoted to the Atwater Kent Model 20.

The two-stage tuned radio-frequency amplifier in this receiver completely covers the present broadcast band, as shown by the chart of approximate dial settings, plotted against wavelength, Fig. 1, so we are able to confine our attention to improving the audio amplifier, which is located, together with the detector tube, on a small bakelite shelf at the right-hand end of the set.

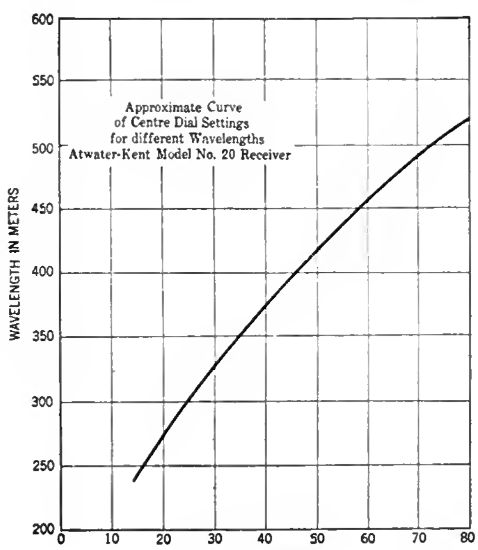


FIG. 1

This is the tuning chart of the Atwater Kent Model 20 Receiver. The receiver, as will be noted, completely covers the broadcast wavelength band

In order to secure better quality audio amplification from this Atwater Kent receiver, the frequency characteristic of the audio amplifier should be improved; a power tube, with proper C voltage, should be installed in the last audio stage; an output device should be wired in, and one of the new cone speakers may be used.

By improving the frequency characteristics of the amplifier, over amplification of some musical notes and under amplification of others may be avoided, and a natural, round, mellow tone results. The proper use of a power tube will prevent overloading, when the receiver is adjusted for normal volume. There are several good reasons for using an output device, but, in this instance, the main one is to prevent damage to the speaker. As for using a good speaker, it is obvious that no matter how excellently a signal may be amplified, if it is sent into a poor speaker, good quality cannot result.

There are four different ways in which the frequency characteristic (or ability to reproduce the entire musical scale with uniform clarity and intensity) of the Atwater Kent receiver may be improved. First, we may substitute two of the new type audio transformers for the transformers supplied with the set. Second, we may employ an external high quality power amplifier in place of the audio amplifier in the set. Third, we may replace the amplifier unit in the set with an equally compact, but infinitely better resistance-coupled amplifier. Fourth, we may replace the amplifier in the set with an impedance-coupled one. All four types of amplifiers will give most excellent results. The first three will be described here.

A TRANSFORMER-COUPLED AMPLIFIER

AS THE amplifier supplied with the set is of the transformer-coupled type, it is very simple to replace the old type transformers with a pair of the new high quality audio transformers and to make provision for the use of a C battery. The Atwater Kent receiver is not equipped with a C battery. As the excellence of an improved amplifier of this type will depend almost entirely upon the transformers used, it is important that good instruments, such as Rauland Lyric, Amertran De Luxe, Jefferson, or the new General Radio 200 A be employed. There are also several other suitable transformers now on the market.

The first step is to remove the set from the cabinet and then take out the six screws that hold the two transformers to the shelf. Turn the set over and cut the four wires, under the shelf, that go to each of the transformers. Then mount the two new audio transformers in the places formerly occupied by the old transformers.

Tube	Plate Voltage		
	135	150	180
CECO F . . .	9	15	20
UX-112 . . .	9	9	
UX-171 . . .	27	33	40

GRID BIAS VOLTAGES

This table gives approximate grid bias voltage for three last-stage tubes. Values slightly different than those given may be tried until best results are obtained

Three of the four wires cut from each of the transformers should now be connected to the corresponding terminals of the new instruments by running them through small holes which have been drilled through the brown bakelite shelf near the different new transformer terminals. It will be found necessary to solder extension leads to the different wires in order to make them reach the terminals of the new transformers. The connections of the cut wires are as follows:

Green wire goes to +B terminal on transformer.

Yellow wire goes to Plate terminal on transformer.

Black wire goes to Grid terminal on transformer.

Red wire is not used. Cover end with tape to prevent short-circuit.

It will be noticed that no connection has been made to the terminal on each transformer marked minus Fil. These terminals are to be used as minus C binding posts, as the Atwater Kent receiver is not provided with C battery binding posts. That on the first transformer should connect to the negative 4½-volt terminal of the grid bias supply, while that on the second transformer connects to the negative 9-volt tap. We are assuming that a 201-A tube is employed in the first audio stage and a Ceco type F type tube in the second (output) stage. The regular minus A terminal serves the double duty of minus A and +C binding post, as is evident in Fig. 2.

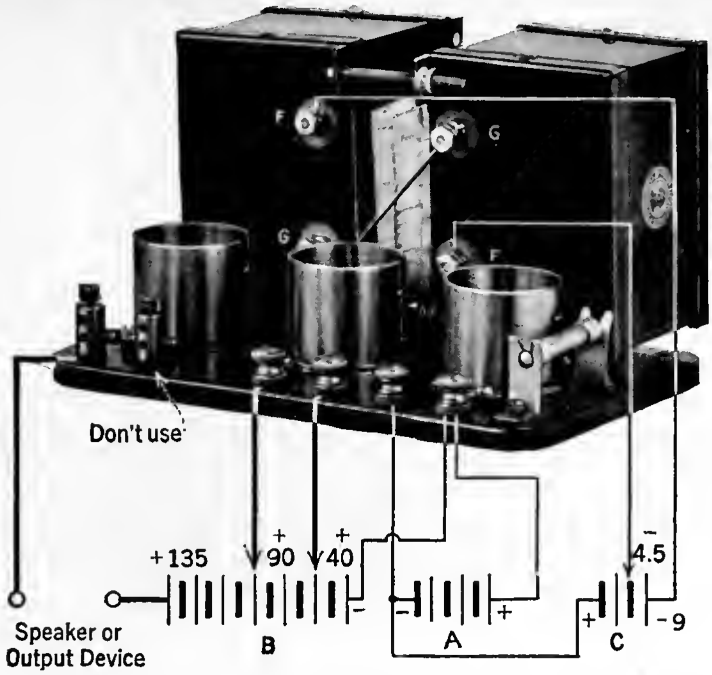


FIG. 2 RADIO BROADCAST Photograph

Having substituted new transformers for those supplied in the receiver, we have a few battery changes to make. This combination picture should make clear the wiring to the A, B, and C batteries. The voltages specified are naturally only approximate

There are two good reasons for using a C battery. One is economy (a C battery greatly prolongs the life of the B battery), and the other is audio quality. Without proper C voltages it is impossible to obtain good audio quality, as discussed by George Crom in his article starting on page 745 of RADIO BROADCAST for October, 1925.

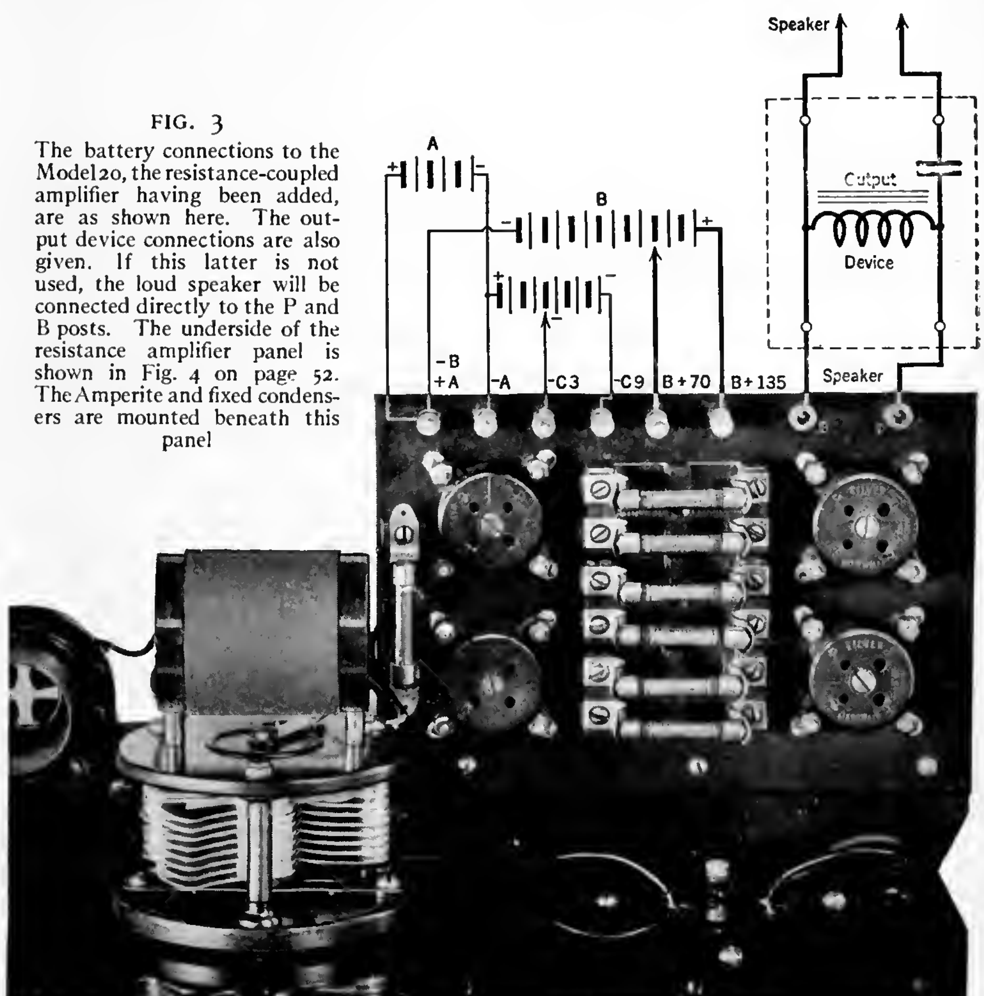
We now have an amplifier which, when used with a 201-A tube in the first stage (middle socket) and a power tube, such as the Ceco F in the last stage (end socket), and with batteries connected as shown in Fig. 2, will give exceedingly fine results in connection with a good loud speaker.

It is well to remember that, within certain limits of practicability, the higher the B voltage used on the last tube, the better, as high B voltages permit the use of high C voltages, which decrease the possibility of the amplifier overloading on loud signals.

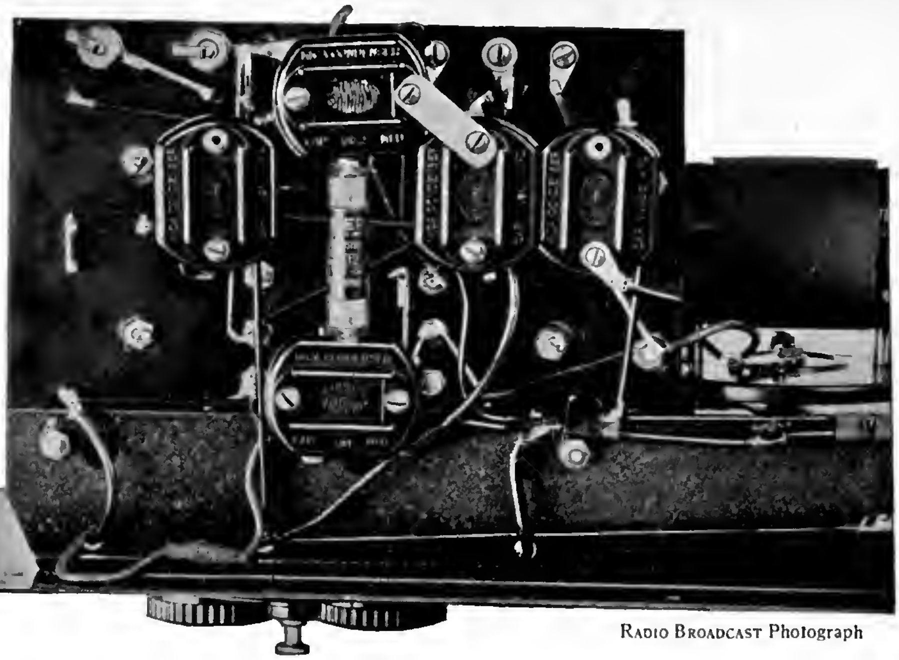
An accompanying table, on this page, gives approximate B voltages for any value of C voltage for several different power tubes. The UX-171 tube requires very much less B voltage for a given value of C voltage than any of the other tubes. Thus, when considerable volume is wanted, and high B voltages (180 or so) are not available, the 171 is a good tube to use. The amplification constant of the 171 is very much less, however, than that of the Ceco type F, for example. Also, while it is *desirable* to use an output device with any power or semi-power tube in order to keep

FIG. 3

The battery connections to the Model 20, the resistance-coupled amplifier having been added, are as shown here. The output device connections are also given. If this latter is not used, the loud speaker will be connected directly to the P and B posts. The underside of the resistance amplifier panel is shown in Fig. 4 on page 52. The Amperite and fixed condensers are mounted beneath this panel



RADIO BROADCAST Photograph



Radio Broadcast Photograph

FIG. 4

An under-the-panel view of the resistance-coupled amplifier which may be easily and advantageously substituted for the supplied transformer-coupled one in the Model 20 Receiver

the d. c. component of the plate current out of the speaker windings, it is *essential* to use such a device with the UX-171, due to the high plate current that it draws. The construction of an output device is described in another part of this article. It is very desirable to use a B line supply device with sets using an UX-171 type tube in the last stage of the audio amplifier on account of the large amount of current required by such a tube.

It quite frequently happens with sets using cone speakers that a detector tube that is the least bit microphonic will cause a howl to build up in the loud speaker, due to mechanical oscillation. One of the best cures for such trouble is to locate the loud speaker some distance from the radio set, say on the opposite side of the room. Such an arrangement is also of considerable aid to the person tuning the set as it gives him a very much better idea of just how the set sounds to the others in the room who are not standing right alongside of the loud speaker.

Another solution for mechanical oscillation is to install one of the spring suspension type of tube sockets, such as the new Benjamin. To substitute another socket for the detector socket in the set, remove the brass socket shell (it is just held by two prongs extending through holes in the shelf), and fasten the new socket in its place. Connections are then made from the terminals on the new socket to the screws that hold the contacts of the old socket.

Another cure for mechanical oscillation is found in wrapping around the detector tube a piece of cloth.

USING A POWER AMPLIFIER

A SOMEWHAT more elaborate and costly, but yet perhaps one of the finest ways, especially where great volume with well-nigh perfect quality is desired, to improve the audio end of the Model 20 Atwater Kent receiver, is to construct a power amplifier, such as that described by Arthur H. Lynch on page 224 of Radio Broadcast for July, 1926. As will be remembered, this amplifier consists of one stage of transformer- and one stage of resistance-coupled amplification, with A and B power obtained from the lamp socket.

To connect the power amplifier to the receiver in place of the usual amplifier, it is merely necessary to disconnect the + Det. B lead from the binding post on the shelf of the Atwater Kent receiver and fasten it to one of the input (marked +B) posts of the power amplifier. The other input post (marked P) of the power amplifier is connected to the screw that holds the plate prong of the detector tube socket on the shelf of the Atwater Kent receiver (left-hand rear contact of the left-hand socket, looking from front of set). The other connections to the receiver and power amplifier are made in the usual manner, the loud speaker being, of course, plugged into the jack on the amplifier panel, and no tubes being used in the last two sockets of the Atwater Kent receiver.

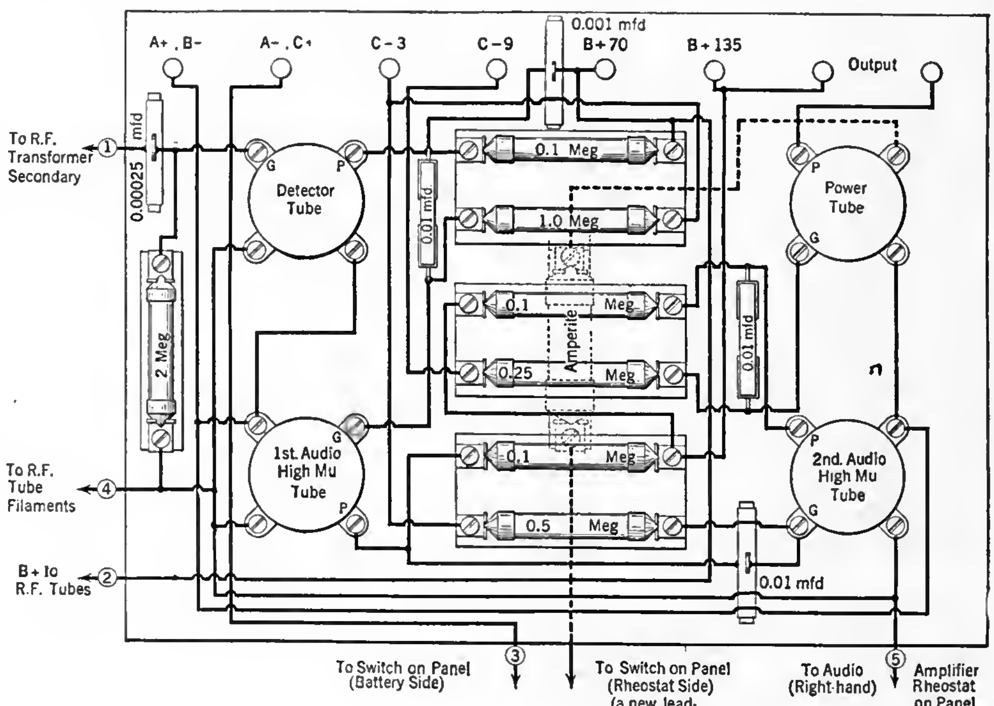


FIG. 5

The wiring diagram of the resistance-coupled amplifier. The values for the condensers and resistances are also given here. Connections to the rest of the receiver (to the r. f. part) are indicated

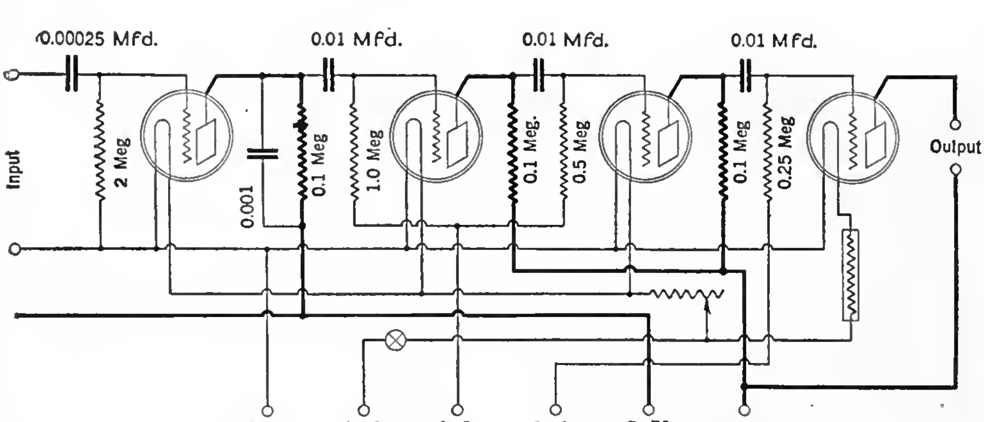


FIG. 6

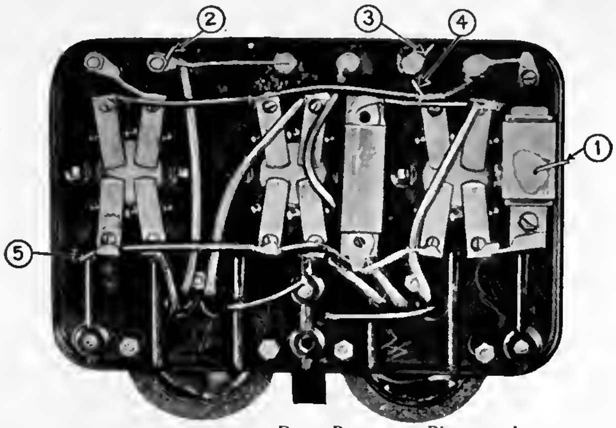
This is the schematic diagram of the resistance-coupled audio amplifier and detector circuits shown in Fig 5. The input connects to the output of the second r. f. stage in the receiver

A RESISTANCE-COUPLED AMPLIFIER

MANY readers may prefer to substitute a new audio amplifier unit of the resistance-coupled type. Such a unit is easily and inexpensively constructed from standard parts in a very short time. It may also be quickly and easily substituted for the regular Atwater Kent amplifier.

Figs. 3, 4, 5, 6, and 7 show the construction, wiring diagram, and method of installation of such a resistance-coupled amplifier. Four tube sockets, three double resistor mountings, a single detector grid resistor mounting, and binding posts are mounted on the top of a $5\frac{1}{4}''$ x $7\frac{3}{4}''$ x $\frac{3}{16}''$ bakelite panel. On the under side of this panel are mounted an Amperite for controlling the filament current of the power tube and the several different fixed condensers, the capacities of which are shown in Figs. 5 and 6. Although four plain UX sockets are shown in the model illustrated, it is preferable to use one of the spring suspended sockets for the detector tube.

To install the completed resistance-coupled amplifier in place of the old, proceed in the following manner:



Radio Broadcast Photograph

FIG. 7

The wires to be snipped when removing the amplifier from the original Model 20 Atwater Kent Receiver to substitute a resistance-coupled amplifier, are here indicated. Study this picture in conjunction with Fig. 5, whereon the numbered wires correspond to those numbered in this picture

First Step: Cut and tag for indentification the following leads: Detector grid lead, cut at grid condenser. Plus A lead, cut at binding post. Negative A lead, cut at binding post. Plus B 90 lead, cut at binding post. Negative A lead from rheostats to socket, cut at socket.

Second Step: Remove the Atwater-Kent amplifier shelf and fasten the resistance-coupled amplifier shelf in its place.

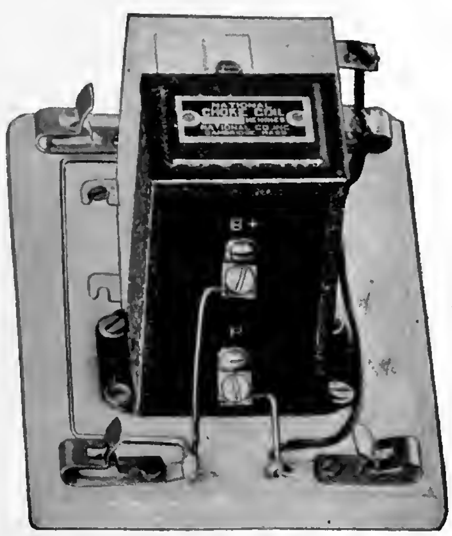
Third Step: Solder the leads cut in first step to the new amplifier, as indicated in Fig. 6.

Fourth Step. Remove the rheostat disc from the front panel (unfasten the three screws behind the panel) and solder a lead to its battery switch side. Replace the rheostat disc and run the new lead to the Amperite.

Either a type F Ceco or a UX-171 power tube should be used in the last audio stage. High-Mu tubes, such as Cleartron, Ceco, or Daven, should be employed in the first two stages.

The following is a list of parts for the resistance-coupled amplifier.

1 Bakelite Panel $5\frac{1}{4}$ x $7\frac{3}{4}$ x $\frac{3}{16}$ inches.
4 UX Sockets, General Radio or Benjamin.
3 Double Resistor Mounts (Lynch).
1 Single Resistor Mount (Lynch).
1 Metalized Filament Resistor Pack (Lynch).



Radio Broadcast Photograph

FIG. 8

The output device mounted on a small piece of board. It consists of a choke and a 4-mfd. fixed condenser

1 Type 112 Amperite, Mounted.
3 0.01 Mfd. Sangamo Mica Condensers.
1 0.001 " " "
1 0.00025 " " "
8 Binding posts.

PARTS FOR THE OUTPUT DEVICE

1 Base, 4 x 5 inches.
4 Binding posts.
1 Tobe or American Electric 4-mfd. Condenser.
1 National Impedance, Type A.

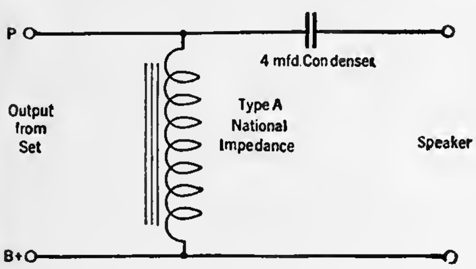


FIG. 9

The wiring connections for the output device. The posts marked P and B plus connect to the set, as indicated in Fig. 3. This output device may be used with any receiver. Mayolian, General Radio, and National make complete output units contained in a single metal case

It is important in a resistance-coupled amplifier that only the best of resistors be used, as most of the cheaper grades of the impregnated paper types not only deteriorate after they have been used a short time but are also very noisy. The new metalized filament resistors, such as those of Durham, Dubilier, and Lynch, now available on the radio market, give exceptionally fine results in amplifiers of this type. The Lynch resistors are also marketed in small boxes containing a complete set of the proper size units for a resistance-coupled amplifier and, in addition, a two-meg. resistor for the detector tube. The proper places in the different mounts for the several different values of resistors is indicated in Fig. 5.

OUTPUT DEVICES

As PREVIOUSLY mentioned, it is well with any type of output tube to employ an output device for keeping direct current out of the speaker circuit. Direct current in the speaker cord, although perhaps only fifteen or twenty milliamperes in magnitude, is quite capable of starting a fire, especially where long speaker cords of poorly insulated tinsel are employed. Fig. 3 shows how to connect the output device illustrated in Fig. 8, and the necessary batteries, to the resistance-coupled amplifier.

A very satisfactory output device for use with the re-vamped Atwater Kent receiver may be easily constructed from a 4-mfd. fixed condenser and a type A National impedance. The condenser and impedance may be mounted on a small base, as shown in Fig. 8, or else may be directly fastened to the back of the cabinet.

Output transformers are manufactured by Silver-Marshall and General Radio. A circuit diagram for the output device is shown in Fig. 9, while a list of parts is given at the end of the list for the resistance amplifier.

USE B LINE SUPPLY UNITS

REGARDLESS of the type of amplifier employed in the re-vamped Atwater Kent receiver, a B supply unit of either the a. c. or d. c. types will give excellent results. As almost all a. c. B current line supply devices supply voltages well in excess of 100 volts, sufficient voltage for properly operating the power tube in the last audio stage is readily obtainable. With the d. c. variety of B units, however, the maximum voltage obtainable is but about 100 volts. In such a case, it is necessary to add a 45-volt B battery in series with the B supply unit, as shown in Fig. 10.

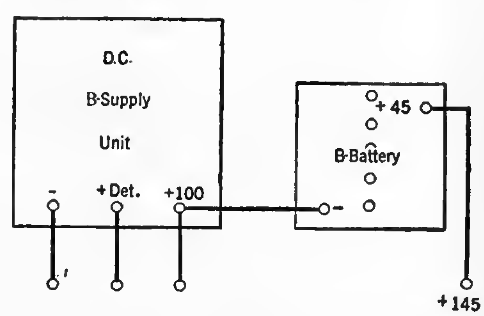


FIG. 10

If you use a line supply device for your B supply, and it does not give you more than one hundred volts or so, an ordinary B battery may be connected in series to make up for the deficiency when power tube operation is required

A Short-Wave Super-Heterodyne Receiver

A Paper Delivered Before the Radio Club of America Showing How a Simple Short-Wave Regenerative Receiver is Converted into a Vastly More Sensitive Short-Wave Super Heterodyne—Constructional and Operating Suggestions

By GEORGE J. ELTZ, Jr.

Radio Sales Manager, Manhattan Electrical Supply Company

THE reception of short-wave radio signals, both telephone and telegraph, has been almost universally accomplished by means of the single-circuit regenerative receiver. This type of receiver, while it has been practically abandoned for the reception of longer wavelengths, is excellent in operation on about 3000 kc. (wavelengths of 100 meters, or under). Indeed, so well has the single-circuit receiver operated that perhaps sufficient attention was not given to other methods of reception. With this thought in mind, the author decided to investigate the possibilities of the super-heterodyne method of reception and, as a result, the receiver described was evolved. The receiver was constructed and first operated in October, 1925.

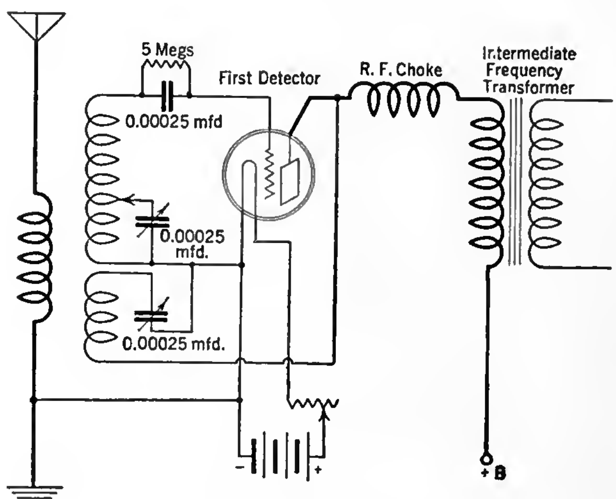
The super-heterodyne used for the reception of short waves differs somewhat from that used for the reception of broadcasting, although of course the general theory is identical.

The super-heterodyne method of reception consists of tuning the incoming frequency, beating with it another frequency, and then amplifying and detecting the beat note. The actual signal listened to has in it none of the original frequency or the frequency which caused the beat note. In the reception of broadcast programs or other signals between 1500 and 600 kc. (200 and 500 meters) the beat note selected is a frequency somewhere between 30 and 80 kilocycles. This relatively high frequency is selected to prevent the introduction of distortion by elimination of the side-band frequencies in the intermediate amplifier and filter.

In the reception of short waves, particularly the reception of c. w., this element of distortion may be disregarded, and such has been the case in this receiver, the assumption being that most of the signals received will be c. w.

The ordinary "super" used for broadcast reception has two tunings: first, the loop or antenna circuit and, second, the oscillator circuit. This short-wave "super" has only one tuning arrangement, in which is combined both the tuning operations indicated above. This method of tuning was selected because of its simplicity and because it makes possible the construction of what is practically a single-control set.

The intermediate frequency chosen is 22 kilocycles, which, while too low a frequency for good telephone reception, when simple tuned circuits are used, is satisfactory for c. w. or telegraph signals. The selection of this frequency necessitates detuning the set 22 kilocycles from the incoming signal, but at the frequencies corresponding to wavelengths of 100 meters or under, this detuning is of no importance in decreasing signal strength.



CIRCUIT OF FIRST DETECTOR-OSCILLATOR

FIG. 1

The reader will recognize the description above as applying to the "autodyne" or "self-heterodyne" type of "super." The beat note of 22 kc. is created in the same manner as in the broadcast set but at a lower frequency. For the reception of short-wave telephone signals, the amplification and detection of the 22-kc. beat note is accomplished in the usual manner. When c. w. signals are to be received, another beat note must be created either by means of another oscillator tube or by a self-heterodyne beat note in the second detector tube. This latter method has been selected, a beat note of 1000 cycles being chosen as the most satisfactory. This detuning of the second detector circuit, while it may appear to be inefficient because of the low intermediate frequency is not so bad as it seems, since the amplification in the intermediate circuit is very great and there is plenty of energy to spare.

To summarize, the action of the entire receiver is as follows:

1. Approximate tuning to the incoming frequency by the first detector tube (which is also an oscillator) and the creation of a 22-kc. beat note.
2. Amplification of the 22-kc. beat note.
3. Detection of the beat note with:
   a. Straight detector for telephone.
   b. Oscillating detector for c. w.
4. Amplification at audio frequency.

The entire action is controlled by one dial.

DESCRIPTION OF THE SET

THE first detector and oscillator circuit may be any of the conventional short-wave receiving circuits. The one chosen is given in Fig. 1. Two variable condensers are shown but all the tuning is done with the one in the grid circuit. The condenser in the plate circuit must be set for each band of frequencies covered; for instance, from 7096 kc. to 6663 kc. (40 to 45 meters), 6663 kc. to 5996 kc. (45 to 50 meters), etc. This setting is not critical, the only requirement being that the tube oscillate strongly but not so violently that it blocks.

The coils, condensers, choke coil,

The Facts About This Receiver

Name of Receiver	Eltz Short-Wave Super-Heterodyne Receiver.
Type of Circuit	Super-heterodyne
Number of Tubes	Five: 1st detector; two intermediate-frequency stages; 2nd detector, and one stage of audio frequency amplification.

Radio-frequency amplifiers at short wavelengths have not generally been found satisfactory, so the accepted short-wave receiver, without r.f. amplification, has remained the stand-by. In such receivers, a detecter tube is made to oscillate and beat with the incoming c.w. signal to produce a note of about 1000 cycles. In the Eltz super-heterodyne receiver described here, the same system is employed with the exception that the beat note is caused to be 22 kc. or 22000 cycles, which is inaudible. This is readily amplified by the intermediate-frequency amplifying stages, then again detected or rectified, and finally amplified at audio frequencies.

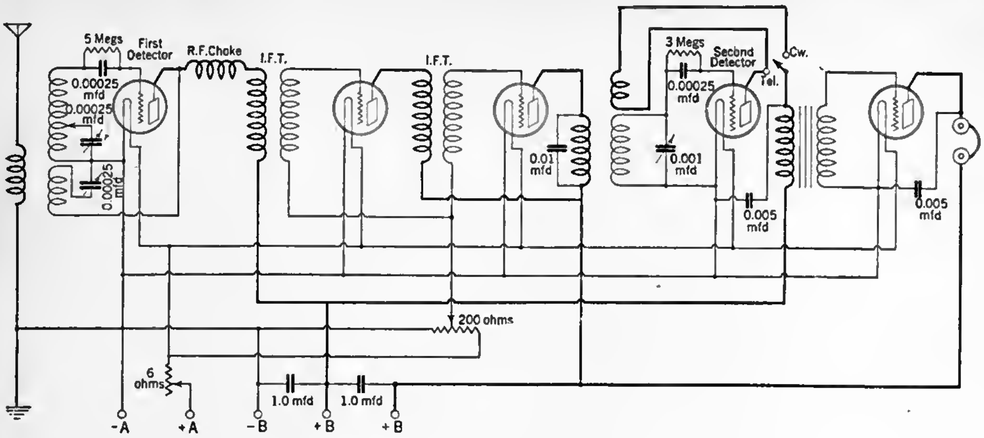
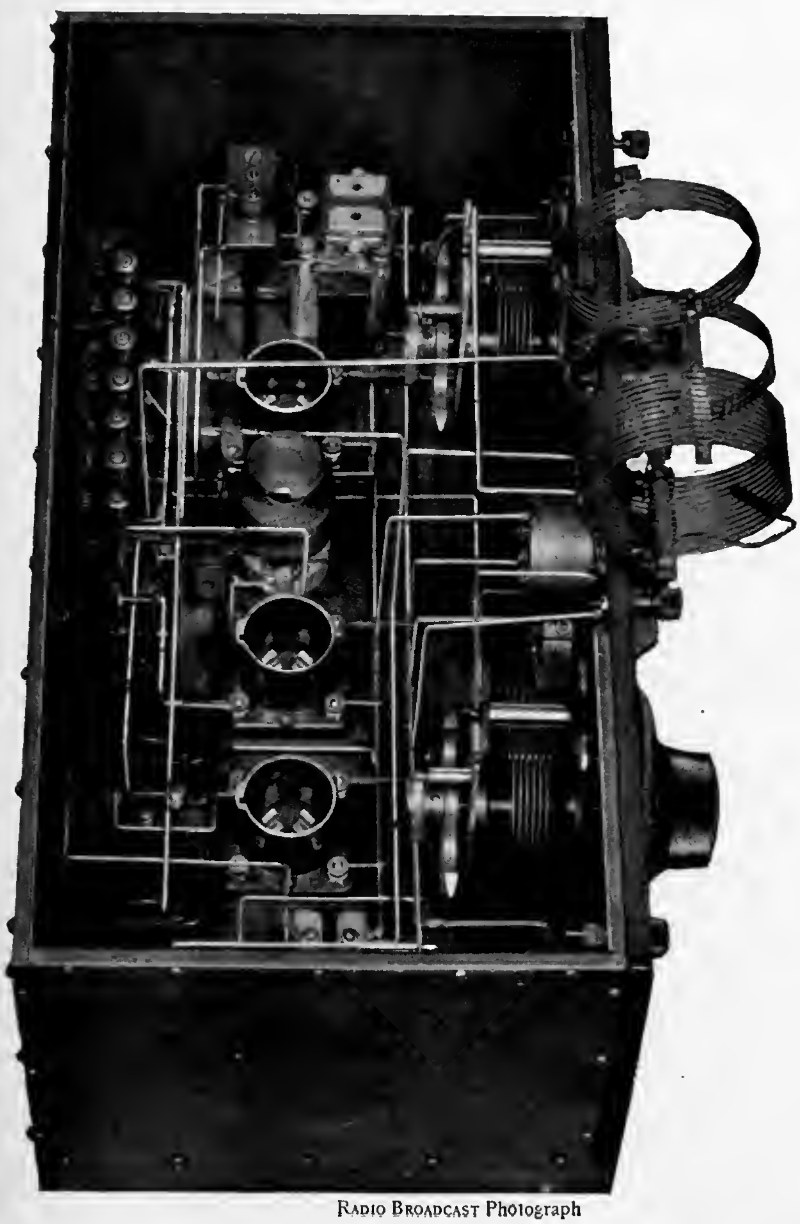


FIG. 2

etc., are identical with those which would be used in the construction of a regenerative set. The variable condenser in the grid circuit must be provided with some means of close adjustment as the setting is rather critical. The plate circuit condenser can be set with an ordinary knob or dial, without trouble.

The choke coil consists of 100 turns wound on a wooden form 1 inch in diameter and 2 inches long. A honeycomb or similar coil of 150 or 250 turns will also serve very nicely. The intermediate transformer must be one capable of amplifying the rather low frequency of 22 kc. In this set, those manufactured by the General Radio Company were used, but there are probably any number of others which will serve.

The coils used in the antenna, grid, and plate circuits are made by winding bare copper wire of No. 16 gauge over a form on which are placed four narrow strips of celluloid, equally spaced. The wire is spaced with string and, when completely wound, the string is removed and the wire cemented to the strips by means of liquid celluloid. The construction of this type of coil is familiar to any-one who has followed the development of the short-wave regenerative receiver.



THE INTERIOR

Of the Eltz five-tube short-wave super-heterodyne is shown in this illustration. The coils, starting at the lower one, are: (1) A-B; (2) C; (3) D. These letters may be explained by reference to Fig. 3 on this page. The flexible lead for tapping A-B may be clearly discerned

Radio Broadcast Photograph

The diameter of the coils is 3 inches for whatever frequency band the coil is designed to cover. Figs. 3 and 4 show the number of turns to be used for each frequency band. Three coils were used by the author to cover the amateur bands.

The figures given for the coils are only approximately correct, as the method of wiring, mounting, etc., all affect the capacity of the coils and, in consequence, the number of turns required to cover a given frequency range.

Where the operator or constructor has a satisfactory regenerative receiver already in operation, there is no need to change, even though the circuit differs from the one shown. The only requirement is that the primary of the first intermediate transformer be free of a capacity shunt greater than 0.00025 mfd.

THE INTERMEDIATE AMPLIFIER

THE complete circuit of the receiver is shown in Fig. 2. By reference to this circuit it will be observed that two untuned intermediate transformers are used and one tuned or filter transformer of special construction. As already mentioned, the intermediate transformers used are those manufactured by the General Radio Company type number 271. These particular transformers have a flat characteristic which permits a considerable gain at 22 kc. Others of different make but of nearly similar characteristic are probably available.

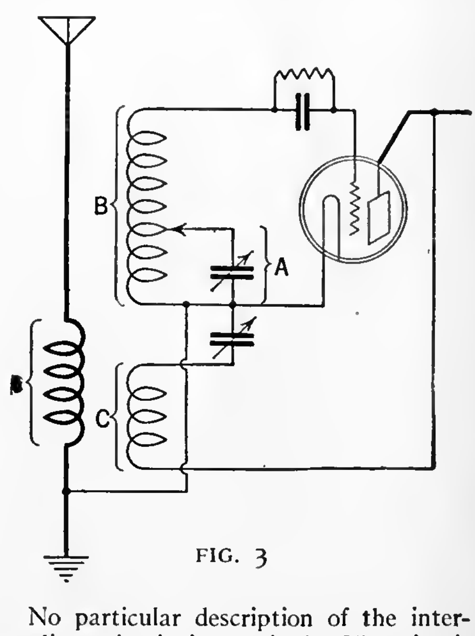


FIG. 3

No particular description of the intermediate circuit is required. The circuit is a conventional one and the same precautions observed in the construction of any super-heterodyne should be followed. To prevent undue feed-back in the untuned circuits, space the tubes and transformers liberally and keep them in line.

THE FILTER CIRCUIT

BECAUSE of the low intermediate frequency, the filter transformer must be of a special design. By reference

COIL

WAVE BAND	A	B	C	D
40	4	13	3	6
50	6	28	4	6
80	8	28	4	8

FIG. 4

to Fig. 3, it will be also observed that three coils are used. The coil in the plate circuit of the tube preceding the detector and the coil in the grid circuit of the detector comprise the tuning or filter circuit. The coil in the plate circuit of the detector tube is the feed-back coil by means of which the beat note of 1000 cycles is created in the second detector tube.

The specifications of these coils are given in Fig. 5. In winding these coils no particular care need be used, random winding is perfectly satisfactory. Approximately the number of turns specified, however, should be wound, otherwise the frequency of the intermediate circuit will be changed. In Fig. 4, the spacing between coils is shown. No hard and fast rule can be given on the point, as the arrangement of the circuit placing of the coils, etc., will have some effect. Once adjusted, however, there is no need for further change. The coils shown make a rather small assembly. If the space occupied is no factor, honeycomb, duo-lateral, or other form wound coils of similar nature can be used. The coils should be arranged as in Fig. 6. The spacing can be somewhat greater than that specified for the home-made assembly.

The variable condenser shown across the grid coil is of 0.001-mfd. capacity. Because of the rather large space occupied by a 43-plate air condenser of this capacity, a variable mica condenser was chosen. The air condenser is probably better from a standpoint of efficiency. The condenser across the grid coil determines the frequency of the beat note which is heard in the telephone. Keep this frequency as low as possible since the lower the note, the more closely will the primary and secondary circuits be in tune.

If telephone signals are to be received, a switching arrangement should be provided to permit cutting the plate coil of the second detector in and out of the circuit. Radio telephone signals can be received when the second detector is oscillating, but reception is extremely difficult as the "zero beat" method must be used, and the slightest change in frequency at either the receiver or transmitter causes an audio beat.

No particular instructions are required here. Any good audio transformer is satisfactory. If radio telephone signals are to be received as well as c.w., the transformer should be of good design. For c.w. reception only, a transformer having a high ratio between primary and secondary is best, since, although some distortion may be introduced, the amplification is higher and the distortion is of no importance.

Two fixed condensers are shown in the audio circuit. These condensers are required as a bypass for the 22-kc. frequency, which otherwise would feed back through the head telephones and the body to the input and cause trouble.

GENERAL COMMENTS ON CONSTRUCTION AND OPERATION

The particular receiver to which the foregoing remarks apply was one with complete shielding of the intermediate, second detector, and audio circuits. The coils comprising the first detector circuit were not shielded but acted as loops for the reception of moderately distant stations.

The principal advantage in the shielding came in the elimination of long-wave interference. Subsequently, it was found that by regulation of the amount of regeneration in the untuned intermediate transformers, practically the same result could be obtained, and at no sacrifice in sensitivity. It is recommended that the set first be made unshielded and then the shielding applied if the long-wave c.w. interference is bad. In another model of this same receiver, constructed by Mr. C. R. Runyon, no shielding was used and results were entirely satisfactory.

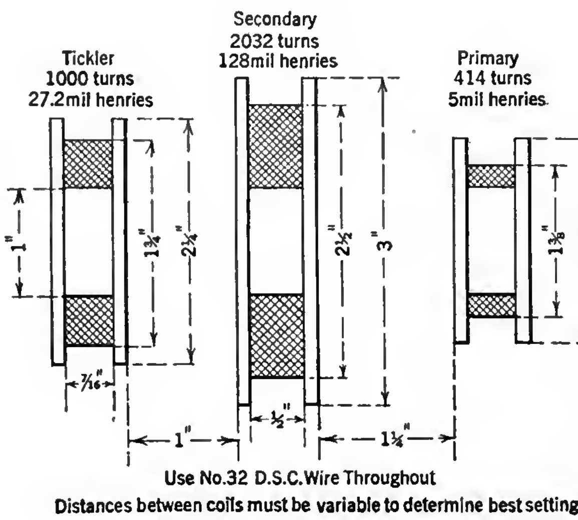


FIG. 5

It is difficult to form a definite opinion of the merits of this receiver over the simple regenerative set. There is absolutely no question of its increased sensitivity, but strange as it may seem, there is some question of its selectivity. The reason for this is the presence of two widely separated tuning points for each station as against the presence of two closely placed tuning points always found with the regenerative set. The selectivity of the super-heterodyne is better than the selectivity of the regenerative set for each point, but if it chances that another station is 44 kc. away from that being tuned, it will also be heard. If this is the only interfering station, it can be eliminated by tuning the oscillator to the other point.

In a section where interference is bad, the widely separated double tuning point unquestionably is a disadvantage, but on the other hand, the same condition also occurs to a certain extent with the regenerative set. Here the interference is measured by the sensitiveness of the ear, the wider the frequency band it is possible for one to hear, the greater the interference. As a matter of fact, the super-heterodyne can effect a separation between two stations impossible with a regenerative set, and yet be less effective than the regenerative set if it so happens that stations are in operation, 44 kc. removed.

While the arguments set forth above appear to place the super-heterodyne at a disadvantage compared to the regenerative set, as a matter of fact, the selectivity is about the same for all practical purposes and the sensitivity of the super-heterodyne superior. Signals which are just about audible on the regenerative set are unpleasantly loud with the super-heterodyne. In a good location for loop reception, the small coils of the first detector circuit are all that are required for ordinary reception over distances comparable with those possible with a regenerative set and a good antenna.

If a good antenna is used, the distance possibilities of the short-wave super-heterodyne are limited only by the static level. For the reception of signals from a certain station, or stations, where it may be possible to remove interference caused by double tuning by changing the transmitting frequency, the super-heterodyne receiver is most satisfactory.

In operation, the plate condenser is set for strong oscillation and all the tuning accomplished with the grid condenser. Here the action differs from the regenerative set with which it is necessary to adjust the plate condenser for each frequency. Because of this single control the manipulation of the receiver is simpler and the possibility of picking up stations increased.

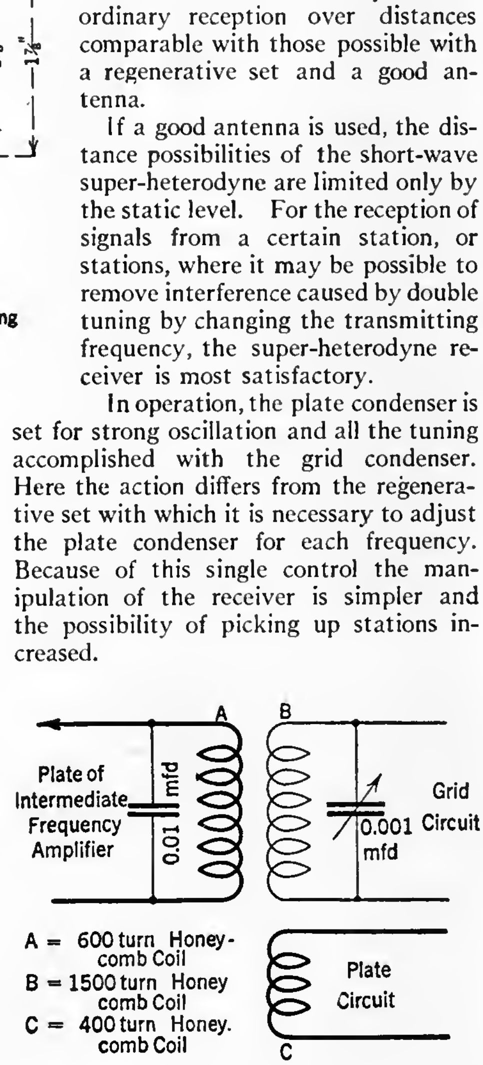


FIG. 6

A New Plan to Regulate Radio Broadcasting

A Keen Analysis of an Extremely Complex Problem—An Original and Operative Scheme Which Takes Into Account All Factors—Among the Broadcasters—Resuscitation After Electrical Shock

"AS THE BROADCASTER SEES IT"

By CARL DREHER

Drawings by Stuart Hay

THE number of wavelengths or frequency bands available for broadcasting purposes is limited by the following:

(1) The needs of other radio communication services as important, if not more so, than broadcasting;

(2) The design of existing receivers representing a capital investment by the radio listening public, which it is necessary to take into account in any reform schemes;

(3) Technical considerations arising from the propensity of stations not sufficiently spaced in frequency, to heterodyne and otherwise interfere with one another, as well as acoustic factors involving side-band width required for good quality transmission.

At this writing there are more individual broadcasters than can be properly accommodated in the space available. The number of aspirants is increasing by the week. This condition is responsible for the white hair and stooped shoulders of the United States Supervisors of Radio in congested districts, who are relieved, perhaps, by the recent decision of the Attorney General of the United States that, under existing laws, the Secretary of Commerce has no power to regulate wavelengths and operating hours of broadcast stations.

It is not improbable that the tendency to link up stations will increase, and perhaps technical methods can be developed to stack several transmitters of the same program on a single wavelength. But this is a ray of hope, rather than a solution of a pressing problem. The present situation is that we are issuing licenses, trusting that heaven will provide the wavelengths, in the face of the fact that heaven has yielded up all the wavelengths it has, within the limits of the three conditions above set forth. What, then, is to be done?

When a number of people want something, and there is not enough of the desideratum to go around, some must do without, wholly or partially. Admitting this principle, we must further concede the right of organized government to set up a procedure to decide equitably who shall have and who shall not. In other words, a legal mechanism must be set up to mediate between desire and possession. This holds for steam yachts and it should also hold for wavelengths. The problem in regard to wavelengths is by no means appalling, for one does not have to possess a wavelenth in order to be happy. Hence, if someone is shut out, he will have little warrant for appealing to the Deity and starting a revolution; it is not as if he were denied the bread of life.

What, then, shall be the method of rationing out wavelengths? The same, it may be suggested, as that used for rationing out steam yachts: competition. If I want a steam yacht I must acquire, in competition with other persons desiring the same thing, the price of the yacht; then, and only then, can I have my desire. Free competition, according to orthodox economic theory, means progress. It has its deprivations and disadvantages, but we believe that it is the best method in the long run. The problem of radio broadcasting today is to work out means, and to prescribe them by law, whereby time on the air will be given to the broadcasters with the best claim to it, by virtue of merit, in proportion to their merit, as long as the same exists, and no longer. This involves the determination of what constitutes merit in a broadcaster, and how it shall be rated.

With perhaps more temerity than sense, I shall set forth some views on this subject. It should be understood that these ideas are my own, neither the magazine, nor the company with which I am connected, nor any other of my radio associations, is in the slightest degree responsible for them. Furthermore, if I am an advocate of my own system, it is solely for the purpose of stimulating thought, in the hope that some solution, perhaps one compounded out of the ideas of many men, will be found for a technical and social problem which must be faced.

The problem is, of course, a complicated one. How could it be otherwise? It is part of the complication of industrial civilization. We create these Frankenstein monsters, and we must grapple with them. The present job is no more intricate than rate-fixing for public service utilities, and perhaps similar in that quantitative analysis must be the basis of its solution. The principal trouble with this aspect of the radio art is its lack of quantitative data and thinking based thereon.

DURING recent months, much attention has been centered on legislative halls at Washington, where Congressman and Senator have been struggling with the problem of enacting a law to regulate radio. It matters little here that, with only a few shining exceptions, a surprisingly small amount of real thought has been devoted to the problem by the legislators. Several proposals now drafted in bill form await the attention of Congress and their provisions for regulating radio, insofar as it relates to other services than broadcasting, is generally thought to be satisfactory. It is our opinion that in practically all of the radio bills, the regulations for broadcasting are not completely thought out, and in any case, were any bill passed, the law would cry for revision in a few years, if indeed the measure would not do irreparable harm to broadcasting while it operated. The fault of both is that the regulatory provisions for broadcasting are by no means flexible enough. Mr. Dreher here presents a scheme for broadcast regulation which takes into account all the interests involved in this complex problem. It is worthy careful reading. While there are many details in the plan to be amplified, we have no hesitancy in saying that we believe Mr. Dreher's intelligent proposals are genuinely calculated to operate for the best interests of all of us concerned in broadcasting. Comments are welcomed.

—THE EDITOR.

The social worth of a broadcasting station, under existing conditions, might be rated as about half contingent on program and half on technical factors. If the signal is loud and transmission good, but the program is not worth listening to, the station is as bad as one which presents a brilliant program but hashes it up in transmission, to the point where no one cares to listen to it. If either factor—transmission or program—rates zero, the net result should be zero, which indicates a multiplication process of final calculation. However, as the discussion is of a tentative nature at best, let us sacrifice something for simplicity and use an additive method We may assign 50 per cent. to program; 25 per cent. to power; 25 per cent. to audio-frequency characteristic, freedom from internal (station-generated) noise, etc. On this basis we may proceed to a fairly detailed enumeration of the points of a 100-per-cent. station. However, it is recognized that as time passes, all broadcasting stations remaining on the air will, presumably, attain excellent quality, and there will be no further object in rating them on this factor. The value assigned to such qualities would then be distributed among the other technical and program characteristics of the stations under consideration.

First of all, the power of the transmitter must enable it to be heard over disturbing noises—static, high tension leaks, etc. Grant it one point for each 100 meter-amperes, up to a limit of 25 points. The meter-ampere is the unit of transmission effectiveness: the product of the current in the antenna by the effective (electrical) height. A 500-watt broadcasting station runs with about 10 amperes in the antenna which has an effective height of perhaps 30 meters. That makes 300 meter-amperes, or 3 points in the above scale. The meter-amperes product goes up as the square root of the power; thus a 5000-watt station, such as is not uncommon now, would rate 9 points. A large station with a 50-meter (effective height) antenna, and a transmitter putting 50 amperes into that antenna, would get the maximum of 25 points, and beyond that, increase in power would not bring added consideration. That is, the scales would not be weighted in favor of extreme "super-power," while adequate power capacity would receive proper recognition. Here, as throughout this speculation, we must beware of static concepts in a progressing art. Should high power broadcasting be increasingly desired by the public, the rating might be changed to one point for, say, every 300 meter-amperes, up to the same maximum of 25 points. The rating standards would require periodic revision, to keep up with the advance of the art, to which the system must be a stimulus, not a sedative.

The quality of a broadcasting station, likewise, is no mysterious matter, in as far as it is a function of the apparatus installed. If it transmits impartially all the usual audible frequencies of speech and music, free from distortion due to overloading, transient effects, and a few other technical bugs; and if the operators know their business, it will put out first-rate stuff. If, on the other hand, it loses the lower frequencies, the output will sound "tinny"—metallic or nasal, without natural roundness. Loss of the higher frequencies is even worse; it results in a characteristically muffled output. An expert can estimate, by merely listening to the station, where it "cuts off" at the high and the low end. Better still, with an audio oscillator and galvanometer, he can take the transmission characteristic of the station, a graph which shows how it treats audio frequencies over the range that matters. If the curve is a sensibly straight line between 50 and 8000 cycles, say, and there are no overloadings anywhere in the system (all matters capable of measurement) the station cannot help sounding good on the air, unless the operators are plumbers. It would be no great feat to express the quality numerically. We shall allow 25 per cent. for a station perfect in these respects in the existing state of the art. If technical measures should be developed to overcome fading, at the transmitter, stations so equipped would be entitled to a higher technical rating, and such an improvement might take over the coefficient released by a common attainment of excellence in such a factor as the audio characteristic discussed above.

So far we have been dealing with things which can readily be expressed quantitatively. But what about program, which has a value of 50 per cent. in this table, a factor full of conflicts of opinion and individual taste, in which one man's opinion is supposed to be as good as another's? Is it not written, *De gustibus non est disputandum*? Then who shall be the arbitrator? To my mind, we can arrive at a result valid at least for the majority of listeners, by an indirect route. The good programs, of whatever sort—jazz, classical, or instructional—are where lots of people are, and most of them must be paid for. Here we have two criteria: Electrical accessibility to centers of population, and expenditures for artists, whether made directly by the station or by a sponsoring advertiser. Reduced to the lowest terms, this means money, for artists and wire lines. Stations with studios in, or lines to, great centers of population, would have the advantage, as they should have if the public is to be properly served. The program capacity of a station could be rated by such a method, taking the index as proportional to the population of a given area around each of the studios from which the transmitter could be fed (overlapping areas not to count), modified by the number of field events per week which the station was willing to sustain, and the money directly or indirectly paid to performing and composing artists. Of course the enterprise of program staffs is an incommensurable factor, but, given the population, wire lines, and money for artists, the main determinants are taken care of. I do not envy the proposed broadcast station appraisers their jobs, but, intricate as these would be, with the setting up of standards, the work would not be impossible of performance.

Of course, the proposed method of rating stations would in no way supersede any existing regulations that have been found serviceable. The present inhibitions on radiation of harmonics, malicious interference, etc., would naturally be included in whatever legislation was passed to meet the needs of the situation. The lid might also be clamped down on the more flagrant and raucous forms of broadcast advertising, without interfering with the milder and more judicious modes.

A Proposal for an Operative Scheme to Regulate Radio

REDUCED to a brief outline, the scheme for an operative plan to regulate and control broadcasting, proposed by Mr. Dreher, is:

1. *Establishment of a suitable commission with power to rate broadcasting stations as to public service value or capacity, and facilities for determining the same.*
2. *Allocation of wavelengths on a population basis, and with due regard to technical limitations.*
3. *Evaluation of hours of each day as to relative importance for broadcasting.*
4. *Distribution of available time and wavelengths to applying stations according to individual ratings and values assigned to hours, exchange of hours to be permitted, subject to ratification by the commission.*
5. *Modifications as necessary to secure flexibility and optimum service to listeners.*
6. *Provision for judicial review of major decisions.*

By the method roughly outlined above every broadcasting station, existing or proposed, would receive an index number. This figure would determine its share of time in the ether in its locality. But first localities would have to be weighted, presumably by population, to decide the number of wavelengths to be allotted to each section. The method here would be substantially the same as that formulated by the First and Second Radio Conferences: division of the country into zones and allocation of channels to as many stations as can be accommodated without excessive interference.

The next step in the plan is the determination of the relative values of the various hours of the day, and the days of the week, for broadcasting purposes. At present the demand is all for the evenings. Everybody wants to broadcast from 6 P. M. on. Without a prohibitive amount of trouble, data could be secured showing the probable number of listeners in any given region during the diurnal cycle. On this basis, values would be assigned to the various hours of each day of the week, somewhat as follows:

	Time	Value
Monday	4–5 P. M.	6
	5–6	10
	6–7	20
	7–8	30
	8–9	30
	9–10	30
	10–11	20
	11–Mid	10
	Mid–1 A. M.	5
	1–2	2

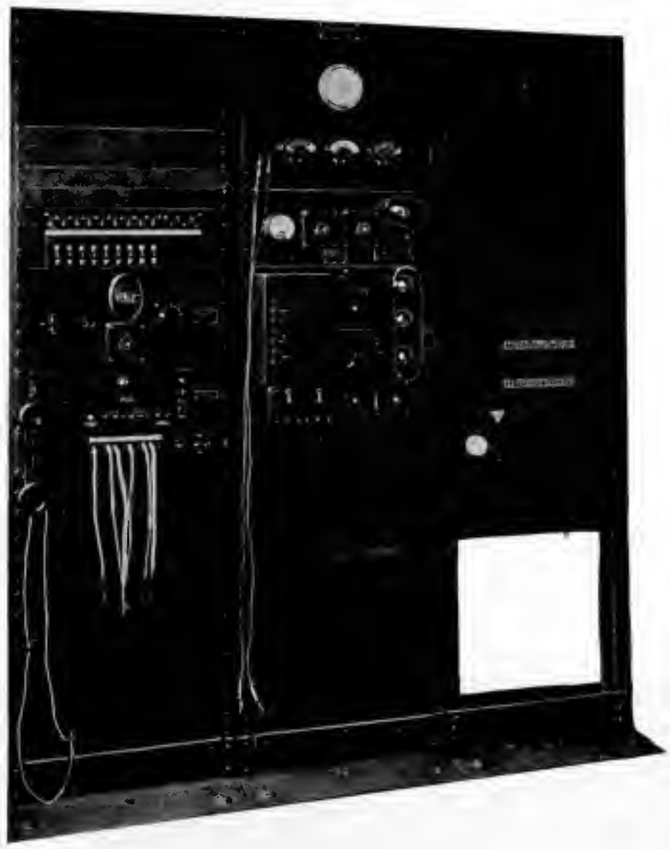
The broadcasting privileges for a limited time may now be handed out. The metropolis of Smithtown has, to the great chagrin of its Chamber of Commerce, been assigned only one wavelengrh, 324 meters;

but it has this full time. There are three stations, WAA, WEE, and WXX, and they all want to broadcast six evenings a week from 7 to 11 P. M. Instead of wrangling in the Radio Supervisor's office and splitting time on some nebulous basis, the three disputants submit their stations to the commission and in due time they are assigned percentages as follows: WAA, 60; WEE, 50; WXX, 30. WAA, having the highest rating, gets first choice of daily hours up to the amount of its rating. It takes from 7 to 9 P. M. daily, a requirement of the arbitral commission being that the daily hours must be taken consecutively. WEE, with its 50 points, chooses from 9 to 11 P. M. WXX has to be satisfied with from 5 to 7 P. M., an interval to which its 30 points entitle it on third choice. This is only the first approximation to a final settlement. The management of WAA wants two evenings from 7 straight through to 11, because of program exigencies. They meet the representatives of WEE out of court and patch up a deal involving exchange of program hours. This is presented to the commission and ratified. The standing of the local broadcasters being numerically defined, trading can take place on a perfectly definite basis, as with money. As for WXX, if he isn't satisfied with his time allocation, all he has to do is take the kinks out of his transmission characteristic, smooth out his generator hum, and increase his budget for hiring artists. On the basis of these changes he may apply for a new rating, next year, and upset the layout. Under these conditions no broadcaster is going to sit back on his haunches. If he is unable to keep up with the procession he will have to get out or retire to an inferior place, exactly the same as in business, association football, or amour.

When all time was taken up, no more stations could get in—except by putting up a better station than the worst of those having tenure. This situation is unpleasant, inasmuch as some worthy cause with the desire to broadcast, but with limited resources, may be left out in the silences. But this is a situation not as bad as that tolerated at the present time, when a man may have the desire and the ability to put up a superior broadcasting station, and be unable to get a wavelength simply because some inferior station is already occupying it. He may buy out the latter, but at what price? The weaknesses of the proposed system seem to me preferable to the existing and potential abuses of the present one.

At this point let us examine two of the salient defects of the merit system of time-frequency allocation. An eminent authority with whom the subject was discussed, while commending the motives leading to the formulation of this scheme, pointed out two grave objections. In the first place, he indicated, the system takes little account of the evils of time division, which is without doubt the cause of some poor broadcasting. If a program director is forced arbitrarily to terminate his performance at a given hour, because the station next in the ranking has the air at that time, it will add a serious restriction to his other troubles. This must be admitted, but after all the best stations would have to divide time least, and, the splitting of time on any one day being a disadvantage, the stations would tend to trade their time so as to minimize this difficulty.

Secondly, the plan as so far advanced disregards the financial interests of broadcasting associations. If a broadcaster invests $100,000 in a station, securing full time use of a certain wavelength, any competitor, by spending the same amount, may theoretically obtain equal time division, thereby depreciating the value of the first station's investment perhaps 75 per cent., since the value of a station may be presumed to go up in more than direct proportion to the hours used. In other words, part of the first broadcaster's capital has been confiscated.



CONTROL EQUIPMENT OF THE PRAGUE, CZECHO-SLOVAKIA STATION

We might handle this by providing for a payment covering the unamortized portion of the dispossessed station's investment, by the newcomer, the actual amount to be determined by the regulatory commission, which would have definite schedules subject to judicial review. As broadcast installations are very rapidly amortized under present conditions—the life of an ordinary station is not over four or five years—these settlements would not run into excessive amounts. A suitable time lag should also be provided, for the sake of reasonable economic stability. In other words, the stations would have ether-franchises of indeterminate duration, but with a certain minimum time to protect each holder. My own feeling is that these two safeguards are sufficient, and that a somewhat uncertain tenure of the communal highways of the ether is a good thing. Perhaps this is too radical, and priority and past services should get more consideration. The balance here depends on one's general political and economic views; the legislators could set it according to the preponderant opinion of the time.

Summing up, the salient points of the proposed scheme for regulating broadcasting are as follows:

1. Establishment of a suitable commission with power to rate broadcasting stations as to public service value or capacity, and facilities for determining the same.
2. Allocation of wavelengths on a population basis and with due regard for technical limitations.
3. Evaluation of hours of each day as to relative importance for broadcasting.
4. Distribution of available time and wavelengths to applying stations according to individual ratings and values assigned to hours, exchange of hours to be permitted, subject to ratification by the commission.
5. Modifications as necessary to secure flexibility and optimum service to listeners.
6. Provision for judicial review of major decisions.

Under (5) there might be included such features as provision for purely local stations of limited power on special wavelengths. There might also be a check on propagandist stations—bodies having some special interest to express directly in the material broadcast, as distinguished from general public service, where the motive in broadcasting is not directly expressed in the material radiated. The quotas of the former class of stations might be reduced by some predetermined ratio. These are matters of detail which would have to be included in the powers of the regulatory commission or its subdivisions.

Fools rush in where angels fear to tread. But they may persuade the angels to follow and do what needs to be done.

AMONG THE BROADCASTERS

Czecho-Slovakia

THE invasion of Czecho-Slovakia by the Western Electric Company is shown in two accompanying photographs of the 5-kw. Prague station's technical equipment. Everything is there, including the smoothing-out condensers, the safety gap on the transformer, and the water-cooled tubes. The first picture shows the control equipment, located in the same building in Prague which holds the studios. The power plant is situated in another quarter of the town. It is said to be capable of developing 7.6 kilowatts, but the normal output is 5.2 kw. in the antenna.

The third illustration shows a 500-watt (antenna power) transmitter of French manufacture, used at Brotislova in the same country. At least, that is what the name looks like to us, in our admittedly benighted state regarding Czecho-Slovakian towns and things. Note, in the middle panel, below the tubes, the slide-type variable resistances which are still popular in Europe. Puzzle: What are the three panels, and why do you think so? The one to the right is probably a tank-antenna circuit with coupler and radio-frequency ammeters. The others might be anything: rectifiers, modulators, amplifiers, or oscillators. Having searched without success for the family opera glass, wherewith to read the inscriptions on the meters, I have given it up. Send in your guesses, gentlemen. Czecho-Slovakian and French radio operators are barred from the contest.

WPG

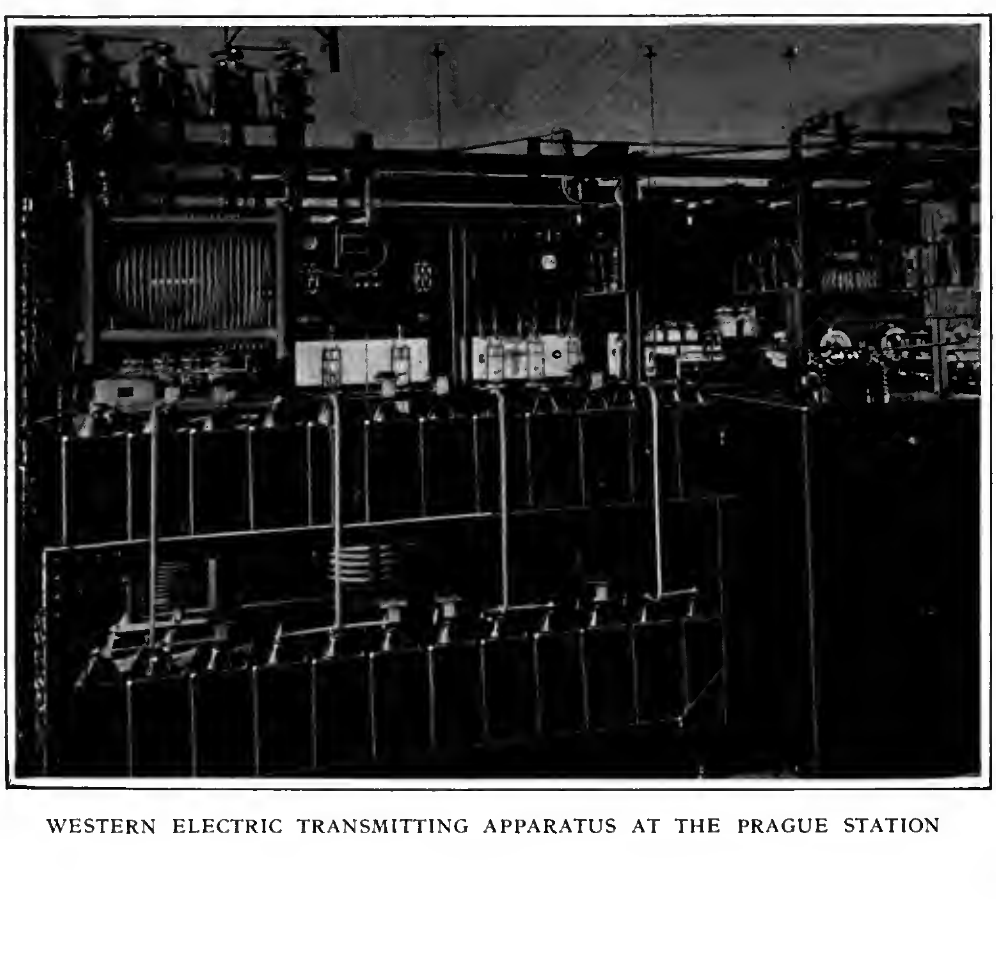
ON MY occasional week-ends in the Catskills, where my antenna swings in a maple grove and a three-tube set, more or less Roberts, with one tube reflexed, keeps me in touch with the dear broadcasters, the new WPG 5-kilowatt Voice of Atlantic City is doing its part in keeping the field strength where it should be. It is holding its own, during August, with all the other aspirants of the ether, except the 50-kilowatters and such, who are necessarily few. The quality is first-rate, also, and this may be partly due to the master oscillator circuit which, according to a recent issue of the *Western Electric News*, is in use at WPG and other 5-kw. W. E. installations.

A FRENCH 500-WATT TRANSMITTER AT BROTISLOVA, CZECHO-SLOVAKIA

It was found by Bown, Martin, and Potter in the United States, as well as by some investigators in England (see "Some Studies in Broadcast Transmission," by the former authors, *Proc. I. R. E.*, Feb., 1926; and A. G. D. West's article on "The Design of a Broadcasting Station," in the *Year Book of Wireless Telegraphy and Telephony*) that a certain type of distortion could be traced to a slight frequency wobble, inherent in the usual method of modulating broadcast transmitters. This rapid variation within the cycle of the modulating frequency manifests itself, by a complex interference ingeniously traced by Bown, Martin, and Potter in their paper, in wave form distortion at the receiver, sounding somewhat like tube overloading only worse. Stabilization of the radio frequency of the carrier and sidebands of the transmitter helps to eliminate this "night distortion," as the British call it. The method employed is to use a "driver" or "master-oscillator" with a 50-watt tube, which may be crystal-controlled. This is isolated from the modulator circuit by means of two stages of radio frequency amplification, resistance-coupled. Care must be taken to shield the driver from the later high power stages. The result of these precautions is that the transmitter holds a constant frequency during modulation. A corollary result is that distortion is reduced to selective fading (with respect to audio frequency), which is apparently due to wave interference, and does not hash up the quality as badly as the frequency wobble aforementioned.

Station WLS of the Sears Roebuck Agricultural Foundation, Chicago, is using a similar frequency stabilizer in its 5-kw. transmitter.

We shall probably have more to say about transmitter frequency stabilizers in subsequent issues.



WESTERN ELECTRIC TRANSMITTING APPARATUS AT THE PRAGUE STATION

KPRC

THAT the Southerners may not feel neglected, let us not forget to mention KPRC of the *Post-Dispatch* of Houston, Texas, which has been letting the world (excepting the dead spots) know how it feels, since May 9, 1925.

At KPRC they have two studios on the top floor of the twenty-two story office building of the *Post-Dispatch*. One is a solo studio, intended for single artists (the qualification is purely numerical and mommas and poppas are not barred) but much larger than most studios of this type. The ensemble studio will accommodate an 85-piece band. The solo studio looks like a drawing room, while the larger studio is more of a workshop and contains less in the way of artistic furniture. The walls and ceiling of both rooms are deadened acoustically, monks cloth being draped over the asbestos and hair felt in the large studio, and brocaded damask hangings in the other room.

The technical equipment is the usual Western Electric layout, with mixing panels and all the latest jiggers. The power plant of the station is in the publishing plant of the paper, at some distance from the studios. The station kicks out lustily and has been heard in Halifax, Nova Scotia, Hawaii, etc.

Mr. G. E. Zimmerman is station Supervisor and Alfred P. Daniel announces. When the control operators are not on duty at the station they pound out dots and dashes on their amateur transmitters.

Resuscitation After Electrical Shock

NOT long ago, a high tension fuse in a mid-Western broadcasting transmitter blew out, while the station was on the air. The operator, a boy nineteen years old, started to put in a new fuse, without shutting down the machine. In his anxiety and hurry he came into contact with the high potential conductor. This cost him his life. He was able to gasp, "I'm not hurt," when help reached him, but he died a few minutes later.

". . . KEEPS ME IN TOUCH WITH THE DEAR BROADCASTERS"

In another broadcasting station, a month or so before the accident above, one of the technicians took the discharge of a smoothing out condenser, after the set had been shut down. This man also was killed.

At a chemical plant in the East, a conveyer system became charged with 220 volts, a. c., normally not a dangerous voltage. The men who set out to remedy the difficulty, however, had a caustic solution on their hands, which was equivalent to placing them in an electrolytic bath. Four of them were killed, the electrician of the plant first, followed by those who tried to rescue him, heroically, but in the wrong way.

Recently an experienced technician at one of the 50-kw. broadcasting plants told me of a narrow escape he had, partly through luck and partly because the engineer's powers of observations did not fail him at a critical time. He was testing tubes on 10,000 volts plate. Something arced over in the set. The technician pushed a button which operates a relay to take plate voltage off the transmitter. He did not trouble to open the main breaker manually. The relay opened, but for some reason arced at the contacts, maintaining the circuit with somewhat reduced voltage on the plates. The engineer, unconscious of the danger, started to climb into the set, over a protective railing surrounding the apparatus. As he touched this railing he felt a tiny spark, the charging current which every object near such a transmitter collects. This warned him that his death warrant, signed and sealed, was being thrust into his hands. He had just time to tumble back from his perilous position. Now he opens the main breaker and clips a short-circuiting lead between the plate bus and ground before he works on the set. A good rule, if one is not tired of life.

Broadcast operating, and electrical work on high tension circuits in general, are not especially dangerous—if one is careful. But not everyone is careful all the time. Now and then a man is caught. When he is taken off, if his heart is good, he may still be saved. The method of resuscitation is presumably familiar to most broadcast operators, but a few may not know the details, and it is certainly worth recounting them on the chance that somewhere a life may be saved.

A man is not dead until he is cold and stiff. But under the impact of a severe electric shock he ceases to breathe, owing to the paralysis of the nerves controlling respiratory action. It is necessary to continue the respiratory function artificially, until the man once more has the power to breathe normally for himself.

Agreement seems to be general at this time that the best method of artificial respiration is that known as the Schaeffer or prone-pressure system. It is exceedingly simple and less tiring to the operator than other methods—an important factor in a job which may have to be continued for hours.

As soon as the man who has sustained the shock is freed from the circuit, he should be laid on his stomach, one arm extended, and the other bent at the elbow, with the head turned to one side and resting on the hand so as to leave the mouth and nose unobstructed. Waste no time in listening for heart action or other tests; all that is irrelevant. If an assistant is available, send him for a physician. In the meantime, artificial respiration should be started without delay, unless to make sure that the man has nothing in his mouth or throat which might interfere with breathing; such a search only takes an instant.

The operator kneels straddling the patient's hips. He places his hands on the small of the patient's back, fingers over the lowest ribs, the thumb parallel to the fingers. A man breathes largely in the region of the diaphragm and lower chest; the object of the movements is to compress and expand this region rhythmically.

At the rate of twelve to fifteen times a minute, the operator presses forcefully but not violently on the lower ribs, keeping his own arms stiff. A count of about two seconds is allowed between pressures, in which the operator rests. The easiest way in which to time the movements is for the operator to synchronize them with his own breathing.

No attempt should be made to administer stimulants. Such measures should be left to the physician, when he arrives. In general, a man stunned by an electric shock needs only air. Artificial respiration should be carried on in a cool, airy place, if one is close at hand; but no time should be wasted carrying the man to such a place, if more than five or ten seconds are involved.

If the patient revives and begins to breathe normally, the operation may be discontinued, but under no conditions should he be permitted to sit up or exert himself. He should be persuaded to lie quietly on his back until the physician judges it safe to move him. There are cases on record where men were revived after over an hour's work, only to die of heart failure when they got up under the impression that they were all right.

In electrical work, as elsewhere, an ounce of prevention is worth a pound of cure. The best rule is to kill and tag all circuits before working on them, and to short-circuit the plate bus by some simple device which should always be handy for this purpose. When trouble occurs during a program, work as rapidly as possible—but see that the plate current is off before you touch portions of the high tension circuits. Better a thousand times that the dancers should wait a few seconds longer—that an attentive audience be deprived for a few moments of its entertainment, than that a man should lose his life.

"NOBEL PRIZE MAY BE AWARDED TO INTREPID INVESTIGATORS OF MYSTERIES OF GALLON"

RADIO ENGINEERS DETERMINE EXACT NUMBER OF CUBIC INCHES PRESENT IN GALLON

Results to be Given to American Association for Advancement of Science—Nobel Prize may be Awarded to Intrepid Investigators of Mysteries of Gallon

DURING the month of July I paid a visit to my colleague, D. N. Stair, the chief of the brave men who turn sixty cycles a. c. into radio frequency at Bound Brook, New Jersey. Among other things, we discussed the problem of scale deposition on the water-cooled plates of the large tubes, and the feasibility of substituting surface water for the deep-well supply in use. Then, still earning our salaries virtuously by such cogitations, we strolled to a point about a thousand feet from the station building, where a tile pipe emitted a small stream of clear water, the drainage of the nearby fields. Here we sat down, looking at the bright green vegetation in the rivulet, and trying to decide whether the flow was sufficient to fill our cooling system in the allowable time.

"First," I announced, "we must know the number of cubic inches in a gallon. I was taught this figure in school, but of course I have forgotten it. No doubt you can tell me."

"I fear," replied my colleague, "that the figure has also escaped my mind."

"Six hundred and forty acres to the mile," I reflected aloud, "and there are one thousand seven hundred and twenty-eight cubic inches in a cubic foot. But that has nothing to do with the cubic contents of a gallon. Suppose you get your *Electrical Engineers' Handbook*. After mastering the difficulties of the index system, in two or three hours we can find what we want."

"An *E. E. Handbook* is one of the things we haven't got at this station," replied Mr. Stair, sorrowfully.

"What!" I ejaculated. "Do you mean to tell me that you operate a plant of this size without an *E. E. Handbook* on the premises, if only for the sake of appearances? Well, then, get your slide rule. On the back you will find tables and all sorts of useful facts collected by savants, from Euclid to Einstein."

"No slide rule, either," was the answer. "We use a table of logarithms."

"Then we are driven to using our wits. Now let us see if we can reflect credit on our Alma Maters dear, the test shops at Schenectady, and Aldene, etc. In my mind I have a picture of a certain gallon jug of port wine which, materially, exists at my home, forty miles away. I judge the jug to be about seven inches in diameter and ten inches high. The area of the base is 3.1416 times the square of the diameter, or about one hundred and fifty-four square inches. Multiplying by ten, we arrive at the conclusion that there are one thousand five hundred and forty cubic inches in a gallon, approximately. Does that figure sound familiar?"

"But," protested Mr. Stair, "the area of a circle is 3.1416 times the square of the radius, not the diameter."

"You are right," I assented immediately. "Therefore we must divide the previous result by four. The new answer is three hundred and eighty-five cubic inches to the gallon."

". . . BY FINDING THE TIME REQUIRED TO FILL THE CAN ONCE"

"It still sounds high," observed my colleague.

"I wish it were higher, when it comes to the port wine," I replied. "The higher the better."

At this point Mr. Stair had an idea. He produced a one-gallon oil can and measured it triumphantly.

"There are two hundred and nineteen cubic inches in one gallon," he trumpeted, after some figuring, "unless the oil merchant is a crook."

"He probably is."

But now, using the empty oil can, we were able to measure the flow of the stream directly, in gallons per minute, by finding the time required to fill the can once. We then returned to the station, where we found Mr. Geer, an engineer of an associated company. Mr. Geer likes to do things himself, and at this moment he was striking a cold chisel with a hammer. I interrupted him.

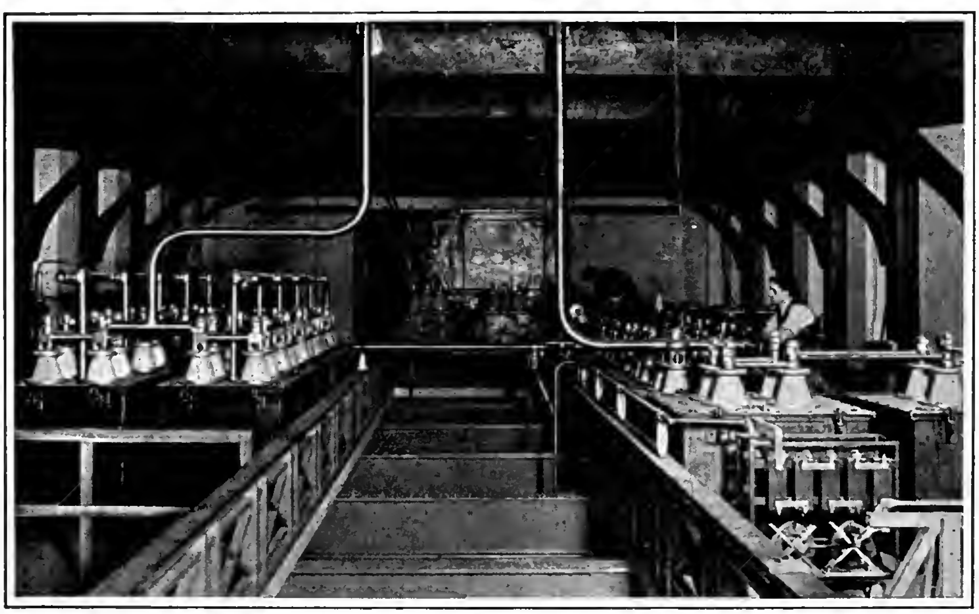
"Brother Geer," I asked him seriously, "how many cubic inches, to your mind, constitute a gallon?"

"Two hundred and thirty-one," answered Mr. Geer without an instant's hesitation.

"Preposterous," I said, "I have just calculated three hundred eighty-five and Stair finds two hundred and nineteen."

Nevertheless, I felt something hauntingly familiar about the figure Mr. Geer had mentioned. On the train back to New York I suddenly recollected that I carry in my pocket a small souvenir notebook issued by a nationally prominent engineering firm, containing wire tables, weights and measures, etc. Sure enough, there were and are two hundred and thirty one cubic inches in a gallon.

"Oh, well," I reflected, "our scheme of weights and measures is unworthy of a civilized, scientific people. I shall join a society in favor of the adoption of the metric system."



CONDENSERS AT RUGBY, ENGLAND'S NEWEST STATION

The station is so arranged that either short or long waves for telephony or long distance telegraphy can be used for communication with the British colonies or with the United States. The condensers shown are able to withstand 800 amperes at 40,000 volts. The bus bars and lugs are about six inches in diameter and large enough for one's fist to fit inside. Six million sheets of mica, carefully tested and gauged, to the thickness of three-thousandths of an inch were used by the makers, the Dubilier company, into the units which make up the bank

The Technical and Scientific Aspects of Broadcasting

The Processes Involved in the Transmission and Reception of Broadcast Programs—A Simple and Lucid Explanation of the Functions of the Various Units of the Transmitter and Receiver

By RALPH BOWN

Vice President, Institute of Radio Engineers

BROADCASTING differs from other forms of wireless telephony in that the transmission is sent out from one station for the purpose of reaching a large number of receivers scattered over an area, whereas other forms of telephony generally involve two-way transmission between two terminal stations only. Moreover, the apparatus used in broadcasting not only must transmit intelligible speech but must also transmit the subtle intricacies of vocal and instrumental music with the highest degree of faithfulness and freedom from distortion.

Stated briefly, the purpose of a broadcasting system is to pick up air-pressure variations due to sound waves, transport a facsimile of them by radio means to a multitude of receiving points, and reproduce at these points sound waves as nearly as possible like the original ones. The pickup, or input and the reproducing, or output, ends of the system respectively, are comprised of two pieces of apparatus which in principle are essentially like the corresponding parts of the ordinary telephone instrument. At the input end is a telephone transmitter, or microphone, to produce electric current having variations in intensity corresponding to the variations in air pressure on the diaphragm caused by the sound waves. At an output end some form of telephone receiver is used to reproduce from such electric currents the corresponding sound waves. Since the method of transporting the electrical counterpart of the sound waves from the microphone to the telephone receiver is not by electric currents or waves on wires, as in ordinary telephony, but by electromagnetic waves in free space, the mechanisms which intervene in the process are of a distinctive character.

The radio transportation or transmission is accomplished by sending out from the transmitting station electromagnetic or radio waves which vary in intensity in the same manner as do the telephonic currents from the microphone. At receiving stations, these radio waves are intercepted, and their intensity variations converted back into intensity variations of a telephonic current, which actuates the telephone receiver. There are several distinct processes involved:

1. Producing the high-frequency alternating electric current which, when introduced into a radio antenna, causes the radiation of electromagnetic waves. This current is produced by an electrical "oscillator."

2. "Modulating" this current, or causing its intensity to vary in the same manner as does the intensity of the telephone current from the microphone.

3. Radiating the electromagnetic waves by causing the modulated high-frequency current to flow in a radio antenna, or aerial.

4. Intercepting some of the radiated waves' energy by a receiving antenna in which modulated high-frequency currents, similar to those flowing in the transmitting antenna are, thereby, caused to flow.

5. "Detecting," or converting the modulated high-frequency current into telephone currents having the same variations in intensity.

6. At both the transmitting and receiving stations, amplifying the currents to increase their power and to make up for losses in power suffered in transmission through the various parts of the entire system.

The mechanisms involved in items (1), (2), and (3) constitute the Transmitting System, while those involved in items (4) and (5) constitute the Receiving System. In the transit of the waves through space between these two terminal systems, lies the field of Radio Transmission.

THIS is the second article to be published in RADIO BROADCAST *through the courtesy of the* Encyclopaedia Britannica, *the thirteenth edition of which has just been published,. In last month's* RADIO BROADCAST, *an article on the microphone, by H. J. Round appeared in these pages, and on this occasion we take pleasure in reprinting from the new* Britannica *an article on broadcasting by Ralph Bown, well known in radio engineering circles in this country and abroad. Mr. Bown is Vice President of the Institute of Radio Engineers. He is in the Department of Development and Research of the American Telegraph and Telephone Company.*

—THE EDITOR.

The most important device used in the transmitting and receiving systems is the ubiquitous vacuum tube, or thermionic valve. It is employed in the most modern apparatus for performing many functions, including generation of high-frequency currents, modulation of these currents by telephonic currents, detecting or converting the high-frequency currents to reproduce telephonic currents, and amplifying both high-frequency and audio-frequency (telephonic) currents.

TRANSMITTING SYSTEM: The transmitting system comprises (1) the microphone, which is placed at the studio or theater, and toward which the sound waves of the voice or instrument are projected; (2) the amplifier and control devices, which magnify the electric currents from the microphone by the desired amount; and (3) the radio transmitting station, which sends out radio waves modulated in accordance with the amplified microphone currents.

Highly specialized forms of microphones are necessary in order to respond accurately to the wide range of sound frequencies and intensities of speech or music. The music, for instance, that comes from a symphony orchestra, consists of tones which range from fundamental bass notes of less than 100 vibrations or cycles per second up to harmonics at 5000 cycles or more. Thus it covers a range of frequencies of at least 5000 cycles or, as it is expressed by the engineer, a band of frequencies at least 5000 cycles wide. One kind of microphone in wide use consists of a tightly stretched duralumin diaphragm having two carbon microphone buttons attached to opposite sides of it at the center. The two buttons are connected with the electrical circuit in such a way that distortion tends to be balanced out. The placing of the microphone with reference to the performers, and the acoustic qualities of the surroundings, are of great importance in achieving the best results. For this reason, where possible, the program is performed in a studio room especially designed for control of placing, sound absorption, and echoes.

Since the range of volume, or loudness, covered by the program may be very large, the amount of amplification applied to the microphone currents before such currents go to the radio transmitter must be adjusted frequently in order that they may neither overload the transmitter, giving rise to distortion, nor fail, through weakness, to actuate the transmitter sufficiently. The amplifier adjustment, therefore, requires to be manipulated by a control operator who is provided with a radio receiver so that he can hear the program exactly as it is heard by the radio audience. To guide his judgment further in manipulating the volume control, the operator is usually provided with an electrical device called a "volume indicator" which gives him a visual indication of the strength of the telephonic current at the output of the amplifier. The amplifier and control apparatus, and the radio transmitter, as well as the wire telephone circuits between them in cases when they are physically separated, must be carefully designed to transmit the telephone currents without distortion.

The radio transmitters employed in broadcasting are not different in principle from those employed in other forms of radio telephony but are designed with special attention to stability, freedom from distortion, and purity of transmission. In most types, the telephone currents delivered from the control apparatus are amplified and impressed upon the oscillator tubes, which generate high-frequency currents. The output of the oscillator is thus modulated[1] to correspond with the original sound variations. In the smaller power transmitters the modulated high-frequency currents then go directly from the modulating system to the antenna, but in some equipments, amplifiers containing powerful, metallic, water-cooled tubes are interposed. The antenna systems of broadcasting stations resemble those of wireless telegraph installations.

[1] See RADIO BROADCAST Laboratory Information Sheet No. 25

FREQUENCY ASSIGNMENT

THE assignment of carrier frequencies to broadcasting stations is an important consideration. When there is no modulation, that is, during the silent intervals of a program, a broadcasting station sends out waves of a single frequency, as in continuous wave (c.w.) radio telegraphy. This frequency is known as the carrier frequency,[2] and is expressed in kilocycles. When modulation takes place by speech or music, there are also transmitted two "sidebands," or sets of waves which occupy two bands of frequencies, one on either side of the carrier, each about 5000 cycles (half a kilocycle) in width making the total transmission cover a band some 10 kilocycles in width—with the carrier frequency in the middle. The frequency range available for broadcasting is limited, being, in the United States and Canada, for instance, from 550 kilocycles to 1500 kilocycles. Thus there are only 95 non-overlapping 10-kilocycle bands, or channels. Two stations in the same service area cannot occupy the same band or even closely adjacent bands without causing interference to each other, so it is necessary to assign station frequencies in accordance with some form of geographical zoning system, and the total number of stations which can operate simultaneously is definitely limited. In popular usage, the wavelength in meters is commonly used as a measure of the carrier frequency of a station, and in classified lists of stations, both the carrier frequencies and wavelengths are often given. The numerical relation between the two is the same as for any propagated wave motion, either one being equal to the velocity of propagation divided by the other.

RECEIVING SYSTEM: The functions of the receiving system are (a) to collect the radio wave energy in its antenna, in the form of high-frequency currents; (b) to select, to the exclusion of other channels, the currents lying in the band of frequencies occupied by the station to which it is desired to listen and then, (c) to amplify these currents, and (d) to convert them into audio-frequency (telephonic) currents, which are in turn amplified and delivered to the telephone receivers or a loud speaker.

FORMS OF ANTENNAS: Two kinds of antennas are in common use, the one, an elevated wire similar to a transmitting antenna, and the other a loop antenna consisting of a coil of a few turns of wire wound on a frame or other support. The former is electrically more efficient, but the loop being relatively small is often more convenient. The selecting of stations is done by means of tuning circuits having electrical inductances or coils, and electrical capacities or condensers. These are adjustable, so that the circuits may be tuned to respond most strongly to currents in the band of frequencies sent out by the station it is desired to receive. Making these adjustments is known popularly as "tuning-in." In the arrangement and form of the tuning circuits and the vacuum tube amplifiers, receiving sets have a wide variety of differences in detail, but broadly they fall into three main classifications: (1.) Regenerative Sets; (2.) Radio-Frequency Amplifier Type Sets; (3.) Intermediate-Frequency Amplifier (Super-heterodyne) type sets.

In addition to these types, there is a class of much simpler and less sensitive receiving sets known as "crystal sets," which contain no vacuum tubes. A crystal set consists merely of an antenna, the tuning circuits, and a "crystal detector" which serves to convert the modulated high frequency currents into audio-frequency (telephonic) currents. A crystal detector is a device which utilizes the electrical rectifying properties of certain crystalline minerals. The lead ore galena is one mineral thus commonly employed.

REGENERATIVE SETS: In regenerative[3] sets a controllable coupling of some kind is provided between the output and input circuits of the amplifying or detecting tube, or tubes, so that some of the amplified voltage may be fed back into the tubes again and be re-amplified many times. This gives more effective use of a small number of tubes. Such sets, when the "feed back" coupling is wrongly manipulated, will generate continuous high-frequency oscillations which cause waves to be sent out from the antenna as at a transmitting station. These waves may be a troublesome source of interference to other receivers and, for this reason, a decline in the use of regenerative sets is being forced by public opinion.

RADIO-FREQUENCY AMPLIFIERS: In the second type (Radio-Frequency Amplifier) the radio-frequency currents are amplified by a multi-tube amplifier before being impressed on the detector tube, which converts them to audio-frequency currents. If no precautions are taken to avoid coupling between the output and input of the amplifier, this type may also be regenerative. Various expedients are employed in the design and construction of high-frequency amplifier types to guard against regeneration, and to make them stable and non-oscillating.

INTERMEDIATE-FREQUENCY (SUPER-HETERODYNE) TYPE: In this type of receiver[4], the modulated high-frequency currents from the antenna are combined in a converter tube with continuous high-frequency currents generated by a local oscillator tube circuit. From their interaction in the converter tube there results a modulated intermediate frequency, usually of the order of 50 kilocycles. The intermediate-frequency currents are amplified and passed to a detector tube, which reproduces audio-frequency currents from them. This type of set is stable and easily adjusted. It is, however, usually more complicated and expensive than the other types.

AMPLIFIERS: All types of receiving sets except the simplest, contain, or must be used with, audio-frequency amplifiers which, coming after the detector tube, amplify the audio-frequency currents to a sufficient intensity so that they will operate the telephone receivers or loud speakers which reproduce the sound vibrations.

In order not to distort the high-frequency or audio-frequency currents, it is necessary that the various circuits in the receiving set pass these currents with equal efficiencies for the different frequencies in the band, and that the various tubes, particularly the detector and audio-frequency amplifier tubes, be of sufficient size to transmit the currents without becoming overloaded.

The portions of the receiving system in which distortion is hardest to avoid are the audio-frequency amplifier and loud speaker. The best amplifiers are designed to amplify uniformly all frequencies ranging from 100 cycles, or even less, to 5000 cycles or more, since all these frequencies are important in accurate reproduction of speech and music. In the same way, the transfer efficiency from electric energy to sound energy by the loud speaker should be substantially constant over this range. The load-carrying capacity of the amplifier and loud speaker must be adequate to provide the desired volume, or distortion, due to overloading, will result.

LOUD SPEAKERS: Loud speakers[5] are roughly divided into two classes—the horn types and the hornless types. In the horn type, the diaphragm is attached by its edges to the small end of a horn which forms a sort of megaphone to concentrate the sound. In one of the most common hornless types the diaphragm is a shallow cone, one to three feet in diameter, made of paper or cardboard. The cone types have become very popular because they reproduce the lower frequencies, or bass notes, which give rich fullness and naturalness to music, better than do the ordinary horn types. For the higher frequencies, the two types are not so widely different. Horns, if made sufficiently long, are also capable of reproducing the low notes. Such long horns may be looped or coiled to avoid unwieldiness. It is yet too early to say whether the horn or hornless type will ultimately be developed to the greatest perfection.

FORMS OF SETS: In physical form, receiving sets range all the way from an assemblage of the various elements or parts as separate units wired up by the user, to the most pretentious sets in which the entire system, including loud speaker and power supply sources, is housed in an elaborate cabinet designed to be a beautiful piece of furniture. The most common arrangement, however, consists of the receiving set proper (enclosing the tuning and radio-frequency circuits, and very often also the audio-frequency amplifier), the batteries or other power supply sources for the vacuum tubes, and the telephone receivers (or loud speaker). This combination is flexible, and the various parts of it may be purchased separately to suit the owner's preference.

POWER SUPPLY: From the user's standpoint, one of the annoying problems is that of power supply. The power supply for filament current is usually a storage or dry battery called the A battery. Storage battery units have been developed which are simple and convenient for use in the home. They contain, within one box, both the battery and a means of charging it from house electric lighting circuits. Dry batteries, made up in block form and called B batteries, are commonly used to supply the small current at 50 to 150 volts required by the vacuum tube plate circuits. There are also used to a considerable extent so-called B battery eliminators. These are devices in which current from a lighting circuit is used to supply plate-circuit current. In some receiving systems using vacuum tubes that require only a small filament current, this also is obtained by rectification from lighting circuits, and the entire set is operated from an electric-light socket, thus doing away entirely with batteries.

RADIO TRANSMISSION: When the radio waves are thrown out, or radiated, from the antenna at the transmitting station, they tend to spread out in all directions somewhat as do the waves in a pool of water when a stone is dropped into it. As they travel outward in ever-increasing circles, their initial energy is spread over a larger and larger circumference so that the intensity of the waves must correspondingly decrease. If the energy merely spread out in this way, none of it being lost, the wave intensity would change inversely as the distance increased. But, due to the absorption[6] in the atmosphere, and in the ground, of a part of the wave energy, which is thus dissipated as heat, the falling-off of wave intensity with distance is more rapid. The amounts of absorption caused by various kinds of terrain differ widely, being smallest for

[2]See RADIO BROADCAST Laboratory Information Sheet No. 16.

[3]See RADIO BROADCAST Laboratory Information Sheet No. 1.

[4]See RADIO BROADCAST Laboratory Information Sheet No. 36.

[5]See RADIO BROADCAST Laboratory Information Sheet No. 46.

[6]See RADIO BROADCAST Laboratory Information Sheet No. 2.

(Continued on page 76)

The Technical and Scientific Aspects of Broadcasting

(Continued from page 64)

transmission over the ocean, or bodies of salt water, and increasingly greater for fresh water and dry land. Since a broadcasting station is usually not surrounded on all sides by a uniform terrain, the efficiency of wave-travel in different directions is not the same. As a result, the received wave intensity may not be the same at all points equidistant from the transmitting station. Mountains and steel-frame building areas of large cities cause particularly heavy absorption, which may amount to almost complete suppression of the waves so that on the far side of such obstructions there is sometimes an area of very low wave intensity called a "dead spot." At such places, or near places where the terrain changes abruptly, as at a coast line, the waves may be deflected somewhat from their course and be thrown across the path of another part of the waves which has not been deflected. This gives rise to wave interference patterns of the same nature as those produced at the edges of shadows by diffraction of light. Since radio waves are millions of times longer than light waves, the patterns are relatively gigantic and one such pattern may cover an area of a hundred square miles or more. Within the area, the wave intensities at points separated from each other by only a fraction of a mile may show wide differences.

Interference: If the wave intensity were the only factor in radio reception, it would theoretically be possible to receive from a station at any distance, since, as the waves became weaker, the sensitiveness of the receiving system could be increased by using more amplifiers. However, the atmosphere is nearly always filled with vagrant radio waves which enter the receiving set, producing noises called "interference," which submerge the weak radio signals it is desired to receive. These vagrant waves come from a multitude of sources. The most potent come from the atmosphere itself, and these, in a manner not yet fully understood but commonly thought to be due at least in part to thunderstorms, produce waves which cause in the receiver crackling sounds known as "atmospherics" or, less properly but more popularly, as "static." The various sorts of electrical systems which are a part of every modern community where broadcasting exists are capable of throwing off radio waves when the currents flowing in them change abruptly. These may give rise to clicking, buzzing, and chattering noises.

The vagrant waves are present at all frequencies and therefore cannot be tuned-out by the selectivity of the receiving set. For this reason, satisfactory, noise-free reception from a station can be obtained only in areas where its signal wave intensity is much greater than the intensity of the vagrant waves. The intensity and amount of the "atmospherics" change with the time of day and season of the year, being greater at night and much greater in the summer time. Superimposed on these regular changes are large fortuitous variations. The amount of absorption of radio waves at broadcasting frequencies is influenced markedly by sunlight, being less at night. On account of these two variables, which are not closely related to each other in detail, satisfactory reception from distant broadcasting stations is largely a matter of chance. In densely populated areas, where there also is interference from powerful nearby broadcasting stations, and perhaps from a multitude of regenerative receivers, reception from distant stations becomes well-nigh impossible.

Fading: Another impediment to radio reception at distances of more than one or two hundred miles is an annoying waxing and waning of the signal intensity, called "fading." The causes of this phenomenon are not fully known, but the problem is being studied actively by many scientific agencies. The evidence so far adduced has led to a theory that at distant points waves from the transmitter arrive by two or more routes, at least one of which is by way of the upper reaches of the earth's atmosphere. At times, these waves, coming by different routes, oppose and nullify each other while, at other times, they add together and assist each other. In going through these two states in progressive alternation they produce fading. The fading may be selective as to frequency so that the different frequencies within the band transmitted by a station are differently affected, and there is distortion of the received speech or music.

Interconnection of Broadcasting Stations: The method of achieving widespread distribution of a broadcast program which has been applied most successfully is that of interconnecting a number of stations by telephone wires so that they all simultaneously broadcast the same program. These broadcasting stations, located at strategic points scattered over the area to be served, permit the large majority of listeners to receive the program just as satisfactorily as they receive local programs.

The audio-frequency currents from the microphone which picks up the program, after passing through the control operator's amplifier, are delivered to a system of telephone lines which in many respects resembles an electric power distributing network. Trunk wires go out from the program center to various parts of the country, and from these, at appropriate points, connecting wires branch off to the broadcasting stations. Telephone repeaters are placed in the circuits at suitable points to amplify the currents so that they may reach the broadcasting stations without material loss in volume. As has already been pointed out, distortion of the telephone currents must be very small or the faithfulness of reproduction at receiving points will be spoiled. On this account, the very best kinds of telephone circuits and associated apparatus are employed.

This form of large scale broadcasting has reached its greatest development in the United States and England. In the United States, as many as 29 stations have thus been tied together to broadcast a common program of national importance. On such an occasion, many thousands of miles of land wires are involved, and stations on the Pacific and Atlantic coasts 3000 miles apart, broadcast the same program in unison. In England, as well as in the United States, chains of stations, less widely scattered, are in every-day use.

References: Technical development in radio broadcasting has been so rapid and so recent that up-to-date information must be sought in current issues of technical periodicals. Articles on receiving systems are usually confined to one type or to the products of one manufacturer. For transmitting systems and transmission, the following articles are suggested:

"Transmitting Equipment for Radio Telephone Broadcasting," by Edward L. Nelson. *Proceedings of The Institute of Radio Engineers*, Vol. 12, pp. 553.

"Broadcasting Transmitting Stations of the Radio Corporation of America," by Julius Weinberger. *Proceedings of The Institute of Radio Engineers*, Vol. 12, pp. 745.

"Some Studies in Radio Transmission," by Ralph Bown, Deloss K. Martin, and Ralph K. Potter. *Proceedings of The Institute of Radio Engineers*, February, 1926.

Here's the most economical "B" battery ever built for radio ★

IN THE production of Heavy-Duty radio "B" batteries Eveready has established a new standard of "B" battery life and economy.

Eveready Heavy-Duty 45-volt "B" Batteries will outlast any Light-Duty 45-volt "B" two to one regardless of the number and kind of tubes used! Moreover, though lasting twice as long, they cost only one-third more!

To cap the climax of "B" battery economy, in Eveready Layerbilt No. 486, Eveready has perfected a Heavy-Duty "B" battery of unequaled endurance and dependability—positively the greatest "B" battery in service and satisfaction its price can buy.

You can make no mistake in buying Eveready Layerbilt No. 486 for *any* set using normal voltages (45 to 135 volts).

You will be buying the utmost in dependability of "B" power—the greatest "B" power operating economy—D. C. (direct current) in its purest form, which insures pure tone quality.

With colder evenings at hand, radio reception is vastly improving. Equip your set now with Eveready Layerbilt No. 486, the greatest "B" battery ever built for radio.

LEFT—*Eveready Layerbilt No. 486.*

RIGHT—*No. 7111 Eveready Dry Cell Radio "A" Battery, 1½ volts.*

EVEREADY
Radio Batteries
-they last longer

Manufactured and guaranteed by

NATIONAL CARBON CO., INC.
New York San Francisco
Canadian National Carbon Co., Limited
Toronto, Ontario

Tuesday night means Eveready Hour—9 P. M., Eastern Standard Time, through the following stations:

WEAF—*New York*	WGR—*Buffalo*	WGN—*Chicago*
WJAR—*Providence*	WCAE—*Pittsburgh*	WOC—*Davenport*
WEEI—*Boston*	WSAI—*Cincinnati*	WCCO { *Minneapolis* / *St. Paul* }
WTAG—*Worcester*	WTAM—*Cleveland*	
WFI—*Philadelphia*	WWJ—*Detroit*	KSD—*St. Louis*
	WRC—*Washington*	

The *Radio Broadcast*

LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of RADIO BROADCAST *have until recently been answered either by letter or in "The Grid." The latter department has been discontinued, and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," appear now a series of Laboratory Information Sheets. These sheets contain much the same type of information as formerly appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* RADIO BROADCAST *of much greater interest to our readers.*

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department. The first index appears this month.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are requested to send their questions to the Technical Information Service of the Laboratory, using the coupon which appears on page 98 of this issue. Some of the former issues of RADIO BROADCAST, *in which appeared the first sets of Laboratory Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company at Garden City, New York.*

No. 41 RADIO BROADCAST Laboratory Information Sheet November, 1926

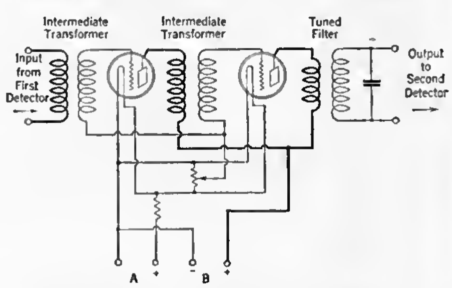
The Super-Heterodyne

INTERMEDIATE-FREQUENCY AMPLIFIER

IN THE super-heterodyne there is a group of apparatus termed the intermediate-frequency amplifier which functions to amplify the beat notes produced by the action of the first detector and local oscillator (See Laboratory Sheet No. 36). Characteristics which a good intermediate-frequency amplifier must possess are discussed below.

In the first place, all of the transformers used in the amplifier must be resonant at the same frequency. Improperly matched transformers are a cause of poor operation of a super-heterodyne, since the overall efficiency of the entire receiver can be considerably lowered if one of the transformers is slightly different in characteristics from the others. Matching of the transformers is not an easy process since the matching must usually be done with very low voltages in order to make the conditions similar in every way to those found during ordinary operation.

The resonance curve must be sufficiently broad so that all side bands which make up the signal are evenly amplified. On the other hand, if the resonance curve is too broad, the selectivity of the system will not he good enough. No trouble should be met with as regards selectivity in the intermediate amplifier when properly matched air-core transformers are used, but these must be carefully designed to prevent some of the side bands being cut off, due to their (the transformers') sharp peaks. Iron-core transformers are often used in super-heterodynes in conjunction with a filter. Since the selectivity obtained from the iron-core transformer is not great enough, it is necessary to improve this characteristic by placing, either before or after the amplifier, a tuned circuit, known as the filter, designed to pass only those frequencies for which the transformers give the maximum amplification.



Regeneration in the intermediate-frequency amplifier will considerably improve the selectivity and sensitivity by sharpening the resonance curves of the transformers.

The common method of connecting together intermediate-frequency amplifiers is illustrated in the diagram, in which potentiometer control of regeneration is used.

No. 42 RADIO BROADCAST Laboratory Information Sheet November, 1926

Super-Regeneration

THE THEORY EXPLAINED

WHERE loud signals are required from a loop, and the number of tubes is limited to one or two, super-regeneration can be used. Super-regenerative circuits are not very selective and hence are not very good for working through interference. The principle of super-regeneration is simply explained by a mechanical analogy. Suppose a clock to be wound up and the pendulum placed carefully in its lowest position and left there. The clock will not start itself. But now, suppose strong puffs of air come along at the proper interval to start the pendulum swinging slightly. Once it starts ever so slightly an ideal spring and escapement mechanism would cause its swinging to increase even if the puffs of air stop coming in. The oscillations of the pendulum "build up" and in due time the amplitude of swing reaches a limit determined by friction, air resistance, etc. But if we confine our attention to a sufficiently short period of time after the swing starts to build up, we will find that the amplitude attained during this time is proportional to the strength of the incoming puffs of air. At the end of this period, let the pendulum be stopped and set again at its lowest point so that the whole operation may be repeated. A great deal more swinging is done by the pendulum if the clock is wound up and the puffs of air are playing on it, than if the clock were not wound up, in which case the pendulum would only swing the very small amount caused by the air puffs.

In the electrical sense, in super-regeneration, we have a circuit all set to oscillate, *i.e.*, wound up and balanced, so to speak, so that some incoming ether wave is required to start it oscillating. This is similar to our analogy, in which the puff of air is necessary in order to start the pendulum swinging. In the super-regenerative receiver, the oscillations started by the incoming waves are permitted to build up very rapidly in the same manner that they would be built up in an ordinary regenerative receiver if the coupling was greatly increased beyond that necessary to make the detector oscillate. However, before the circuit can break into continuous oscillation the entire oscillation is automatically extinguished by another oscillation (generally about 10,000 cycles) which opposes the incoming oscillations every 20,000th of a second. This 10,000-cycle oscillation may either be generated in the same tube or in another tube coupled to the detector. During half of each cycle, that is, every 20,000ths of a second, the 10,000-cycle oscillation has no effect upon the incoming signal and during the other half of the cycle its effect is to prevent the production of any high frequency oscillation in the detector circuit.

Consequently the signal energy is very large during half of each 10,000 cycle oscillation, and on the whole there is very much more energy in the detector grid circuit than would be present under ordinary conditions. A comparatively large voltage is therefore impressed on the grid, which makes a correspondingly large amount of energy available in the plate circuit.

SM

630

SILVER SHIELDED SIX

The S-M 630 Shielded Six Kit—including matched and measured parts to build this remarkable receiver—price $95.00.

The 633 Shielded Six Essential Kit contains four condensers, four radio frequency transformers, four coil sockets, four stage shields and the link motion—all factory matched—price $45.00.

Clear and complete instructions, prepared by S.M engineers, go with each kit—or will be mailed separately for 50c.

Prices are 10% higher West of the Rockies

The Radio Broadcast star of approval is on the Shielded Six! In the October issue this remarkable receiver was described at length—approved by the Radio Broadcast laboratory!

The Shielded Six is one of the highest types of broadcast receivers. It embodies complete shielding of all radio frequency and detector circuits. The quality of reproduction is *real*—true to the ear.

Behind the Shielded Six is competent engineering. It is sensitive. Day in and day out it will get distance—on the speaker. It is selective. Local stations in the most crowded area separate completely—yet there are but two dials to tune. These features—its all metal chassis and panel, its ease of assembly and many others, put it in the small class of ultra-fine factory-built sets, priced at several times the Six's cost.

220 & 221 AUDIO TRANSFORMERS

220 Audio Transformer.............$6.00
221 Output Transformer............ 6.00

Prices are 10% higher West of the Rockies

S-M 220—the big, husky audio transformer you hear in the finest sets—the only transformer with the *rising* low note characteristic that means real quality—not only on paper—but when you hear it. It is a power job—yet the finest of audio amplifying devices is sold, with a guarantee for but $6.00.

The S-M 221 is an output transformer that will bring out the low notes on your present set. It should be used between the last audio tube and the loud speaker—it eliminates blasting and will increase speaker capacity for handling strong signals without distortion, $6.00.

SILVER-MARSHALL, Inc. ★

838 W. JACKSON BLVD. CHICAGO, U. S. A.

No. 43 RADIO BROADCAST Laboratory Information Sheet November, 1926

Field Intensity Measurements

DERIVATION OF THE FORMULA

ON LABORATORY Sheet No. 39 were given some data regarding the measurement of the field intensity of broadcasting stations. Further information concerning this subject is given on this sheet, with regard, especially, to the derivation of the formula which was given on the previous Laboratory Sheet.

With the field intensity of some base station known, from actual measurements at a distance of ten miles, it is possible to calculate the field intensity of the base station at any other distance up to about fifty miles, by the formula given below:

$$Fb = \frac{10}{d} F_{10}$$

Where Fb=field intensity of base station at distance d; d=distance from station in miles; F_{10}=radiation constant of base station.

The field intensity, F, of the station under test, is determined by the relative deflections of a meter in the plate circuit or the detector tube when signals from the base station are being received and when signals from the test station are being received. The two field intensities will be proportional to the meter deflections; the greater the deflection, the greater the field strength. Therefore we can write:

$$F = Fb \frac{I}{Ib}$$

Where F=field intensity of station under test; I=meter deflection when signals from test station are being received; Ib=meter deflection when signals from base stations are being received.

If the total amplification in the receiver is held constant, the only other factor that would influence the results would be the antenna resistance, and we can take account of it by placing in the formula the ratio of the antenna resistances at the two wavelengths (it is always best to use as a base station one which is transmitting on a wavelength quite close to that being used by the station under test). Putting this ratio in the formula we have:

$$F = Fb \frac{I}{Ib} \times \frac{R}{Rb}$$

which is the same as the formula given in the former Laboratory Sheet.

A great deal of work has been done on this subject and some very interesting data were given in the August, 1926, issue of RADIO BROADCAST by Mr. Albert F. Murray, who recorded the work done by Doctor Pickard. The methods used by Doctor Pickard must be used if the station whose field intensity is to be determined is located at any distance over about fifty miles. For distances less than fifty miles, practically all the energy is received by what is commonly called the ground wave, but for distances very much greater than fifty miles, energy is also received by other paths, so that a formula which only takes into consideration that energy received by the ground wave cannot be used for very great distances.

No. 44 RADIO BROADCAST Laboratory Information Sheet November, 1926

The R. B. "Local" Receiver

NECESSARY EQUIPMENT

IN THE August, 1926, issue of RADIO BROADCAST, there was described a high-quality local receiver by Mr. Kendall Clough. This receiver was designed particularly for local reception and consists of a stage of radio frequency amplification coupled to a non-regenerative detector and the usual audio amplifier. Both of the tuned circuits are contained in shields. The C battery form of detection is used since this method of detection permits the handling of loud signals without distortion. All tuning is accomplished by varying the two condensers. The only other controls are a filament rheostat and a volume control. The following apparatus was used in the original model:

1 7 x 18 x 3/16-Inch Bakelite Front Panel.
1 7½ x 17 x 3/16-Inch Bakelite Sub-Panel.
1 Pair Silver-Marshall 540 Mounting Brackets.
1 Yaxley 3-Ohm Rheostat, R_3.
1 Yaxley 25-Ohm Rheostat, R_2.
1 Yaxley No. 1 Open-Circuit Jack, J_1.
1 Yaxley No. 10 Filament Switch.
2 Silver-Marshall 316A 0.00035 Condensers, C_1 and C_2.
2 Kursch-Kasch 4-inch Dials, Zero Left.
2 Silver-Marshall No. 631 Stage Shields.
2 Silver-Marshall 515 Coil Sockets.
2 No. 115A coils, 1578–545 kc. (190–550 Meters).
4 Silver-Marshall No. 511 Sockets.
1 Sangamo 1.0 mfd. Condenser, C_3.
1 Sangamo 0.002 Condenser, C_4.
2 Silver-Marshall 220 Audio Transformers T_1 and T_2.
1 Silver-Marshal 221 Output Transformer, T_3.
1 Coil Belden Flexible Hook-Up Wire.
6 ½ x ¼-Inch Lengths Brass Tube for Mounting Coil Sockets.
1 Elkay Equalizer, Type 35, R_1.

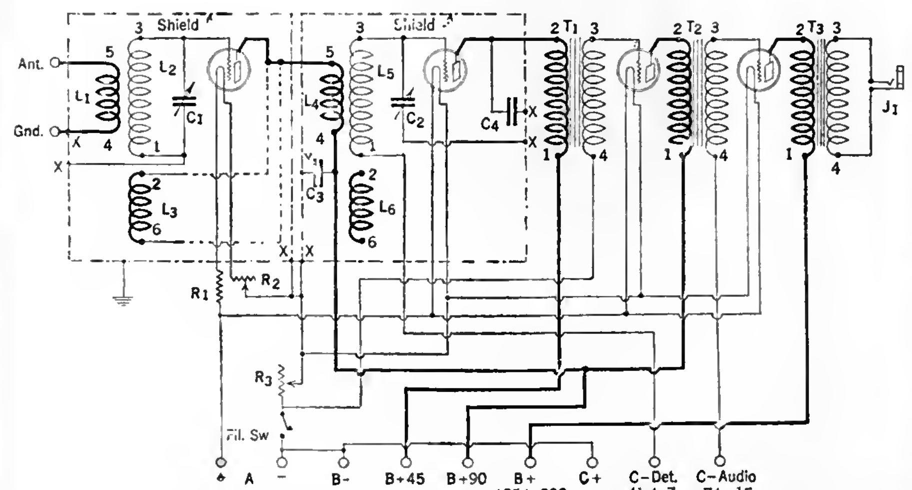
An Assortment of 6/32″ Round Head Screws and Nuts, together with Lugs.

Home-made coils may be made up in accordance with the following specifications:

For the secondaries marked L_2 and L_5 on the diagram, Laboratory Sheet Number 45, wind ninety turns of number 22 d.c.c. wire on a 2-inch tube. The primaries, L_1 and L_4, consist of 13-turn windings wound over the centers of the secondaries. The primary and secondary windings are separated from each other by layers of cambric tape or other insulation. If a 201-A tube is to be used in the r. f. stage, an additional winding is necessary on the first coil. This additional winding, marked L_3 on the diagram, should consist of five turns of number 26 d.c.c. wire. The winding, L_6, can be ignored. It is merely shown since it is to be found on the manufactured coils if they are purchased. It is not, however, connected into the circuit in any way. Shields should preferably be used and are indicated in the diagram by a dot-dash line. The "Xs" of the diagram indicate parts of the circuit that are connected to the shields. The shielding may consist of aluminum cans made to fit over the apparatus. Numbers on the diagram correspond to those to be found on the manufactured coil sockets.

No. 45 RADIO BROADCAST Laboratory Information Sheet November, 1926

The R. B. "Local" Receiver



Data on the R. B. "Local" Receiver appears on Sheet No. 44

No. 46 Radio Broadcast Laboratory Information Sheet November, 1926

Loud Speakers

SOME GENERAL CONSIDERATIONS

IT IS easy enough to fix a megaphone to a telephone receiver to produce a loud signal, and some loud speakers are merely refinements of this idea. The horn concentrates the sound in one direction, and the tapered column of air within the horn that fills the space about the small receiver diaphragm at the small end, and swells gradually out to join the open air at the flared end, supplies something for the diaphragm to work against. The diaphragm is caused to set more air in motion just as if a bigger diaphragm were used, thus increasing the volume of sound produced. But inasmuch as the best reproducers are only about 2 per cent. efficient (that is, of 100 units of electric energy entering them only about 2 leave in the form of sound energy), only small efficiencies are likely to be obtained even when good horns are coupled to the diaphragm. The great sensitivity of the human ear tends to make up for the inefficiency with which energy is converted from mechanical to acoustical by means of vibrating bodies. In ordinary speech only about one erg (the erg is the physicist's unit of energy) per second is converted into sound energy. How little this is can be seen from the following calculation: Reckoning that the average human being talks the equivalent of two hours steady talking per day, and that the average population of the United States since the Revolution is forty millions, and that power is worth two cents per kilowatt hour, then, from the energy point of view, all the talking that has been done in the history of our country is only worth $8.59!

In addition to the low efficiency of the conventional loud speaker, there is also distortion introduced in this method of making radio signals audible by the horn. An excellent method of mitigating this is by the use of two or three separate horns, each with its own diaphragm. In the case where three are used, for example, one is a very long horn that responds well to low tones; the second is an ordinary-sized loud speaker responding fairly well over the middle range; and the third is a very small horn giving the very high-pitched notes. The three horns, all working at once, combine to give a satisfactory uniform response over the whole audible range. The three horns, of course, are combined in a single box. The long horn can be coiled to save space, if necessary.

Another type of loud speaker avoids such distortion as is due to the horn by using no horn at all. This type of speaker usually, but not necessarily, has a large, light, stiff paper cone for a diaphragm, and this alone is sufficient to give it a good "grip" on the air. At present only a few commercial types of loud speakers give any sort of an approach to the goal of quality, which is to have all frequencies transmitted from speaker to listener with equal efficiency.

No. 47 Radio Broadcast Laboratory Information Sheet November, 1926

Index

No. 48 Radio Broadcast Laboratory Information Sheet November, 1926

Index

A Way of Increasing Selectivity

A Higher, More Exposed Antenna Will Improve Sensitivity But Broaden Tuning—How This May Be Remedied—Adapting a "Selectivity Unit" to Any Receiver

By HAROLD JOLLIFFE

HOW many of you fans who are always building and rebuilding your receivers into all manner of trick circuits, buying more tubes, and accessories, and generally striving to pull in more DX, ever pause long enough in your experimenting to reflect that by erecting a long, high antenna you are virtually adding the equivalent of another stage of radio frequency amplification to your set? The distance-getting ability of a large antenna versus a small one may be compared to the difference between a good headset and an insensitive one; the good headset brings in signals from distant stations quite clearly and distinctly, while the poorly-designed phones reproduce them so faintly that you have to strain your ears to find out what it's all about!

And it's analogous with antennas. A long unsheltered antenna will bring in signals from far greater distances than a small, low one can ever hope to pick up; stations heard on the small antenna will come in with a remarkable increase in volume when the set is coupled to a longer, higher antenna. And this simply because the antenna, being high and covering a greater area, is collecting considerably more energy, thereby resulting in a more pronounced radio frequency delivery to the detector. True, indeed, there will be a notable decrease in selectivity ordinarily, but we're coming to that now, and it is this factor with which we are concerned in this article.

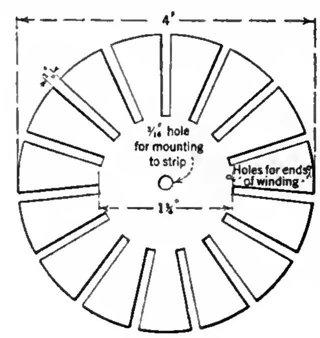


FIG. 1

There are several types of receivers in use to-day which employ a tuned antenna circuit. By this is meant that the primary coil is capable of being tuned to the exact frequency of the incoming signal, either by means of a variable condenser of the proper capacity, a system of taps, or a combination of both. The well-known three-circuit variometer set is an example of a receiver of this type. There are also many receivers which employ the "shock excitation" method of coupling, *i. e.*, the untuned, or aperiodic primary, as in some forms of neutrodyne receivers. Each system has certain advantages. The first, the tuned primary, provides greater signal strength, since the antenna coil may be tuned exactly to the frequency of the desired signal and, in turn, the secondary may be brought into resonance with the received signal. The second, the untuned primary form, makes for greater selectivity at some sacrifice in volume because the primary coil, having a low value and not variable, cannot be tuned to the signal frequency but depends for its operation upon "shocking" the grid coil where the selection of the desired signal is accomplished. The greater the number of turns the broader will be the tuning, with an increase in volume; likewise, as the number of turns is reduced, selectivity is more pronounced, with a decrease in signal strength.

In the course of some experiments with a four-tube Teledyne receiver, the writer found that, by cutting down the antenna coupling coil from ten turns to one, and then loading this one turn with a specially designed loading coil, thereby making it a combination of the two coupling methods referred to above, the selectivity was as sharp as if the one turn alone were used, while the volume was practically the same as with the ten turns. The antenna used during these tests, and which was subsequently used with great success last winter, was 175 feet long and 115 feet high at the main support—a water tank. The results were so pleasing in this case that the idea was tried with a standard single-circuit receiver; and, in view of the fact that no radio frequency amplification was employed that would aid in boosting the selectivity, the results were eminently satisfactory.

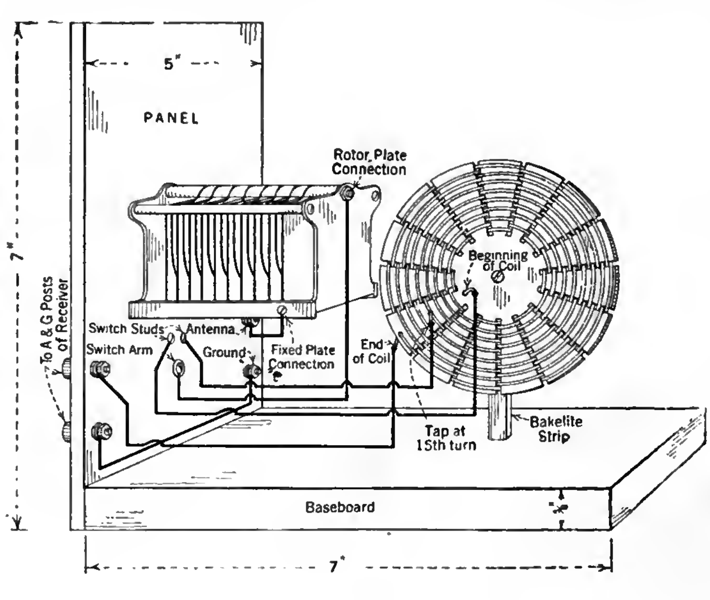


FIG. 2

The author therefore decided that it is possible to use a long, high antenna system, with the resulting high energy-intercepting qualities, without sacrificing that degree of selectivity which is generally obtained only by the use of a small antenna, provided that the proper apparatus is employed.

The first thing to do is to build the variable loading unit; the constructional details are

shown in the accompanying sketches. It consists essentially of a tapped spiderweb coil and a variable condenser. Great care must be observed in the construction of this unit, for, since another piece of apparatus is being added to the receiver proper, it is obvious, if the best results are desired, that the design should be in accordance with the most advanced ideas on low loss efficiency. It is apparent that there would be no use in adding to your receiver an instrument that would effectually block the passage of weak signals, due to the resistance introduced.

The variable air condenser employed should preferably be of the straight frequency-line grounded rotor type, and the requirements of the circuit are such that this condenser should have a maximum capacity of 0.001 mfd. The inductance is of the well-known spiderweb type, coupling, as in the commercial type of the Browning-Drake receiver, the Teledyne, and any set in which the antenna is connected directly to some point on the grid inductance of the first tube, it will be necessary to remove the two exterior wires which connect with the antenna and ground posts. In their stead is placed a piece of copper wire no smaller than No. 14 and long enough to reach from the antenna terminal, once around the grid coil, and thence to the ground post. In order that this wire will not cut into the finer wire of the grid coil, it should be covered with a good grade of spaghetti. This single turn should also be made very secure so that it will not come loose. This constitutes the coupling coil through which the received energy is transferred from the loading unit to the receiver proper. The output terminals of the

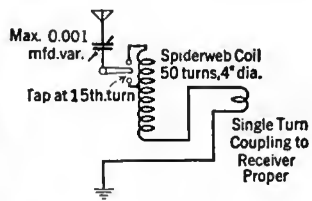


FIG. 3

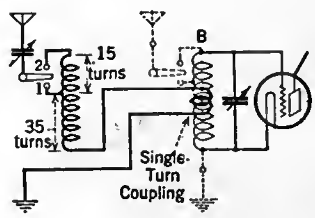


FIG. 4

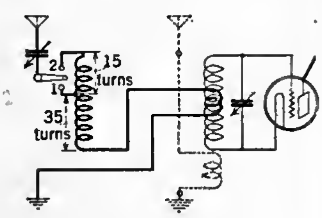


FIG. 5

since such a coil offers a very low resistance to high frequency currents, and is very easy to construct. It consists of fifty turns of No. 22 d.c.c. magnet wire wound in and out of every other slot of the form, and tapped at the fifteenth turn from the beginning. The form may be purchased at a radio dealer's or made at home from heavy cardboard, according to Fig. 1. No shellac, varnish, or other such material is used on this coil. After the coil has been completed, it may be mounted on a baseboard directly behind the condenser by means of a bakelite mounting strip, with a small brass angle. See Fig. 2. It is important that it be placed at right angles to the electrostatic field of the condenser and also that it be out of inductive relation to the first coil of the receiver itself. If any coupling, however slight, exists between the loading unit and the coils of the receiver, the purpose of the one-turn coupling coil will be defeated, as no energy should be transferred except at this point.

In mounting the switch points on the panel, keep them as far apart as the width of the switch blade will permit. It is also in the interest of efficiency to use points with a very low head, not more than $\frac{1}{16}$ inch high. Keep the leads to these points at least an inch apart. Observance of these precautions will result in a very low capacity effect at a point where large losses might otherwise be encountered.

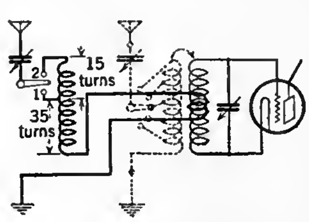


FIG. 6

All connections should be made with No. 12 or No. 14 copper wire, soldered where necessary, and covered with spaghetti to produce a neat appearance. By connecting the rotary plates of the variable condenser to the ground side of the circuit, all capacity effect from the operator's hands will be entirely eliminated.

When the unit has been completed, it may be housed in a suitable cabinet to match that of the receiver. While the panel specified is seven inches high, this may be varied to correspond with the height of the receiver with which it is to be used, thereby presenting a more harmonious appearance. Fig. 3 is a wiring diagram of the unit.

Now that we have the unit completed and have erected as large an antenna as circumstances will permit, let us see how we can apply the idea to receivers employing various forms of coupling.

Assuming that your receiver employs direct loading unit are connected to the antenna and ground posts of the receiver, and the antenna and ground are then hooked to their respective posts on the unit. How the connections should be when this has been done is shown in Fig. 4, the dotted lines indicating the former connections.

If your set employs aperiodic coupling, as in many modern receivers the changes to be made are very similar. The small coil which is connected between the antenna and ground posts and coupled to the grid inductance is removed and in its place is put the one turn of heavy wire. Fig. 5 illustrates this.

In a set in which the antenna circuit is tuned, such as a vario-coupler set, where the outside winding is connected between the antenna and ground and the rotor is used as the main tuning inductance, the primary will have to be unwound and removed. It is not necessary, of course, to dismantle the coupler, but it would not do to leave the unused primary coil in such close relation to the grid coil. The one turn of heavy copper wire is wrapped around the secondary and connected to the antenna and ground posts as before. See Fig. 6. If a tuning condenser has previously been used in the antenna circuit, it may be employed in the loading unit, provided it is of the proper capacity.

From the above it is apparent that the one-turn coupling idea may be applied to practically any type of receiver designed for use with an outside antenna. While, in the writer's case, it was used with a long, high antenna, it may also be employed with an ordinary antenna where interference is very marked. If the unit is to be used with a small antenna and a set employing no radio frequency amplification, better results will be secured by the use of a coupling coil composed of two turns instead of one.

The operation of the unit is very simple. For frequencies above 857 kc. (wavelengths below 350 meters), the switch lever is set on the first point so that but thirty-five turns of the loading inductance are included in the antenna circuit. The dials of the receiver are then adjusted to the settings at which a station is known to come in, after which the antenna condenser is varied until signals are heard. The first dial of the receiver will not read exactly the same as formerly.

No tears in these tunes!

Unless, perchance, they're tears of joy. For there's only unalloyed pleasure in a set kept at its lively best with a Rectigon. Your batteries are charged with ease and convenience. But more than solid comfort—there's no costly grief. You'll shed no agonizing tears because of spoiled furnishings, ruined clothes. You can do your charging wherever you wish. There's nothing in a Rectigon to spill or burn. No acids, no chemicals —and no moving parts.

when you do your own charging with

The Westinghouse Rectigon Battery Charger

©, 1926, W. E. & M. Co.

No noise as it charges—not a bit of fuss. Not even a murmur that would disturb the mildest slumber.

Saves its cost in short order—Count the dollars spent in a few trips to the service station and you'll hotfoot it for a Rectigon, for the good it does your pocketbook as well as your batteries.

Snaps on in an instant—Just plug into the light socket, snap on the terminals. Saves service station bother. Spares interruptions caused by absent batteries.

Charges both "A" and "B" batteries—Keeps both packed with power. Bulb is used for "B" battery charging and it is enclosed, like all other parts, in metal, safe from accident. (Rectigon charges automobile batteries, too.)

Perfect safety for your set—If you tune in while you're charging there'll be no harm either to set or batteries. Nor will batteries be discharged if anything happens to the current while your Rectigon's attached.

No Storage Battery Radio is Complete Without a Rectigon

★

THE RECTIGON'S a superb Westinghouse product. Things you *can't* see, like extra heavy insulation, things you *can* see, like the durably enameled case—all are of highest quality. Westinghouse also manufactures a complete line of radio instruments, and Micarta panels and tubes.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

Tune in on KDKA - KYW - WBZ - KFKX

THE BEST IN CURRENT RADIO PERIODICALS

The Thirteenth Installment of a Useful Classified Survey of Material Appearing in the Radio Press

By E. G. SHALKHAUSER

How This Survey Can Help You

HOW often have you looked for information contained in some article which you recall having read months ago—the description of the Browning-Drake receiver, or the measurement of losses in inductance coils, for example? After looking through probably several issues of a dozen different publications, you either give up or become interested in something altogether different.

When data is wanted on some particular subject, a systematic file of subjects and titles becomes a real radio encyclopedia. Instead of having merely the title of an article given, which often is misleading, a summary of the contents gives all the information. These surveys cover the radio field as gleaned from material in to-day's periodicals. They will always serve as a future reference-guide to all who are interested in the science of radio, whether engineer, manufacturer, dealer, experimenter, or listener.

To be of practical value and easily accessible, these surveys should either be pasted in a scrap book, or, better still, be pasted on individual cards and filed according to numbers, or alphabetically. In the matter of classification of articles, the Bureau of Standards circular No. 138 has been followed. This may be obtained from the Government Printing Office, Washington, District of Columbia, for ten cents. In addition, each abstract has certain key-words placed at the upper right, which may be used for the purpose of filing articles alphabetically.

With this series of surveys we hope to aid our readers and help them through many difficulties which they no doubt have often experienced. The writer is prepared to give information and references to articles previously surveyed upon receipt of a stamped and self-addressed envelope.

Following is the series of headings, made up according to the Dewey Decimal System used in the Bureau of Standards circular No. 138:

R000 RADIO COMMUNICATION IN GENERAL.
Under this heading will appear all subject matter pertaining to laws, regulations, history, publications, etc., which deal with radio in a general way.

R100 PRINCIPLES UNDERLYING RADIO COMMUNICATION.
Here will be given the phenomena of radio waves, their underlying theory of propagation, the principle of antenna and counterpoise, design and characteristics of vacuum tubes and their behavior in circuits, types of circuits, transmitting and receiving apparatus and their principles of operation.

R200 RADIO MEASUREMENTS AND STANDARDIZATION METHODS.
The various known methods which have been used in measuring frequency, wavelength, resonance, capacity, inductance, resistance current, voltage, dielectric constants, and properties of materials, will be mentioned here.

R300 RADIO APPARATUS AND EQUIPMENT.
A description of various types of antennas and their properties, the use of the electron tube in various types of receiving and transmitting sets, other methods of transmission of signals, various detecting devices used in reception, instruments and parts of circuits, come under this heading.

R400 RADIO COMMUNICATION SYSTEMS.
The spark, modulated wave and continuous wave systems in transmission, beat and other methods of reception, wired wireless, automatic printing, the buzzerphone and Fullerphone, will be given here.

R500 APPLICATIONS OF RADIO.
To aviation, navigation, commerce, military, private and broadcasting, and the specific information under their headings, are referred to here.

R600 RADIO STATIONS.
The operation, equipment, and management of radio installations, both transmitting and receiving, the testing, the rules and regulations concerning stations, the reports and bulletins issued, will follow under this heading.

R700 RADIO MANUFACTURING.
Data relative to costs and contracts of radio equipment from raw material to finished product including factories, tools, equipment, management, sales and advertising, follow here.

R800 NON-RADIO SUBJECTS.
The matter of patents in general; the mathematics and physics, including chemistry, geology and geography; meters of various kinds; all information not strictly pertaining to radio but correlated to this subject, will be found under this heading.

R900 MISCELLANEOUS MATERIAL.

A Key to Recent Radio Articles

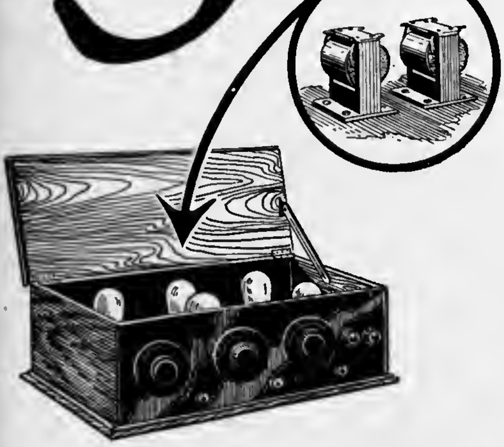
R580. TELEVISION. OTHER APPLICATIONS OF RADIO. TELEVISION.
Radio. Aug., 1926, pp. 9ff.
"Some Notes On Television," H. de A. Donisthorpe.
Television, seeing at a distance by telegraphy or radio, as distinct from photo-telegraphy, involves a process whereby light waves impinge on a selenium cell, which, in turn, modulates an electric current. At the receiving end, the modulated current controls a source of light traversing a ground glass screen in exact synchronism with the image at the transmitter, the whole image being recorded in one-tenth of a second. Although only in the experimental stage, this system, known as the Baird system, will probably some day be put to commercial use, as stated.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, *Infradyne.*
Radio. Aug., 1926, pp. 11ff.
"The Infradyne," E. M. Sargent.
This receiver, of the super-heterodyne type, makes use of the *sum* frequency in the intermediate frequency stages instead of the *difference* frequency, as is generally the case. In the set described, 3200 kilocycles frequency as the step-up frequency, and small air core transformers, produce the results outlined. A ten-tube circuit is presented, having two stages of radio frequency, first detector, oscillator, three stages of intermediate amplification second detector, and two audio frequency stages. Constructional and operating details, including photographs, are given. Special emphasis is placed on the layout and arrangement of parts in the set.

R344.5. ALTERNATING CURRENT SUPPLY. A, B, AND C ELIMINATOR.
Radio. Aug., 1926, pp. 17ff.
"A Complete Socket Power Receiver," G. M. Best.
An A, B, and C battery eliminator, constructed of standard parts and said to be hum-free, is shown. The theory of its operation, parts required for constructing, and practical operating data are presented, thus enabling the experimenter to build his own. A Browning-Drake receiver, described and illustrated, is used in connection with the "power plant."

R132. AMPLIFYING ACTION. AMPLIFYING ACTION.
Radio. Aug., 1926, pp. 24–26.
"How Much Amplification Do You Use?" R. B. Thorpe.
A simple mathematical discussion, accompanied by experimental data and drawings, is presented, relative to voltage amplification of audio frequencies in transformers, resistances, and impedances. The impedances of the various tubes, and their amplification constants in particular are compared in connection with the study of amplification in general.

Stop thief!



Ordinary amplification is the thief of Tone in radio music—

Your own radio set *as it now stands* is a perfect reproducing instrument—up to, and including *the detector tube*. As everyone knows, if you listened with a pair of ear phones to the music from the *detector tube* you would have *perfect reproduction*. If that same quality could only be made to come out of your loudspeaker in great volume, then you would have perfect radio enjoyment.

But it cannot—with ordinary amplification. Too much is blurred, too much is weak, too much is lost altogether.

How can we get this pure detector tone with great volume? Can it be had simply by changing the method of amplification? That depends.

Resistance coupled amplification is better, but many of the high notes are frayed and shattered, and the tone breaks down badly on strong volume.

Large size transformers are also better, but too many weak signals are absorbed. The actuality of the base, and the distinction between one musical instrument and another are lacking.

Impedance Coupling is unstable. It shares most of the faults of resistance coupling, and, like transformers, it absorbs the weak signals.

Electric-light-socket power amplifiers are also better, to be sure. But they operate *after* one of the music-distorting transformers already in the set.

The Truphonic Power Amplifier

An entirely new and different method of amplification has been developed by the eminent radio inventor, Mr. H. P. Donle, and is made by the Alden Manufacturing Company, well known for its Na-ald quality products. It is called the "Truphonic." Already manufacturers of the higher quality sets are endorsing it, and adapting it as the finest type of reproduction. The Truphonic Power Amplifier is different from any other method of amplification. But what is most important, the *results* are different. No more need be said than that the Truphonic passes faithfully *all* notes of broadcasted music.

The Truphonic is a small compact instrument (shown below), which when attached in a few minutes to any radio, brings through the loudspeaker with great volume *the detector tube music* in all of its perfect tonal quality.

What has just been said of the Truphonic can be said of no other method of amplification—regardless of the price you pay.

What Does This Mean to You?

For the price of $20 and an extra tube (using two of the tubes now in your set and one additional tube, either power or regular) you attach the Truphonic in a few minutes to your present radio and at one stroke convert it into the finest reproducing set that money can buy. A strong statement. But you *want* strong statements when the product backs them up.

To-day! To-night! Attach the Truphonic Power Amplifier and get all that radio can give.

For the Set Builder

Truphonic amplification is provided in separate Truphonic couplers for the set builder. Three stages not only give the finest quality of reproduction obtainable but also give considerably more volume than two stages of ordinary transformer amplification. Price $5.00 per stage.

The Truphonic Output Unit protects the speaker against burning out and demagnetization when power tubes are used. (This output is used of course in the complete Truphonic Power Amplifier described above.) Price $5.00.

The Truphonic Catacomb Assembly is also of great convenience to set builders. A lacquered steel catacomb houses three Truphonic couplers and a Truphonic output unit. A special moulded socket panel with 6 or 7 sockets of special construction which hold either U V 201A or all UX tubes, covers this catacomb. This unit may be arranged in a thousand different ways to meet all the requirements of every circuit and set design. Short direct leads to connected apparatus, with a minimum of soldered connections. No holes to drill, no apparatus to mount. A six-foot battery cable is included. Price 6 tube $20, 7 tube 22.

NA-ALD

ALDEN MANUFACTURING CO.
Dept. B19 Springfield, Mass.

TRUPHONIC
Power Amplifier
$20

★

R141.1. RADIO FREQUENCY CIRCUITS. RADIO FREQUENCY CIRCUITS.
RADIO BROADCAST. Sept., 1926, pp. 377–379.
"Higher Efficiencies for Radio Frequency Circuits," Part 1. Zeh Bouck.

A system of maintaining the highest efficiency at all frequencies covered by a tuned radio frequency circuit is described. One control governs the capacity variation and the magnetic coupling of a coil attached to the condenser shaft. The system is called the King "Equamatic" system. Details of the circuit, and the arrangement of coils and condensers, are shown.

R134.7. HETERODYNE ACTION. SUPER-HETERODYNE PRINCIPLES.
RADIO BROADCAST. Sept., 1926, pp. 380–383.
"How to Get the Most Out of Your Super-Heterodyne." K. Clough.

The component parts of the ordinary super-heterodyne circuit are taken up in detail for the benefit of the home builder and experimenter. First, the collector (loop or antenna and coupling coil); second, the first detector; third, the local oscillator; fourth, the intermediate-frequency amplifier; fifth, the second detector; and sixth, the audio amplifier. Upon the principles discussed depend the proper construction and operation of the circuit.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, *Short-Wave.*
RADIO BROADCAST. Sept., 1926, pp. 384-387.
"How to Build and Operate the Jones Receiver," F. C. Jones.

Through a short-wave receiver contest, RADIO BROADCAST attempted to find a non-radiating high frequency circuit. In the receiver described, which won first prize, the principle of the Wheatstone Bridge is used in preventing all but a minimum of energy from reaching the antenna. The author discusses the details of construction, assembly, and testing of this receiver.

R385.5. MICROPHONE. MICROPHONE PLACEMENT
RADIO BROADCAST. Sept., 1926, pp. 394–397.
"The Importance of Acoustics in Broadcasting," B. F. Miessner.

The distortion obtained in radio reception is generally grouped into two classes: First, that due to an overall frequency characteristic of the system which is not flat. That is, the ratio of reproduced intensity to original intensity of sounds is not the same for all frequencies.

Second, that due to an overall amplitude characteristic of the system which is not rectilinear. That is, the ratio of reproduced intensity to original intensity of all sounds is not the same for all intensities.

A third type of distortion, due to directional characteristics of sound receivers and transmitters, also exists. These directional effects vary with frequency, says the writer. Since the microphone should pick up all frequencies without discrimination, it becomes essential that it be placed properly in the studio.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, *Browning-Drake.*
RADIO BROADCAST. Sept., 1926, pp. 398–404.
"The R. B. Impedance-Coupled Browning-Drake," J. B. Brennan.

An impedance-coupled Browning-Drake receiver is described. Layouts of panels, a list of parts, and the method of assembly and operation, are given. In this particular arrangement, the author controls the volume of the energy output by the filament current variation in the radio frequency stages.

R342.15. AMPLIFIER TRANSFORMERS. AMPLIFIERS, *Audio.*
RADIO BROADCAST. Sept., 1926, pp. 409–412.
"Transformer-Coupled Audio Amplifiers," A. W. Saunders.

An outline is given of the fundamental considerations involved in the design of a specific type of audio amplifier, in which is also shown some of the desirable amplifier characteristics which may be obtained in practice. The difference between an ideal and a real transformer is discussed. In practice, it is impossible to meet all requirements of an ideal transformer, as is shown by results obtained from many types of transformers. Many graphs are presented and explained, data showing how they were obtained being included.

R142.3 INDUCTIVE COUPLING COUPLING CHART.
Popular Radio. Aug., 1926 pp. 315 ff.
"A Measurement Chart," R. J. Hoffman.

A chart for calculating the coupling factor for co-axial concentric coils, is shown. Information on how to determine both the coupling factor and the mutual inductance of certain coils is given.

R213. HARMONIC METHOD OF DETERMINING FREQUENCY. HARMONIC FREQUENCY DETERMINATION.
Populor Radio. Aug., 1926, pp. 316ff.
"A New Method of Using Harmonics for Determining Frequencies," M. L. Strock.

With the aid of a quartz crystal and a vacuum-tube oscillator, a method of determining many accurate frequencies is described by the writer. Harmonic heterodyning enables the experimenter to calibrate a waveweter or to determine the frequency of other circuits. The set up of the apparatus, and its operation, is described.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, *Browning-Drake.*
Popular Radio. Aug., 1926, pp. 328ff.
"How to Build the Improved Browning-Drake Receiver," A. H. Lynch.

A Browning-Drake receiver, in which various changes in circuit design have been made, is described in detail. The original conception of Browning and Drake has been altered to includ: a resistance amplifier. Resistance coupling is used in the audio stages.

R376.3. LOUD SPEAKING REPRODUCERS. LOUD SPEAKERS.
Popular Radio. Aug., 1926, pp. 336–337.
"How to Pick Out a Loud Speaker," L. M. Cockaday.

The selection of a loud speaker for a radio receiver depends upon many factors, both in type of receiver and kind of horn and reproducer. In order to pick one that is satisfactory a method of hookup to various types of horns is suggested, which determines the choice by actual test.

A Supremely Fine Instrument

No. 78—$270

"The Mayfair"

"The Canterbury"

No. 75—$150

This pleasing consolette model will grace any home. The six-tube, two dial Oriole Receiver will bring new joy to Radio for you.

Amazing Selectivity---Delightful Tone---Exceptional Volume!

TWO new home delights! First the joy of a supremely fine bit of furniture craftsmanship—a rarely beautiful console to enhance the beauty of your home.

Second the all surpassing joy of true radio entertainment—all the programs of the air brought in with surprising fidelity and beauty of tone. Amazing selectivity that makes radio enjoyable.

The Trinum Circuit makes Oriole Receivers genuinely satisfying in performance. Built with the precision of a fine watch they bring at last to radio that genuine dependability which you have been hoping for. Ask your dealer to show you.

Sales Department
THE ZINKE CO.
1323 S. Michigan Ave.
Chicago, Ill.

Manufactured by
W-K ELECTRIC CO.,
Kenosha, Wis.

"The Warwick"

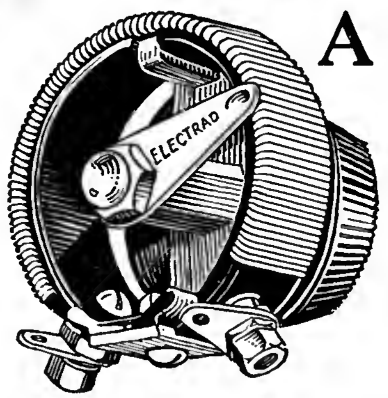
No. 71—$125

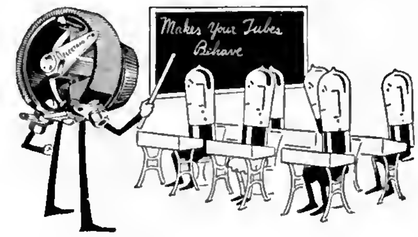
A table model of exceptional grace and truly unusual power. Everything that radio can give, at a price in reach of all.

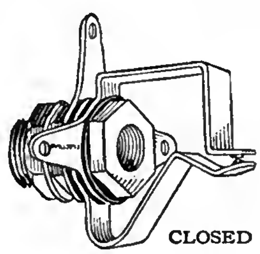
ORIOLE RADIO RECEIVERS

with the Trinum Circuit

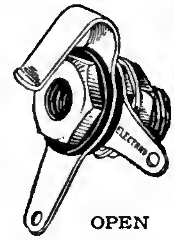
★



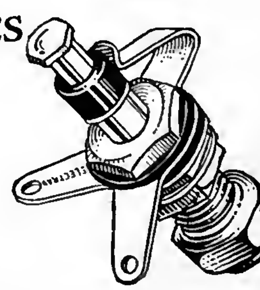


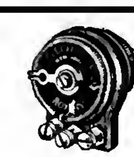


CLOSED



OPEN





R344.5. ALTERNATING CURRENT SUPPLY. POWER AMPLIFIER, *W. E. 25-B.*
Radia. Aug, 1926, pp. 27–28.
"Unfailing B Power From the W. E. Amplifier," E. E. Griffin.

The Western Electric type 25-B power amplifier is described for those who may want to own one and know its circuit and operating characteristics. According to the curve, the output voltage drops from a rate value of 350 volts, 2 milliamps. to 265 volts at 43 milliamps. output.

R384.3. FREQUENCY METERS. FREQUENCY METER.
Radia. Aug., 1926. pp. 38ff.
"A Vacuum-Tube Frequency Meter," G. M. Best.

Constructional details of a vacuum-tube frequency meter utilizing a plate current milliammeter as an indicator for resonance, are shown. Coils for the 1500, 7500, and 3750 kc. (20, 40, and 80 meter) band are used across a 0.00035-microfarad condenser. For increased amplification, a direct current amplifier circuit is shown. This makes the meter more sensitive.

R344.3. TRANSMITTING SETS. TRANSMITTER, *Short-Wave.*
Radio. Aug., 1926, pp. 39ff.
"A Low-Powered Master Oscillator Transmitter," F. C. Jones, 6 AJF.

Amateur station 6AJF shows the circuit diagram and list of parts for the construction of a low-powered master oscillator transmitter. Front and rear views are sufficiently clear to show the complete layout.

R113.5. METEOROLOGICAL PHENOMENA. METEOROLOGY.
Radio News. Aug., 1926. pp. 113 ff.
"Radio Weather Good and Bad," E. Van Cleef.

Observations to determine whether any correlation exists between static and the passing high and low pressure areas, are recorded. When waves travel at right angles to the isobars, reception is reported clearest and strongest. When waves pass from one pressure area across another reception is weaker than when they are confined to a single area. Static is most frequent when the isobars are far apart—when waves travel across areas of little difference in air pressure.

When waves travel in a path parallel to the isobars, fading occurs. It is suggested that other stations coöperate in taking observations relative to the above mentioned data to determine the actual cause of static and its behavior.

R130. ELECTRON TUBES. ELECTRON TUBES.
Radio News. Aug., 1926, pp. 120ff.
"Vacuum Tubes and Their Uses," M. L. Muhleman.

The writer presents a non-technical discussion concerning vacuum tubes and then enumerates the characteristics of the new tubes which have recently appeared on the market. A chart showing all the constants of the various tubes, including voltage amplification factor and output resistance values, is of value.

R800. (347.7) PATENT PRACTICE. PATENTS.
Radio News. Aug., 1926, pp. 124ff.
"Making a Business of Inventions," L. T. Parker.

Advice is given concerning the fundamental laws pertaining to patents and patent practice. Questions such as: "What is patentable"; "What records should be kept"; "How to protect a patent," are answered for for the benefit of the inexperienced inventor.

R582. TRANSMISSION OF PHOTOGRAPHS. PHOTOGRAPH TRANSMISSION
Radio News. Aug., 1926, pp. 126ff.
"The Broadcasting of Pictures," Dr. W. Friedel.

The author's method of recording impressions received at the receiving end of a picture transmitting system, is described. It consists essentially of a cylindrical roller with a spiral edge instead of a stylus. This edge records on a continuous roll of paper, making a uniform and clear impression.

R342.15. AMPLIFIER TRANSFORMER. AMPLIFIER ACTION.
Radio News. Aug., 1926, pp. 142–143.
"More About Audio-Frequency Amplifiers," S. Harris.

This third discussion pertaining to audio-frequency amplifiers takes up the question of transformer performance in actual practice, considering the relation between the sound frequencies passing through the audio stages to the sounds we are accustomed to hearing in actual direct reproduction.

With a frequency limit at the low end of the scale of 50 cycles per second the decision is reached, after other sources of distortion are corrected, that a drop of 5 per cent. in voltage ratio between the maximum and minimum frequency in a two-stage amplifier will produce less distortion than will ordinarily be detected by the human ear.

R381. CONDENSERS. CONDENSERS *Chemical.*
Radio News. Aug., 1926, pp. 144–145.
"Chemical Condensers of Large Capacity," C. J. Fitch.

Constructional and experimental data, relative to the use of aluminum for chemical condensers in A and B battery eliminators, are presented. Although the curves show considerable variation of capacity with formation voltage and kind of solution used, these condensers may be utilized in many ways in the experimental laboratory.

R113.1. FADING. FADING.
Radia News. Aug., 1926, pp. 146.
"Results of Coöperative Measurements of Radio Fading," Bureau of Standards.

A resumé of the findings of the past year and a half on the subject of fading of radio signals, is given. General conclusions arrived at are presented.

R550. BROADCASTING. BROADCASTING, *Who Pays For*
RADIO BROADCAST. Sept, 1926, pp. 367–371.
"How Much It Costs to Broadcast," A. C. Lescarboura.

The solution of the question "Who Pays for Broadcasting?" seems to solve itself through the broadcasting of so-called "Good-will Programs," as expressed by the author. To-day stations are being used as a medium through which various concerns place their name before the public by means of well chosen musical programs, and the public is satisfied. Chain station hookups make available good concerts for the entire continent. The cost of operating the higher class broadcasting stations, and the charges made to those interested in using the station, varies, as is evident from the tables shown.

Buy by the Name

Success in Set Building Begins at the Dealer's Counter

ALL BENJAMIN RADIO PRODUCTS ARE OF THE SAME HIGH STANDARD AS THE FAR-FAMED CLE-RA-TONE SOCKETS

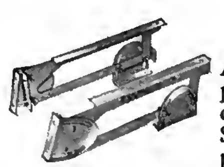
Cle-Ra-Tone
Spring Supported—Shock Absorbing Sockets
Stop tube noises. Greatest aid to non-noisy operation. Contacts always clean.
75 cents each

When you buy your radio parts, buy them right. Everything else being equal, when a name has stood for a quarter of a century's striving toward technical perfection it is practically as safe as a formula as a guide to right buying. When your dealer sells you Benjamin radio products for your set you have already leaped a big hurdle on the way to success.

"Lekeless" Transformers

Uniform high inductance, low distributed capacity and low resistance. The external field is so slight that it permits placing coils close together without appreciable interaction.

Single Transformers, $2.50



Brackets

An aid to simplification in set construction. Supports sub-panel, with room underneath for accessories and wiring. Plain and adjustable.

Plain, 70 cents per pair
Adjustable, $1.25 per pair

Battery Switch

Quick, positive, clean-cut make and break. When it's "in" it's "off," eliminating danger of wasteful use of battery.

30 cents each

Improved Tuned Radio Frequency Transformers

Proved through exhaustive and comparative tests to be the most efficient coil for modern radio sets. Better in all important features and characteristics. Space wound. Basket weave. Cylindrical. Highest practical air dielectric. Gives wonderful sharpness in tuning, better volume and purer tone quality.

2¼" Diameter Transformer

Compact. Especially desirable for crowded assembly. Eliminates interfering "pickup."

Set of three, $5.75 ***Single Transformer, $2.10***

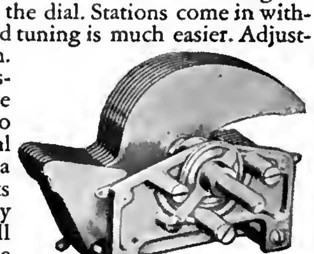
3" Diameter Transformer

Capacity coupling reduced to lowest degree. For use with .00035 Mfd. Condensers.

Set of three, $6.00 ***Single Transformer, $2.25***

Straight Line Frequency Condensers

No crowding of stations. The broadcast range is spread evenly over the dial. Stations come in without interference, and tuning is much easier. Adjustable turning tension. Low loss characteristics give a definite and distinct radio reception. Beautiful in appearance—a credit to the looks and efficiency of any set. Finished in dull silver. Made in three sizes:



.00025 Mfd. $5.00
.00035 Mfd. $5.25 ***.0005 Mfd. $5.50***

If your dealer cannot furnish you with Benjamin Radio Products send amount direct to our nearest sales office with his name and we will see that you are promptly supplied

★ REWARDS FOR RADIO REASONERS

Awards for novel and original hookups, modifications of existing circuits; trade names; slogans. Write our nearest office for full details.

Benjamin Electric Mfg. Co.

New York — **247 W. 17th Street**
120-128 South Sangamon Street — **Chicago**
San Francisco — **448 Bryant Street**

Manufactured in Canada by the Benjamin Electric Mfg. Co. of Canada, Ltd., Toronto, Ontario

R113.6. REFLECTION OF RADIO WAVES. REFLECTION PHENOMENA.
Popular Radio. Aug., 1926, pp. 319ff.
"Does the Human Boby Reflect Radio Waves?" Major J. O. Mauborgne.

The experiments conducted by the writer on frequencies above 3000 kc. (below 100 meters) have netted phenomena hitherto unexplained. The peculiar behavior of the oscillator on waves above 60,000 (below 5 meters), when standing at definite distances from the oscillating antenna, is related in detail, the accompanying photographs showing how the apparatus was set up and how measurements were made.

R800. (537.65) PIEZO-ELECTRIC PHENOMENA. PIEZO-ELECTRIC OSCILLATORS.
Proc. I. R. E. Aug., 1926, pp. 447–469.
"Uses and Possibilities of Piezo-Electric Oscillators," A. Hund.

The author sums up the contents of his discussion on the piezo-electric effects of quartz as follows: (1.) Experiments with quartz plates have shown that they can be used in an electron-tube circuit for producing radio frequency currents of fixed frequencies bearing a definite relation to the dimensions of the plate. (2.) The piezo-electric oscillator can be used together with an auxiliary generator for standardizing a frequency meter. (3.) As single piezo-electric plate can be employed as a standard for the entire range of frequencies used in radio communication. (4.) By using special arrangements, a small plate can be employed for producing audio frequency currents. (5.) Methods are given for grinding a plate accurately to a given frequency. (6.) Formulas are given for designing plates to a desired frequency to a fair degree of accuracy. (7.) Other miscellaneous applications are described.

R800. (347.7) PATENT PRACTICE. PATENT SAFEGUARDS.
Proc. I. R. E. Aug., 1926. pp. 471–477.
"Safeguards For the Radio Inventor," E. N. Curtis.

Precautions for the radio inventor who is not associated with an organization which includes a patent department, together with explanation why such precautions are necessary, are outlined by the author.

R610. EQUIPMENT; STATION DESCRIPTION. STATION, *KDKA.*
Proc. I. R. E. Aug., 1926, pp. 479–506.
"KDKA," G. Little and R. L. Davis.

In this paper are supplemented several of the previous descriptions of station KDKA. The purpose of the paper, as stated, is to bring the history up to date by describing the equipment now in use, both for regular broadcasting and for short-wave international broadcasting, and relay work. The short-wave transmitter, employed for inter-works telegraph service, is also described. The article is well illustrated.

R270. SIGNAL INTENSITY. FIELD-STRENGTH MEASUREMENTS.
Proc. I. R. E. Aug., 1926, pp. 507-519.
"A Radio Field-Strength Measuring System for Frequencies up to Forty Megacycles," H. T. Friis and E. Bruce.

The paper describes field strength measurement sets for frequencies as high as forty megacycles. The apparatus is a double-detection receiving set which is equipped with a calibrated intermediate-frequency attenuator and a local signal comparison oscillator. The local signal is measured by means of the intermediate-frequency detector, which is calibrated as a tube voltmeter.

R800. (621.313.7) RECTIFIERS. MERCURY-ARC RECTIFIERS.
QST. Aug., 1926, pp. 8–11.
"Mercury-Arc Rectifiers," A. B. Goodall.

Three circuit diagrams are shown in which the mercury-arc rectifier is used in supplying the necessary high-voltage B battery supply. To prevent the rectifier from going out during short periods of inactivity, either a lamp or some other device is used to keep a hot spot on the mercury surface. The capacity of the tube is said to be over 6000 volts, and it supplies a rectified current which produces no interference.

R384.1. WAVEMETERS. WAVEMETER, *Short-wave.*
QST. Aug., 1926, pp. 15–17.
"A Shielded Wavemeter for Your Station," F. H. Schnell.

Two shielded wavemeters for short-wave calibration purposes, are described. One of the wavemeters uses a five-plate Karas Orthometric condenser, the other a tapered plate type 167–E Cardwell condenser. Coil data and graphs give the builder all necessary information to construct the instruments.

R344.5. ALTERNATING CURRENT SUPPLY. ELIMINATORS, *A Battery.*
QST. Aug., 1926, pp. 25–29.
"Operating Receiving Filaments Without Batteries," R. S. Kruse.

Several methods are proposed and discussed concerning the elimination of the present A batteries and using substitutes of some sort or other. The "Rectrad," an A battery line supply device, makes use of two rectifier tubes, a transformer, chokes, and 54 microfarads of capacity before the output enters the filaments of the tubes. The Davy A-substitute is similar in principle, but does not use condensers in the filter circuit. Circuits of both eliminators are shown.

R127. ANTENNA CONSTANTS. ANTENNA CONSTANTS.
QST. Aug., 1926, pp. 30–32.
"Straightening Out the Antenna," B. J. Melton.

The article is presented with the intention of straightening out our ideas on radiating systems in general, to show why a grounded antenna can only be operated on a so-called "odd harmonic," to suggest that a simple radiating system is probably the best, and to show how to get the juice into the antenna in such a way that the antenna will be given a chance to radiate it most efficiently. Concerning the latter point, the writer discusses various types of antennas and the current and voltage feed systems which may be used.

R344.3. TRANSMITTING SETS. TRANSMITTERS, *Short-Wave.*
QST. Aug., 1926, pp. 33–35.
"A 20–40–80–Meter Crystal-Controlled Transmitter," L. B. Root.

A description of a crystal controlled low-powered transmitting set, operating on 15,000, 7500, and 3750 kc. (20,-40-, and 80-meter band), including complete wiring diagram, parts needed, and the method of operating, is given.

BOOK REVIEW

An Announcer's Autobiography

YOU'RE ON THE AIR: *By Graham McNamee. Published by Harper and Brothers, New York. 210 pages, 40 illustrations. Price $1.75.*

"TO SUCCEED (in broadcasting)," says Graham McNamee in his book, *You're On The Air,* recently published by Harper and Brothers, "one must not only possess some artistic skill but also that indispensable quality called personality." It is just that quality that has made McNamee himself succeed to such an extent that he has become the "most popular radio announcer" of many listeners-in. And it is that same quality that will make *You're On The Air* a popular book with the same listeners-in, for, regardless of whether or not it was written by McNamee or by Robert Gordon Anderson, whose name appears on the title page as collaborator, it is an expression of McNamee's personality. If Anderson did the writing, he deserves credit for having done a good piece of reporting.

If you know this genial announcer, nothing more need be said about personality; if you don't, tune-in your set on WEAF some evening and listen for "Good evening ladies and gentlemen of the radio audience." That's McNamee. He may be broadcasting a concert, a fight or a political meeting. There is no limit to his activities and he seems to do everything well (though we may parenthetically remark that personally we prefer his sporting stuff to all the rest). After you have listened to him announcing for an evening or two, read his book and get "the inside story of how he does it," as the tabloids would say.

You're On The Air is written in the first person and starts off with a little of the author's history. It seems that McNamee started out on a musical career, the training for which began early in his life. But he says that in these days he was more interested in the world of sport than in the world of music, and he took an active part in sports. "That experience later proved of help," he says, "for not only did it build up my body, but it has enabled me to report more intelligently the big outdoor sport events." When he was eighteen he came to New York to pursue his musical career, which he did most successfully. It was while here that he drifted into radio work quite by chance, having wandered into WEAF's studio simply out of curiosity to see what a studio was like. When he wandered out it was with his first job as announcer in his pocket.

Sprinkled in with the tale of his personal experiences, McNamee has given many interesting bits of information. He explains how programs are arranged; what happens when an artist is late or doesn't get to the studio at all; how much is charged for time on the air; and what happens when there is trouble on the line. He also tells countless anecdotes about well-known artists who have preformed before the microphone. Everyone, the great as well as the small, is nervous the first time he broadcasts.

The book is entertainingly written. Our one objection to it is that is a little too personal; there are too many anecdotes involving the announcer, too many questions from letters to the studio, too many illustrations reproducing autographed photographs sent to McNamee by the artists that have broadcasted from WEAF: and too little of the cold, hard facts behind broadcasting. But it is McNamee announcing and if you like him you will enjoy *You're On The Air.* Incidentally it's the first *good* book on broadcasting to be published.

Here's the Answer

THE "I Want To Know" Booklet issued by HOMMEL is now ready for distribution to every radio dealer who wants to put his customers on a familiar footing with every day radio problems.

It's the alpha and omega of useful radio information—the question and answer of many common radio queries—a booklet that every radio customer will be pleased to get.

Every dealer will profit by their distribution, because these booklets contain not only interesting information that customers want, but also will incidentally serve to stimulate every dealer's radio sales.

Write to-day—the supply is limited.

WHOLESALE EXCLUSIVELY

LUDWIG HOMMEL & CO

929 PENN AVENUE PITTSBURGH, PA.

For All Popular Makes
and Circuits
of radio receiving sets

A Constant Plate Voltage Supply Unit with Power Amplification operates on 110 volt (60 cycle) Alternating Current

Provides voltages of 45, 90, 130 for the receiver and also supplies 180 volts for the UX 171 power tube of the Amplifier.

Uses UX-213 Rectron rectifier tube and UX-171 tube in Power Amplifier.

Price, (without tubes) **$68.**

The

GENERAL RADIO ★

Power Amplifier and Plate Supply

Ask your dealer to give you a demonstration, or write for our booklet containing complete information

GENERAL RADIO CO. CAMBRIDGE, MASS., U. S. A.

THE "RADIO BROADCAST" INFORMATION SERVICE

How to Write for Technical Information—The Scope of This Service

AS WAS announced in the June RADIO BROADCAST, all questions which were formerly sent to "The Grid" will now be handled by the Technical Information Service, RADIO BROADCAST Laboratory. That service is maintained under the following rules:

1. All questions from subscribers to RADIO BROADCAST will be answered free of charge.
2. Non-subscribers to RADIO BROADCAST will be charged a fee of One Dollar for the Laboratory Technical Service.
3. All questions will be answered by mail and none will be published in RADIO BROADCAST.

The Technical Information Service of the Laboratory feels that it is important to define the scope of its service to readers. Although the Service is of very general help to our readers, there are certain demands which can not be met.

The Technical Information Service:

1. Cannot make comparisons between various kinds of receivers or manufactured apparatus.
2. Wiring diagrams of manufactured receivers cannot be supplied. This information can be secured from the various manufacturers.
3. Complete information cannot be given about sets described in other publications, but in all cases (wherever possible), inquirers will be referred to a source of information where the data can be obtained. In this connection, the monthly department in RADIO BROADCAST "The Best in Current Radio Publications" should be of great help, and should be consulted. That department records the most important constructional, technical, and general radio articles which appear.
4. Special receivers or circuits cannot be designed by the Technical Service.
5. Those who ask questions which cannot be answered in the scope of a letter will be referred, if possible, to sources where the information can be obtained.

In response to many requests, lists of the various groups of apparatus tested and approved by RADIO BROADCAST Laboratory will be mailed to all inquirers without charge.

TECHNICAL INFORMATION INQUIRY BLANK

Technical Service,
RADIO BROADCAST Laboratory,
Garden City, New York

GENTLEMEN:

Please give me fullest information on the attached questions. I enclose a stamped addressed envelope.

☐ I am a subscriber to RADIO BROADCAST, and therefore will receive this information free of charge.

☐ I am not a subscriber and enclose $1 to cover cost of the answer.

Name......................................

Address......................................

The "Now I Have Found. . ." Award

SPACE limitations, this month, require that the "Now I Have Found. . ." Department be temporarily omitted. The quarterly award, which is due this month, goes to Mr. H. E. Carlson, of East Saugus, Massachusetts, whose combined rheostat and voltmeter switch was described in the August RADIO BROADCAST.

Weather Forecast Transmissions by Radio

THE following stations in the Illinois section send out regular weather forecasts and reports by radio. With the exception of NAJ and WGO, all reports are in telephony. Amateurs who receive any of these transmissions are requested to write to the Weather Bureau Office, Springfield, Illinois, and report on the quality and service, and say how distinctly the stations are received.

NAJ, Great Lakes. . 2270 meters—132 kc.
9.45 A. M. Morning Lake Forecasts.
4.00 P. M. Storm Warnings.
10.00 P. M. Evening Lake Forecasts.

WGO, Chicago. . . 890 meters—337 kc.
11.00 A. M. and 4.00 P. M. Morning Local and Lake Forecasts.
9.00 P. M. Evening Local and Lake Forecasts.

WLS, Chicago . . . 344.6 meters—870 kc.
9.00 A. M. Morning Forecasts, Special Warnings
1.00 P. M. Repeated.
Corn and Wheat Region Summary Wednesday.
1.00 P. M. Aviation Forecasts Repeated. Except Sunday.

KYW, Chicago. . . 536.4 meters—559 kc.
10.00 A. M. Except Sunday†—Morning Forecasts.
4.15 P. M. †Special Warnings.
11.00 P. M. †Except Sunday and Monday—Evening Forecasts.

WAAF, Chicago . . 278 meters—1080 kc.
10.30 A. M. Morning Forecasts; Weather-Crop Summaries Wednesday During Crop Season.
12.30 P. M. Repeated. Saturday Gives Weekly Forecast. Except Sunday and Important Holidays.

WHT, Chicago . . 400 meters—1260 kc.
12.05 P. M. †Morning Forecasts; Corn and Wheat Region Summary Wednesday.
11.00 P. M. Evening Forecasts. Except Sunday and Monday.

WEBH, Chicago . . 370 meters—811 kc.
9.45 P. M. Evening Forecasts, Chicago and Vicinity, and Special Warnings. Except Monday.

WOC, Davenport . . 484 meters—620 kc.
1.00 P. M. Except Sunday—Morning Forecasts, General Weather Conditions, Weather-Crop Summaries Wednesday.
9.00 P. M. Evening Forecasts. Monday, Silent Night; Special Warnings Sent as Flashes.

WEW, St. Louis . . 360 meters—832.8 kc.
10.00 A. M. Morning Forecasts, General Weather Conditions.
5.00 P. M. Special Warnings. Except Sunday.

KSD, St. Louis. . . 545.1 meters—550 kc.
10.40 A. M. Morning Forecasts, General Weather Conditions, River Stages.
12.40 P. M., Special Warnings.
1.40 P. M., Repeated.
3.00 P. M. Repeated.
10.00 P. M. Evening Forecasts. Except Sunday.

KMOX, St. Louis . . 280.2 meters—1070 kc.
10.00 P. M. Evening Forecasts Except Sunday.

†One hour earlier during Chicago "Daylight Saving."

RADIO BROADCAST

Willis K. Wing, Editor

DECEMBER, 1926

Keith Henney, Director of the Laboratory

John B. Brennan, Technical Editor

Vol. X, No. 2

CONTENTS

BEHIND EDITORIAL SCENES

ALTHOUGH not the first article to appear in the United States on the fascinating subject of "television," A. Dinsdale's article on the experiments and results attained by the remarkable Scotsman, John L. Baird, is by far the most authoritative we have seen. There is certainly no radio subject which excites more interest than "seeing" by radio. Mr. Dinsdale is an English radio experimenter, who is quite close to Mr. Baird. . . . The concluding article in French Strother's provocative series about the problems of the radio industry appears on page 144. The quotation from John K. Barnes's article appended to Mr. Strother's about the manner in which the automobile industry has solved its patent problem is worth the attention of every one who is interested in the business problems of the radio industry.

COULD Hoover solve the perplexing problems of the radio industry? "A nice point," as the Lord Chancellor remarks in *Iolanthe*, and it is suggested on page 148 in the "March of Radio." . . . Few subjects have aroused as much interest as that first discussed by Eugene Van Cleef, of Ohio State University in the May, 1925, Radio Broadcast, "Do Weather Conditions Influence Radio?" . . . Additional conclusions about weather conditions and radio are found in a short and interesting article by Mr. Van Cleef on page 152. . . . The Radio Broadcast Universal Receiver was built last year by uncounted constructors and is daily giving fine service. Howard Rhodes, of the Laboratory staff has devoted several months of work to revising and improving the circuit and a complete constructional article appears on page 154 giving the details of the present model—a remarkably good receiver.

J. ANDREW WHITE in addition to his well known talents as a broadcaster, is a writer of parts; in fact, he is more, he is an editor and for many years edited the *Wireless Age*. There are few so sour-faced as not to get at least one grin out of his fun-poking at broadcasting when it leans toward the uplift.

PRINTERS' INK, the trade publication of advertising men, lists, among the October issues of general and class magazines, Radio Broadcast as first among all radio publications with 36,401 lines of advertising. Then, in order, come *Radio News* with 29,972 lines; *Popular Radio*, 28,743; *Radio*, 19,600; and *Radio Age*, 8,166. In the *Printers' Ink* recapitulation of monthly magazines, Radio Broadcast is the only radio magazine listed at all, with a ranking of twenty first.

THE January magazine is already presenting a problem, for how to fit in all the good articles we have is no small task. The long-awaited constructional article on a good super-heterodyne embodying the principles laid down by Kendall Clough in the September Radio Broadcast is scheduled, as is an extremely interesting two-tube model of the R. B. "Lab." circuit with an extremely fine power amplifier and B supply unit, suitable for either the Raytheon or R. C. A. rectifier tube. The Hammarlund-Roberts "Hi-Q" receiver will be described and there will be a fascinating story of the work done by a New York experimenter with very short waves. A series of articles by David Grimes, describing an extraordinarily fine new receiver employing the inverse duplex principle will also start soon. —Willis K. Wing

Doubleday, Page & Co. MAGAZINES

Country Life
World's Work
Garden & Home Builder
Radio Broadcast
Short Stories
Educational Review
Le Petit Journal
El Eco
Frontier Stories
West

Doubleday, Page & Co. BOOK SHOPS (*Books of all Publishers*)

New York: Lord & Taylor; Pennsylvania Terminal (2 Shops); Grand Central Terminal; 38 Wall St. and 526 Lexington Ave.; 848 Madison Ave. and 166 West 32nd St.
St. Louis: 223 N. 8th St. and 4914 Maryland Ave.
Kansas City: 920 Grand Ave. and 206 W. 47th St.
Cleveland: Higbee Co.
Springfield, Mass.: Meekins, Packard & Wheat

Doubleday, Page & Co. OFFICES

Garden City, N. Y.
New York: 285 Madison Ave.
Boston: Park Square Building
Chicago: Peoples Gas Building
Santa Barbara, Cal.
London: Wm. Heinemann Ltd.
Toronto: Oxford University Press

Doubleday, Page & Co. OFFICERS

F. N. Doubleday, *President*
A. W. Page, *Vice-President*
Nelson Doubleday, *Vice-President*
Russell Doubleday, *Secretary*
S. A. Everitt, *Treasurer*
John J. Hessian, *Asst. Treasurer*

DOUBLEDAY, PAGE & COMPANY, Garden City, New York

TERMS: $4.00 a year; single copies 35 cents.

many times better than in 1921

WITH four times less drain on your "A" batteries than the storage battery tube of five years ago, the filament of a Radiotron UX-201-A throws across to the plate five times as many electrons—a steady stream of tiny electrical charges that carry the song and speech. This is a big increase in efficiency!

And the Radiotron UX-201-A does not burn out—unless you apply a huge, excessive voltage. It does not die gradually, but keeps its efficiency almost to the very end of its life.

These are but a few of the advances in vacuum tube making that have come from the laboratories of RCA and its associates—General Electric and Westinghouse. Unceasing research brings continual improvement in RCA Radiotrons, making possible ever better reception—at lowered cost.

RADIO CORPORATION OF AMERICA
New York Chicago
San Francisco

to get more power

put an RCA power Radiotron UX-120, UX-171 or UX-210 in the last audio stage of your set.

to get more distance

(on a storage battery set)

—put the new special detector Radiotron UX-200-A in the detector socket.

. . .

RCA is not only making Radiotrons steadily better—but is further improving reception with these new special Radiotrons. Keep your set up-to date.

★

RCA Radiotron

MADE BY THE MAKERS OF THE RADIOLA

LIGHTNING NEAR WJZ'S TOWERS

A remarkable photograph of a lightning discharge, taken at the Bound Brook, New Jersey station of the Radio Corporation, at 4:30 on the afternoon of August 12, 1926. The outline of the WJZ towers can be faintly seen to the left of the discharge

RADIO BROADCAST

VOLUME X NUMBER 2

DECEMBER, 1926

And Now, We See by Radio!

How a Canny Scot Turned from Patenting a Waterproof Sock to the Development of Television—Selenium and the Photo-Electric Cell, Their Comparative Effectiveness—The Mechanism Involved in the Transmission and Reception of Pictures of Animate Objects—Commercial Development of the Televisor

By A. DINSDALE

Member, Radio Society of Great Britain

THE last fifty years have seen the development and perfection of many scientific marvels, probably the most outstanding of these being the telephone, the phonograph, the cinematograph, the airplane and airship, and, more recently, radio. All these inventions have come along so rapidly, compared with scientific development for hundreds of years previously, that the world to-day is prepared for the sudden announcement of even more wonderful achievements. Thus, to-day, and without much ado, we are able to announce that the secret of the successful accomplishment of television has been unearthed; a successful television apparatus has been designed and built.

Yet, what is television?

Television is "seeing what is happening at a distance *in the same instant as it happens*," and the name denotes that this feat is performed by means of a system of electric telegraphy.

Over short distances, provided no other objects intervene, this may be accomplished with the naked eye, and, for greater distances, it can be done with the assistance of a telescope or pair of binoculars. But no telescope or binoculars will enable us to see through brick walls, or, from the comfort of our armchair in, say, San Francisco, see the President of the United States as he makes a speech in Congress. On the other hand, science has progressed so far that, under such circumstances, we can *hear* his speech as it is delivered.

Science has also so developed that, still in San Francisco, we can open our morning paper and see reproduced therein a photograph of the President in the act of making his speech. That photograph would reach San Francisco from Washington by wireless or land line telegraphy, and the process is known as photo-telegraphy. It is not television.

JOHN L. BAIRD

Inventor of the Televisor. He is a Scotsman, the son of a Presbyterian minister, about 35 years of age. After the war, Baird started in business selling a patent waterproof sock of his own invention, but ill health intervened and he had to abandon this project. He then took up television, a subject he had previously dabbled in, and has now produced an instrument which is said to be far ahead of any other inventor's scheme for the transmission of moving pictures

For many years, writers of scientific fiction have had no doubts as to what television meant, for in countless stories of this nature the miracle of seeing what is actually happening elsewhere is treated as an accomplished fact, and embodied in the story. Actually, it is only within the last few months that the miracle has become a fact.

The history of television may be said to date from the discovery of the light sensitive properties of selenium. This discovery was made in 1873, by May, one of Willoughby Graham's assistants, and it was not long before the scientists of the day suggested that selenium cells might be made use of to give to the eye what the Bell telephone had already given to the ear. In 1880, Ayrton and Perry actually described a system by means of which this could be done, and it was then confidently predicted that in a very short time it would be possible to see over a telephone line.

It was found, however, that the capabilities of selenium had been greatly overrated. Although a very larger number of workers have been working on television ever since the discovery of selenium, and much ingenious apparatus has been devised, the main stumbling block encountered by every inventor has been the selenium cell, which, although sensitive, is sluggish in action. When used for television purposes, selenium is called upon to convert into electrical impulses literally hundreds of thousands of light impulses per second, and its sluggishness, or chemical inertia, absolutely precludes such rapid response.

The task which selenium is depended upon to accomplish will be understood when it is pointed out that the human eye sees a whole scene in a single comprehensive glance. This, selenium is totally unable to do, and the suggested alternative was to divide up the scene to be transmitted into innumerable small parts, transmit it section by section to the receiving end, and to achieve this so rapidly as to create the effect of an instantaneous glance.

Thus, if a picture only ten inches square were divided up into sections one tenth of an inch square, 10,000 impulses would have to be transmitted practically instantaneously. To portray movement in a natural manner (i. e., give a moving picture effect), sixteen complete pictures must be transmitted per second, which means that the selenium cell has to transform into electrical impulses 160,000 light impulses per second. As the size of the picture is increased so is the magnitude of the task of the selenium cell increased.

THE PHOTO-ELECTRIC CELL

SELENIUM proving a failure, search was made for a substitute, and recently a new device, known as the photo-electric cell, has been tried. Certain metals, such as potassium, sodium, etc., have recently been discovered to possess the ability to generate minute electric currents when exposed to light, and it is this property which is made use of in the photo-electric cell. For television purposes, however, although the response of this new type of cell is instantaneous, and therefore sufficiently rapid for the purpose, the photo-electric cell is not sufficiently sensitive. Its output is of the order of a few micro-amperes only, and such a minute current has to be amplified several million times before it can usefully be employed.

After thus briefly outlining the nature and difficulties of television, we now come to the work of the inventor whose good fortune it has been to provide a practical solution to the various difficulties.

Like Graham Bell, who invented the telephone, John L. Baird is a Scotsman. The son of a Presbyterian minister, he is about 35 years of age, tall, slightly round shouldered, studious in appearance, and possessed of a keen sense of humor of the brand known in Scotland as "pauky." He was trained as an engineer and, on the outbreak of war, was studying at Glasgow University. He immediately offered himself for enlistment, but, on being rejected for active service, served throughout the war as an electrical power station superintendent.

At the conclusion of hostilities, Baird started in business with a patent sock he had invented, which was designed to keep out the eternal damp for which the west of Scotland is world-famous. Money was plentiful and Baird was on the way to "getting rich quick," but ill-health intervened, in the shape of a complete physical and nervous breakdown, and all business had to be abandoned.

We will not trace his subsequent activities; suffice it to say that they form an interesting record of enterprise and ability, dogged by continual ill-health and recurrent illness.

Throughout the years of an active business life Baird had one hobby—scientific research. In the early days of his training he had endeavored to invent an improved selenium cell, and had devised a system of

AT THE RECEIVING END

This is a photograph of the image obtained at the receiving end during one of Baird's early experiments. Vastly improved likenesses are now obtainable

television. His experiments in the latter subject date from 1912. Thus, when, in 1923, he found himself compelled through ill health to abandon business and lead the life of a recluse, he again took up the threads of the television problem where he had left them so many years previously.

With unlimited time at his disposal, Baird soon began to forge ahead, and after only a few months' work he succeeded in transmitting shadow-graphs. That is, by interposing an opaque object between a source of strong light and a selenium cell, he was able to transmit to the distant receiver, and reproduce on a screen, a shadowy outline of the object at the transmitting end.

So far, so good, but shadowgraphs are not television. Baird soon found, like so many other investigators in various countries, that successful television is a much more difficult thing. In the case of television, it is not enough to send mere outlines of the object to be transmitted. Not only the contour, but also all the details and gradations of light and shade, together with a lifelike reproduction of all movements, must be transmitted and received.

To achieve this, the arrangement of scene and light source must be reversed. That is to say, the light, instead of shining on the light sensitive cell, must shine *on the scene*, and, under these conditions, the amount of light which actually reaches the cell is that amount which is *reflected* from the scene.

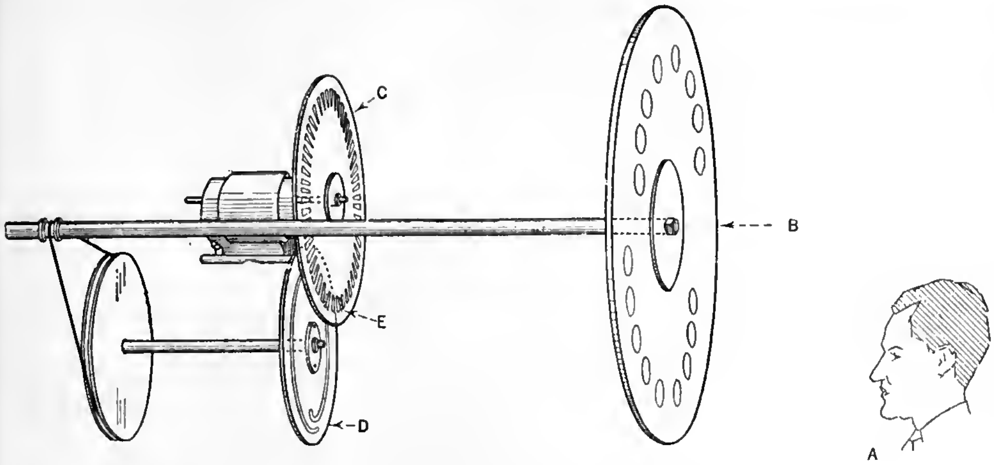
Baird found that the amount of light reflected from the human face is of the order of one candle power only, and when the image of the face is broken up into many small parts for transmission purposes, it will readily be realized that the amount of light which actually falls on the light sensitive cell at any given moment is extremely small indeed.

The full significance of the sluggish response of selenium, and the extremely feeble response of the photo-electric cell, will now be appreciated.

Month after month Baird worked on the problem, using apparatus of the crudest description. The biscuit tins, sealing wax, string, and other makeshifts beloved of the true inventor, and scoffed at by the sterile pedant, were very much in evidence. At last, however, in April, 1925, he had the satisfaction of giving the first public demonstration of television, transmitting outlines between two separate machines. These outlines were not the shadowgraphs referred to above, but were transmitted by reflected light—a most important point, showing an enormous advance over the earlier experiments. They were, however, very rough and flickering, and mere outlines.

The demonstration created considerable stir, but Baird's weird apparatus, old bicycle sprockets, biscuit tins, cardboard discs, and bulls-eye lenses, all tied together with string and sealing wax, failed to impress those who were accustomed to the shining brass and exquisite mechanism of the instrument maker. Also, the scientific world had never heard of Baird. He has no letters after his name, and belongs to no scientific societies and other highbrow institutions. In England, this means that, in the opinion of scientific circles, he could not possibly have achieved anything of scientific importance!

Working feverishly at all hours of the day and night, in the face of diminishing funds, Baird progressed rapidly until, on January 27th, 1926, he gave a successful demonstration before the Royal Institution, one of Britain's leading, and most conservative, scientific institutions. It is typical of the man that, on this occasion, he calmly invited the Institution to come around to his laboratory. About forty members turned up to see the demonstration, and the labo-



THE SLOTTED DISC EQUIPMENT OF THE BAIRD TELEVISOR

Between the object to be transmitted, and the revolving slotted disc, B, is a light-tight partition in which is contained a special collecting lens. Reflected light from the object to be transmitted passes through the collecting lens and then through the slotted discs B, C, and D, and thence to the light sensitive cell. The discs break up the light to be transmitted into numerous flashes

ratory was only capable of holding five or six at a time. However, by exhibiting to them in relays, all were in turn given a demonstration.

THE APPARATUS USED

THE apparatus used at the demonstration is shown in part in the picture diagram on this page. Between the object to be transmitted, A, and the revolving disc, B, is a light-tight partition. A battery of lights, similar to those in use in a photographic studio, are trained on the object or scene to be transmitted, and the light reflected from the scene is collected by means of a lens set in the partition. This lens acts in a manner similar to the lens of a camera, which collects light reflected from what is before it, and focusses the image of the scene on to the light sensitive cell.

Between the collecting lens and the light sensitive cell, however, are several discs. The first of these,. B, carries a series of lenses, which, as the disc revolves, causes a succession of images of the object, A, to pass over the next disc, C. This disc is slotted, as shown, and revolves at high speed. Its task is to interrupt the light reflected from the image, causing it to reach the light sensitive cell in a series of flashes. Before reaching the cell, however, the light flashes have yet to pass through the rotating spiral slots of disc D, which cause a still further subdivision of the image.

E is the aperture through which the light finally passes to the light sensitive cell. The action of the discs, B, C, and D is to cause the light image to fall on the cell in a series of flashes, each flash corresponding to a tiny square of the image.

This, roughly, is the principle ano arrangement of the mechanical part of the transmitter. The entire mechanism, called by Baird an optical lever, is the subject of a master patent which will, in all probability, revolutionize certain other branches of optics. An independent authority has characterized the patent as the product of the brain of a genius.

The arrangement of the lenses on the disc B is such that, as the disc revolves, each lens selects a narrow strip of the image as projected through the collecting lens situated between the object to be transmitted and the disc. This portion of the image, by virtue of the rotary action of the disc, is swept across the aperture E. Each succeeding lens is set a little nearer the center of the disc, so that, as the latter revolves, successive strips of the image are dealt with until the entire image has been swept across the aperture.

At the aperture E, the rotary action and perforations of the discs C and D have the effect of chopping up the long image strips into tiny squares. It is as if a piece of paper were first ruled off into parallel strips in one direction, and then ruled off in the other direction to produce squares. Each square, in the television transmission mechanism, represents a small portion of the image, and the intensity of light in each square depends upon the degree of light and shade reflected from the original object or scene to be transmitted.

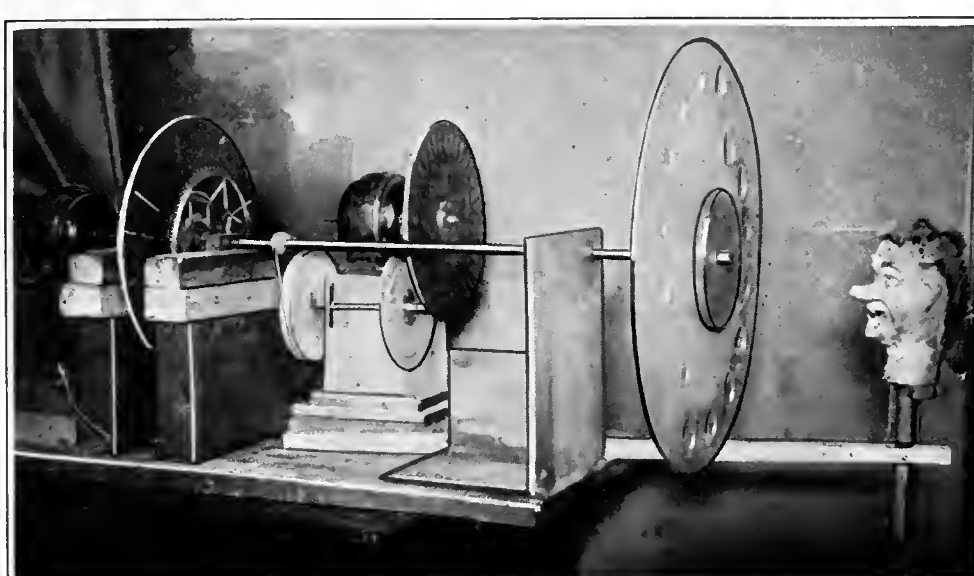
The entire mechanism is so designed that first the strips and then the squares just fit together, without an intervening space, and without overlap.

Passing through the aperture E, the light-squares, or flashes, fall on the light sensitive cell, which is the most vital portion of the whole system. The difficulties in connection with it have already been explained, and the design of a suitable cell has caused Baird more trouble than anything else. Working day and night for long weary months, he experimented with every possible variation of every known type of light sensitive device, and eventually invented a cell of his own, the secret of which is still very closely guarded. All that can be said about it is that it is a cell of the colloidal type, that is, made up of extremely finely divided selenium held in suspension in a liquid.

As the light flashes fall upon the light-sensitive cell, the resistance of the latter is altered in exact accordance with the intensity of the light falling upon it. The light impulses are thus transformed into electrical impulses which are then amplified by means of an ordinary a. f. vacuum-tube amplifier and transmitted over a wire circuit to the distant receiver. If it is desired to use wireless transmission, the television impulses are coupled up to the microphone input terminals of an ordinary broadcast transmitter. The carrier wave is then modulated by television impulses instead of speech impulses.

THE TELEVISOR

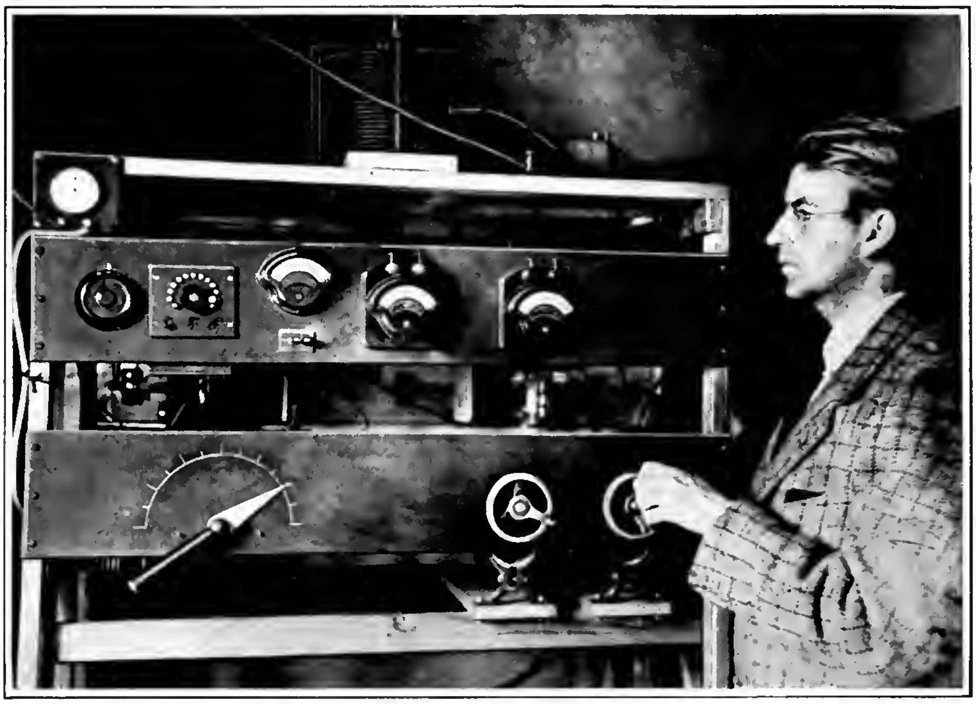
THE receiving apparatus, or Televisor, as he has christened it, has been reduced by Baird to the simplest possible form, so that, from the users' point of view, it shall be no more complicated than, say,



BAIRD'S ORIGINAL TELEVISION TRANSMITTING APPARATUS

This is a photograph of the equipment shown in the drawing at the top of this page. This apparatus has been placed on view at the Science Museum, South Kensington, London. By this act, Baird is officially recognized as a pioneer a loud speaker. It is so designed, in fact, that it can be coupled up to the loud speaker terminals of any radio receiver, in parallel with the loud speaker, so that both speech and vision can be received simultaneously. If desired, the Televisor, radio receiver, and loud speaker can be incorporated in one instrument, like the self-contained radio receiver of to-day.

Television Limited, the company which has been formed to exploit Mr. Baird's system of television in England, is already making preparations to market such a combined instrument, and a commercialized model has been produced. The instrument is contained in a handsome mahogany case measuring about 24 inches by 20 inches by 18 inches deep. On the left of the front panel of the instrument is a ground glass screen about eight inches square, upon which the television images appear, and along-side this is the grilled opening of a loud speaker horn. A few binding posts at the back, for connecting up to the current supply, antenna, and ground, complete the external features of the instrument, which will probably sell for something like the equivalent of $250.



THE TRANSMITTING APPARATUS

Mr. Baird is here shown at the transmitting panel of his television station in London. The carrier wave of the transmitter in London is modulated by television impulses instead of speech impulses. A receiving station has been set up at Harrow, nine miles from London, where the carrier wave is demodulated. Reception is accomplished by somewhat the same process as transmission, only it is reversed

RECEIVING EQUIPMENT

THE mechanism for the reception of the television impulses is very similar to that used at the transmitting end, only the process may literally be said to be reversed. Instead of the light sensitive cell, a source of light is used in the Televisor, the intensity of which is controlled by the incoming television impulses. Bright flashes falling on the light sensitive cell at the transmitter cause strong currents to flow over the transmission circuit, be it wire or radio, and these strong currents cause the light source to shine with great brilliance. Conversely, dim flashes at the transmitting end cause dim responses in the degree of brilliance of the light source at the receiving end.

THE CRUDITY OF BAIRD'S EXPERIMENTAL APPARATUS

Is well emphasized by this picture. One of the several discs employed in the transmission of objects may be discerned in the upper left-hand corner

The beam of light from the light source, constantly varying in intensity in accordance with the light and shade of the scene before the transmitter, is focussed, by means of lenses, onto a ground glass screen. If an observer now looked at the screen, he would see a tiny stationary spot of light on it which would be constantly flickering. In that flicker is contained the image, but the light variations must be spread over the entire screen in their proper sequence before the observer can make anything of it. In other words, the various pieces of the jig-saw puzzle must be put together.

This putting together and laying out of the image is performed by a mechanism similar to that shown in the picture diagram on page 141. Each light variation that comes through is passed through the aperture, E, of two discs, and thence on to a disc similar to B. Each lens on this disc selects the appropriate series of flashes which represent a strip of the picture, and sweep them, in the form of a strip of graduated light, across the ground glass screen. The next lens in order selects the next series of flashes and likewise sweeps them across the screen.

In this way the entire screen is finally covered, all the flashes, or squares, and strips fitting together so accurately that there is no noticeable junction. This action has taken quite a long time to describe, but actually it takes place in less than one tenth of a second! Due to the phenomenon known as "retentivity of vision," the observer thus sees, not a spot of light traveling over the screen at an incredible speed (which is what actually happens), but a complete picture, full of smooth gradations of light and shade, and representing faithfully the scene before the transmitter. Sixteen such complete pictures per second give the effect of smooth animation, as in the case of the motion picture.

As may well be imagined, careful synchronism is necessary between the transmitting and receiving mechanisms. Both are driven by electric motors, and the problem of synchronism depends upon these two motors being kept exactly in step. Baird achieves this by means of small synchronous motors which are used as controllers. An alternating current of a definite frequency (about 60 cycles) is generated at the transmitting end. This serves to regulate the speed of the small synchronous motor which controls the speed of the transmitter driving motor.

This same frequency is superimposed on the carrier wave along with the television impulses, is picked out at the receiver by means of filters, and the receiver output current of that frequency made to drive another small synchronous motor which controls the speed of the Televisor driving motor. Thus, synchronism is entirely dependent upon one thing only, *i. e.*, the a. c. generated at the transmitter, so that any number of distant receivers, or Televisors, are controlled simultaneously and cannot possibly get out of step with the transmitter, unless something goes radically wrong with their mechanism.

From the foregoing, therefore, it is apparent that the carrier wave is made to convey two sets of frequencies, the television impulses and the synchronizing frequency. This latter is audible as a low steady hum, whilst the television impulses depend for their frequencies upon the image being transmitted. For example, the face of an individual looking directly at the transmitter sends out a series of sounds something like "brump, brump, brump," but, when turned sideways, the profile gives out a note like "perahh, perahh, perahh." A hand with fingers extended, if passed in front of the transmitter, will sound like the grating of a very coarse file, and an inanimate object, such as a box, gives a single steady note.

Since his demonstration before the Royal Institution in January of this year, Baird has made phenomenally rapid progress. A few months ago he had to use such powerful lamps at the transmitting end that sitters were almost blinded and burned. Now he has so far improved his apparatus that the light required is little more than is necessary in an ordinary photographic studio, and soon, probably, daylight alone will be found sufficient.

A few months ago, Baird was only able to transmit an object the size of a human face. Now he can take in a complete head and shoulders. Readers may remember that during the early days of the moving picture, the results on the screen were far from perfect. There was a constant flicker, the focus was often wrong, and there was always the "pouring rain" effect. The images on the screen of Baird's Televisor suffered from very similar effects, but these are rapidly being eliminated, until, at the present time, a highly creditable demonstration can be given.

The writer is able to speak authoritatively on this subject of progress, for he witnessed one of Baird's earliest demonstrations, and has been in close touch with developments ever since. The image seen on the Televisor screen is perfectly clear and unmistakable; the sitter before the transmitter can be recognized without the slightest difficulty, and every detail of his features can be taken in, even to blemishes of the complexion. All movements are faithfully portrayed, just as they would be on a "movie" screen. Even the smoke from a cigarette can be seen, and its ascending wreaths followed. The results are not yet as perfect as those seen on a motion picture screen, but such rapid progress has been made that the writer has no doubt in his mind that before long absolute perfection will be arrived at.

BAIRD DEMONSTRATES HIS TELEVISOR TO THE FAIR SEX

A decidedly informal demonstration, one should say. On one occasion forty members of the Royal Institution turned up for a demonstration, and Baird's laboratory was then only large enough to hold six people at a time. By exhibiting to them in relays, he managed to give everybody a view

At present Baird is stepping out of his laboratory as far as the location of his Televisor is concerned, and he is now engaged in broadcasting his television impulses from his laboratory in the heart of London to a receiving station at Harrow, about nine miles distant, using a 250-watt broadcast transmitter operating on 1500 kc. (200 meters). These transmissions are purely of an experimental character and are being conducted nightly after regular broadcasting hours, the object of them being to perfect the technical details of the transmission, from a purely wireless point of view.

At present, as stated above, the television and synchronizing frequencies are within the audio frequency limit, but Baird aims to raise these frequencies above the audible limit so they can be superimposed on the carrier wave of an ordinary broadcasting station without in any way interfering with music and speech. At the receiving end they will then be picked out by means of filters and, whilst speech and music are rendered audible by means of the usual loud speaker, the scene before the microphone at the broadcasting station will be visible on the screen.

Investigators in many countries have been striving to achieve television for some time, and many have claimed to have solved the problem, but have not been able to back their claims by an actual demonstration. Unheralded by claims, and scoffed at by many skeptical "authorities," Mr. J. L. Baird has arrived with his apparatus, the result of years of patient effort, and has actually given demonstrations innumerable to scientists, press men, and curious visitors. He has proved beyond all question or doubt that he has solved the worst and most troublesome problems of television, and its commercial application is now but a question of development.

Physics, mechanics, and optics have been ruthlessly explored to provide this new method of super-communication, and Baird's success is all the more remarkable and noteworthy because he has, from the very beginning, worked all alone. Even to-day he has no technical assistants, for until recently much of his apparatus was of a secret nature. The secrets of some of it are still possessed by Baird alone, and he is too canny a Scot to allow any one into his confidence. Working under such circumstances, therefore, the magnitude of his task can perhaps be appreciated.

Whenever he enters upon a new phase of development, Baird finds himself in need of expert knowledge of some science of which, perhaps, he is in complete ignorance. In order to progress, therefore, he has only one alternative—to go out to a library and get all the available literature on the subject and proceed to digest it. Truly a difficult task, and one which he has faced many times.

Thus, once again is it demonstrated that, in the field of scientific endeavor, much of the best work of a basic and revolutionary character is done by individuals working alone, without the aid of vast organized laboratories, and small armies of skilled assistants. Most certainly is Baird's developmental work in the television field a true example of individual perseverance, and patience, deserving of the ultimate award which now seems likely to be within this grasp. It is too bad that we cannot all personally see Baird and his remarkable apparatus.

What the Future Holds for the Radio Industry

Can We Look for the Emergence of Big Industrial Organizations?—Reasons Why the Radio Corporation Will Not Establish a Monopoly—The Future for the Consumer is Bright

By FRENCH STROTHER

RADIO is an industry as well as an art. It is doubly "charged with a public interest." The ingenuity of inventors has placed in the hands of millions a new and fascinating form of recreation. The enterprise of hundreds of business men has offered the instruments of this recreation in dozens of models at a wide range of price. Therefore, the public has a profound interest in the radio industry. It is a public concern whether that industry shall be constricted into the hands of a few people, or whether it shall continue to offer the widest possible variety of competition in quality and price.

Many things will enter into the fate of the radio industry. Previous articles in this series have indicated the importance of patents. It was pointed out that one of the possibilities was a series of court decisions that could pretty well put the entire industry into the hands of the Radio Corporation. Having considered that possibility, it may be well to consider alternative possibilities.

In the first place, the Radio Corporation itself is a somewhat artificial and unnatural institution. To indicate just what is meant by this statement, let us sketch briefly the career of another patent-sustained industry that seems to us a perfectly natural type. When the late John H. Patterson went into the cash register business, he went with only one idea, namely, to manufacture and sell cash registers. The cash register was a patented invention, a very crude affair, barely capable of practical use, and offering endless opportunities for patentable improvements. Patterson acquired the basic patent and proceeded at once to manufacture and sell. The expected improvements were made, often by outside inventors. The basic patent was attacked in the courts. Down to the day of his death, Patterson was engaged in endless patent suits, but his business grew until it became one of the wonders of the world.

The essential differences between the National Cash Register Company and the Radio Corporation are several. First, the Cash Register Company had John H. Patterson, a man of business genius and masterful character. More important, all of Patterson's eggs were in one basket, and that basket was the cash register business. More than once he gambled every dollar he owned and all he could borrow on some daring stroke to increase his business. It was not enough to say that the business was *his;* the business was *him*—to be ungrammatically emphatic—it was the life of his life, and he had no thought nor interest but to make it succeed.

Again, let us emphasize the fact that Patterson primarily wanted to *make and sell* cash registers. Patents were necessary to him, improvements were necessary to him, patent suits were an unavoidable incident of his battle for a free hand to *make and sell* cash registers. He fought patent suits as he fought competitors—to the bitter end. He was out for blood, in the business sense, and he won out.

THE RADIO CORPORATION—UNNATURAL ORGANIZATION

NOW let us consider the Radio Corporation in the light of this comparison. In the first place, it was founded, not as a business enterprise, but as a patent pool. It was not the creation of a man, but indirectly, the creature of three great corporations, the General Electric Company, the American Telephone & Telegraph Company, and the Westinghouse Electric & Manufacturing Company. These three corporations had, and still have, aggressive managements. They had, and still have, conflicting interests. The conflict of those interests was not removed by the pooling of the radio patents held by the three respectively. On the contrary, the now legally enforced companionship in that pool rather tends to exasperate that natural conflict. Hence, there are internal strains within the Radio Corporation that could not have existed in the Cash Register Company. Patterson was the "king or nothing" type and he stayed king.

Another striking contrast lies in the absence of a man at the head of the Radio Corporation. This is not meant in the slightest sense as derogating the genius of Owen D. Young, General Harbord, or David Sarnoff. They have business genius, as Patterson had, and in the case of Mr. Young, it is probably of a considerably higher order than Mr. Patterson's. But Mr. Young is not head of the Radio Corporation in the sense that Mr. Patterson was head of the Cash Register Company. In the first place, he has the General Electric Company on his hands, and that is a job big enough to occupy most of any man's time and energy. In the second place, he has not got the financial ownership—not mere control, but ownership—of his company. Patterson could, and did, fire everybody in his company when he wanted to make a quick turn and the others could not turn fast enough to keep up with him. Mr. Young would not use such furious methods if he could, and he could not if he would.

To repeat, then, the Radio Corporation is an artificial institution, in that it lacks the natural foundations of a business enterprise, namely, a purely commercial origin, singleness of purpose, and positiveness of control. Its business is of two wholly unrelated kinds: first, public service in the form of telegraphic communications, and second, the manufacture and sale of articles of merchandise, namely radio sets and parts. These two functions call for quite different types of mind and for quite different types of organization. And in exercising the second of these functions, it is further handicapped by the fact that, while it maintains its own selling force, it must depend for its manufacturing upon two associates, the General Electric and the Westinghouse Electric; with the further complication that while these two companies are nominally its manufacturing sub-

THIS is the third and concluding article in the series by Mr. French Strother, one of the associate editors of WORLD'S WORK. *The first of this series of articles proposed to show the course of the inventions and developments in radio which are responsible for the present complex situation. The second, published in* RADIO BROADCAST *for November, gave an analysis of the radio patent structure and something about who owns the important or key patents. This article discusses the problems of the radio industry in a remarkably sane manner. The hazards ventured here about the future of the industry are not in any sense casual; they are the result of many interviews with those prominent in the business side of radio and an extremely careful study of the probable future course of radio, judged in the light of the experience of other industries. It is comforting and important to note that there need be no serious fears about the future of the radio industry; all signs point toward a sane and proper development.*

—THE EDITOR.

sidiaries they in reality control the "parent" company, and with the still further complication that these two joint children-parents are in all other respects violent competitors.

WHO LEADS THE RADIO INDUSTRY?

THE Radio Corporation at the moment is unquestionably the leader of the radio industry, and it is feared by all other radio companies. This fear is based upon the patent structure of the Radio Corporation, and the possibility that court decisions may so strengthen that position as to make inventive competition practically impossible, and destroy the commercial structures erected upon conflicting patents.

The patent complication is, of course, the reason for the development of astonishing successes such as that of A. Atwater Kent. It is a curious commentary on the idea of a legal patent monopoly that his success, like that of several others in the field, rests upon no patents at all. Here is a man of most unusual business talent, who, unable to acquire patents in a developing art, but perfectly willing to pay tribute to whoever the courts decide owns the patents he uses, refuses to wait until the courts get to that point, and plunges into the business while it is on the flood tide, and makes a spectacular success of sheer commercial skill.

It is idle to say that Atwater Kent is a "pirate." He has qualities that no pirate ever had, and they are qualities that the industry needs. Doubtless, too, they are qualities that the industry will eventually be glad to buy, no matter how the patent situation goes; for selling power of his kind does not grow on every bush, and is worth a high price when it can be commanded. This example is cited to indicate the importance of commerce skill, as well as of patents, in the radio industry.

An example can be chosen in another direction. The Stromberg-Carlson Company has had a generation of experience in the manufacture of telephone apparatus. Essentially, the problems of radio manufacture are much the same as the problems of telephone manufacture. Both call for refinement of design, and, to get real results, for extreme skill in fabrication. In engineering language, a first-rate radio set is now a "precision job," calling for calibration of parts to the thousandth of an inch. Haphazard methods of manufacture were all right while radio was a craze over a new mechanical marvel. But genuine skill in manufacture is increasingly perceptible to the radio public, and in time will be universally demanded. That kind of skill is not created in a day. Stromberg-Carlson have it, and doubtless they too will be welcomed into whatever situation the courts may resolve the radio receiver situation into.

A third example may be cited, in a third direction. Inventive genius flowers continually, and often in unexpected ways. Companies which, like A. H. Grebe & Company, maintain research laboratories of their own, may at any time develop inventions so valuable that they, too, may be indispensable to whatever powers control the radio field.

REQUISITES FOR SUCCESS IN RADIO MANUFACTURING

THERE are, then, at least three other necessary factors besides patents. These are commercial skill, manufacturing skill, and inventive talent.

It is only fair to the Radio Corporation to say that it recognizes these things as clearly as anybody else sees them. The Radio Corporation does not wish to possess a monopoly of the manufacture and sale of radio sets. It is reasonably certain that, even if they got favorable judgments in all their patent suits, they would not try to put all their competitors out of business. It is reasonably certain, on the contrary, that they would ask a number of those competitors to share the field with them, under cross-licensing agreements. Doubtless they would insist that such concerns should possess one or more of the qualifications sketched above, namely, exceptional commercial skill, or exceptional manufacturing skill, or valuable patents or inventive staffs.

These would seem to be not unreasonable requirements, and probably most of the independent companies that have one or another of these qualifications would be glad to see the present situation cleared up by some such solution. But for the present, the very nature of the patent law and the unadjudicated status of most of the radio patents make it almost inevitable that patent litigation shall be fought to a finish, so that the whole industry may know where it stands. Even the Radio Corporation, strong as its patent structure is, needs this assurance of certainty—perhaps, exactly because of its patent structure, it may need it even more than the independents. The Radio Corporation is run by thoroughly responsible financial interests, has an investment of thirteen million dollars in patents, and the interests of thirty thousand stockholders to protect. As its fundamental assets are primarily in patents, it has got to find out what the courts say those patents are worth.

Another element in the situation tends to eliminate many companies now in existence. This is the progress of invention. In a short span of years, it is quite possible that television by wireless will be a commercial fact, as it is already a laboratory fact. When that time comes, no receiving set will be valued that does not include this feature, by which the home user may see as well as hear the distant speaker or entertainer. The mechanism of television will require "precision" manufacture of an order beyond the powers of many companies now operating. It requires a trained ear to distinguish between good reception of sound and only fair reception, but any child can perceive the difference between good projection of a motion picture and less-than-good projection. To produce that difference calls for technical skill of a high order. The radio manufacturer who cannot supply it will have a hard time.

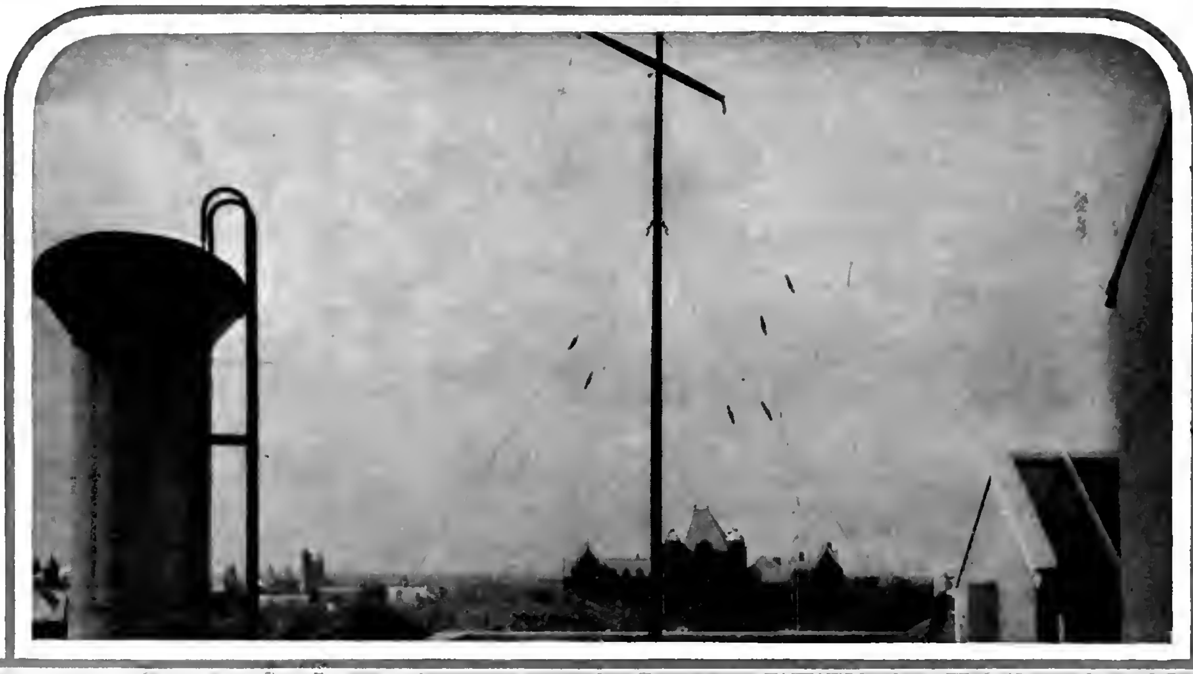
To recapitulate: The radio art is advancing rapidly, in the direction of refinements of basic inventions, designed to improve the quality of performance. Radio patents are in a state of chaos, owing to the inevitable delays in the Patent Office and the Federal Courts. The radio industry reflects that uncertainty in the rapid rise and fall of radio manufacturing companies. Probably most of the independent manufacturers will disappear, either through the failure of the courts to sustain their patents, or through poor manufacture or poor business management. Probably a few independent complete set manufacturers will survive all vicissitudes, by virtue of excellence of manufacturing staff, exceptional business ability, or unusual inventive talent. Probably a cross-licensing system between these independents and the Radio Corporation will then permit all to use any invention they need. In any event, the public is certain to continue to get a considerable variety of choice in receiving sets, at prices adjusted to suit all classes.

The Problems of the Automotive Industry Were Similar to Those Facing Radio Now

IN 1915, practically all the companies in the National Automobile Chamber of Commerce, the successor of all the earlier organizations of manufacturers, which includes all the leading automobile producers, except the Ford Motor Company, agreed to a plan of cross-licensing their patents which permits of their use by every other member free of charge. . . *'It was when the committee started work on a definite plan and the difficulties of appraising the value of patents and fixing royalties for their use became apparent, that it was suggested that no charge at all be made. As no manufacturer had patents worth as much as the aggregate value of the patents of all the others, there was a sound basis of fairness in this proposal. It was this argument that finally convinced the automobile manufacturers in the N. A. C. C. and induced them to adopt the plan. Each one had much more to gain from it than he was asked to contribute."*

"This cross-licensing agreement does not cover radical patents, for it was felt that any company making inventions of a striking character, involving a radical departure from what is known, should be entitled to special compensation if such inventions proved valuable. . . . Patents, such as improvements on the engine, or on other parts of the car, come under the cross-licensing agreement and can be used by all the parties of this agreement free of charge. There are about eight hundred such patents owned by the members of the N.A.C.C. The practicability of this agreement is clearly evident when one stops to realize that a patent of this kind does not give the holder the right to manufacture a car. If it is an improvement on an engine, for instance, the holder of the patent must get licenses from the holders of all other patents on that engine before he can manufacture it. And none of the holders of other patents could make use of his improvement, which might be highly valuable, until they had gotten the right to do so from him."

—JOHN K. BARNES *in* World's Work, *May, 1921.*



THE MARCH OF RADIO

News and Interpretation of Current Radio Events

Why Broadcasting Offers no Real Competition to the Newspaper

EVERY invention faces the opposition of the service it replaces. Radio broadcasting is afflicted with an unusually large number of opponents because its potentialities have been so greatly exaggerated in the public imagination.

Perhaps no group has better cause to watch the progress of radio broadcasting than newspaper and magazine publishers. The trade papers of those industries overlook no opportunity to point out that radio, which they claim to have "nursed from a failing infant to maturity," may some day slowly engulf them. Radio broadcasting threatens the future of newspapers about as seriously as automobiles threaten the shoe business.

As to radio's alleged debt to the newspapers: when broadcasting spread like wildfire in the first year of the radio boom, newspapers took it up with considerable enthusiasm. They published radio news because it stimulated the sale of newspapers. One New York paper, for example, by publishing a radio supplement, nearly fourfolded its Saturday circulation. Another New York paper has taken in practically a million dollars a year in radio advertising for several years. Five radio concerns spend a total of a million dollars a year in newspaper advertising alone. Thus, by increases in circulation and by direct revenue from the industry, the work of newspapers in aiding the inevitable success of broadcasting has been repaid in dollars and cents. Radio advertising in newspapers is growing by leaps and bounds and there are few men in the advertising field who would insist that radio advertising will not equal automotive advertising within five years.

The interest of the radio reader is concentrated largely in the announcements of station programs. This interest continues day after day. Hundreds of thousands, if not millions, of newspapers are brought home every evening instead of being left on train or street car because radio programs are referred to in the course of the evening.

There is much wailing and gnashing of teeth in the trade papers of newspaperdom when such events as the Dempsey-Tunney fight are broadcast. Perhaps not as many extras announcing the result are sold as in the past because of radio. Perhaps the few news events which radio handles successfully offer a little competition once in a great while. If this puts fear into the hearts of newspaper publishers, their hold on public interest must rest on weak foundations. Reader interest in radio, continuing day after day, and the huge expenditure of radio advertisers, counterbalances any loss from this source many times over.

The newspaper has all the news of the world, outside of these very few outstanding events, with which to compete with the radio description. They can bring illustrations and cartoons and opinions of recognized sports writers to the reader, while radio limits itself to a description by a single announcer. Newspapers can outdistance radio in every field of news distribution, even in those few rare events which radio brings to the public effectively. Newspapers, broadcasting an event like the Dempsey-Tunney fight, could popularize their own sports writers and gain attention to their own special way of handling such events, if they used radio to their own advantage as successfully as do other commercial users of broadcasting.

Two fears are constantly in the minds of newspaper publishers: first, that radio broadcasting may become an advertising medium so powerful that it will react on their advertising revenue and, second, that broadcasting may eventually become a disseminator of news rivalling newspapers.

The photograph forming the heading shows the short-wave antenna of the Ontario Hydroelectric Commission at its Toronto station. This station works with a sister station at Cameron Falls, Ontario, near Port Arthur

Both of these fears, experience has already demonstrated, are quite groundless. Radio is established as an entertainment medium and it has demonstrated that it is not an advertising medium. Any one attempting direct advertising by radio insults his audience and is promptly tuned-out. Broadcasting is a valuable good-will medium and may win sympathetic and favorable association with a trade name. It serves as a card of introduction between producers of goods and services and their ultimate consumers. That is a valuable service just as a card of introduction, presenting him to a prospect, is valuable to a salesman, but hardly any salesman would be foolish enough to attach an order blank to a card of introduction.

Printed advertising sells goods. Commercial broadcasting popularizes names. By so doing, it wins sympathetic attention to advertising and consequently makes it more effective. Commercial programs are themselves advertised and it would not be surprising to find, in the course of a few years, that the money spent in advertising commercial broadcasting programs, in order to bring them to the attention of newspaper readers, will actually equal the amount spent on the broadcasting itself.

Differing so in purpose, commercial broadcasting is no rival to the newspaper. And, even if it were a direct rival, it is one of such insignificant proportions that for the newspapers to regard it seriously is no more dignified a spectacle than that of an elephant running for his life at the sight of a mouse.

If the amount spent on commercial broadcasting should ever equal one per cent. of the amount spent on newspaper advertising, commercial broadcasting could well be proud of its tremendous growth. The advertising revenue of many a small town newspaper is greatly in excess of the amount spent on the largest commercial broadcasting chain in the country. With regard to news competition, aside from such news as has actual entertainment value, such as world series games, prize fights and a few other outstanding sporting events, broadcasting is totally unfitted as a disseminator of the ordinary run of news. Imagine a newspaper printed with invisible ink, which shows up one word at a time for one second, and you have a parallel of how broadcasting handles the news. It would take more than twenty-four hours to broadcast the entire contents of a metropolitan daily. The listener would have no choice of subject matter and no opportunity to refer to or re-read a single line of what he gets by radio. Radio, in no way, threatens the editorial or the advertising purpose of the newspaper.

Announcing the National Broadcasting Company

THE formation of the National Broadcasting Company, a subsidiary of the Radio Corporation of America, was announced by newspaper advertisements recently, in which the position and policy of the company was set forth. The first few paragraphs are a clear recognition of the fundamentals upon which broadcasting, commercial and non-commercial, is based. The success of radio broadcasting is dependent entirely upon the ingenuity and showmanship skill used in bringing radio events to the public and the degree to which they stimulate and maintain the desire for radio reception.

The statement says that:

THE POWERS BEHIND THE NEW NATIONAL BROADCASTING COMPANY

Photographed in New York with Vice-President Charles G. Dawes. Seated, left to right: General Dawes; Owen D. Young, chairman of the Board, Radio Corporation of America; General James G. Harbord, president, Radio Corporation of America. Standing: David Sarnoff, vice-president, Radio Corporation of America; M. H. Aylesworth, president of the National Broadcasting Company. On January 1st, 1927, the National Broadcasting Company will begin operations on a national scale with such stations as WJZ and WEAF as part of a chain which can be extended to Denver (KOA) and Oakland (KGO). The National Broadcasting Company is practically a merger of the broadcasting interests of the Radio Corporation, the A. T. & T. Company, the Westinghouse, and the General Electric Companies

The market for receiving sets in the future will be determined largely by the quantity and quality of the programs broadcast.

We say quantity because they must be diversified enough so that some of them will appeal to all possible listeners.

We say quality because each program must be the best of its kind. If that ideal were to be reached, no home in the United States could afford to be without a radio receiving set.

The use of broadcasting by companies seeking the good will of the radio audience must meet these requirements also. The commercial broadcaster who wins the good will of the radio audience is the one who presents it with the finest possible program of its kind. He who endeavors to advertise or to disseminate selfish propaganda alienates the attention of the radio audience and fails in his purpose. Herein lies the protection of the radio audience. Commercial broadcasters will not continue to use the medium if it fail to bring returns in the form of good will. Commercial programs must continue to improve both with respect to the skill of the artists appearing and in the showmanship used in presenting them before the microphone, if they retain the attention of listeners.

Somebody Should Give Edison A Good Radio Set

WHEN a great American inventive genius declares that radio "is very poor because it is badly distorted" and that "it should not be used for musical purposes," it is an indictment which attracts international attention. As the father of the phonograph, Mr. Edison might be excused for bias, but, as a scientist, there is not the least excuse for statements not based on investigation. The musical production attained by the modern high grade radio set is not to be compared with that of the very inferior products of two and three years ago which the inventor must have used as his standard of comparison.

On a number of occasions recently, the recording artists of one of the great phonograph companies have been asked to distinguish between phonograph and radio reproduction which they heard from a concealed instrument. None could tell the difference with certainty and he frequently guessed wrong.

The writer recently had demonstrated to him by Dr. Alfred N. Goldsmith two phonograph records of the same selection by the same operatic star. One was the commercial record produced in the phonograph recording studio; the other was a radio program received on a standard commercial receiver and recorded at Doctor Goldsmith's laboratory. Musical experts have pronounced the radio record better than the other because the artist expressed greater feeling, stimulated by the consciousness of a large and appreciative audience. As to frequency range and fidelity, "quality" experts and curves secured by measurement do not reveal any superiority in phonograph reproduction.

The extraordinary improvement in phonographs during the last year, in fidelity of reproduction and broadening of the reproducing range, is due to the application of radio receiving and transmission apparatus to the phonograph art. The first improvement of any consequence in a decade of phonograph recording was the use of the radio type of microphone in the broadcast input amplifier for what is termed electric recording. Equipment identical with that used in broadcasting studios has enabled phonograph recording by large musical groups in natural playing position rather than by small orchestras, huddled about an unresponsive megaphone, or singers, shouting at the top of their lungs, endeavoring to make the sluggish needle engrave the wax by sheer power of breath.

Likewise, in the reproduction of phonograph records, the use of amplifiers and loud speakers developed for radio sets has effected extraordinary improvement in phonograph reproduction, resulting in the revival of that once well-nigh forgotten business. For the first time, volume of a phonograph can be regulated, without introducing distortion, to suit the desire of the listener. Tonal quality, by reason of undistorted amplification and the extensive widening of the frequency band handled and the use of radio loud speaker equipment, has restored the phonograph in public confidence.

Mr. Edison would have been much more accurate if he had said that the old fashioned phonograph, before the application of radio inventions to recording and reproducing, was very poor "because it was so badly distorted" and that the application of radio pick-up apparatus in recording and radio amplifiers and loud speakers in reproduction makes the phonograph now equal in quality to the finest radio set.

Where the WEAF Audience Is Supposed to Be

AN ITEM in the New York *Times* furnishes a rather illuminating analysis of the audience of WEAF and the sixteen stations linked with it by wire lines. It estimates that the network reaches 59.5 per cent. of the receiving sets in the country and that 50.1 per cent. of the total population of the country is within the service area of the sixteen stations. 71 per cent. of the listeners live in the city and 29 per cent. are rural.

The number of radio sets reached by each of the stations in the network is estimated as follows: New York 702,000, Boston 380,000, Philadelphia 265,000, Washington 166,000, Buffalo 125,000, Pittsburgh 208,000, Cleveland 172,000, Detroit 224,000, Cincinnati 187,000, Chicago 354,000, St. Louis 146,000, Minneapolis 73,000, and Davenport 88,000, making a total of 3,090,000. The average number of listeners per set is estimated at five, which corresponds to the number in the average American family.

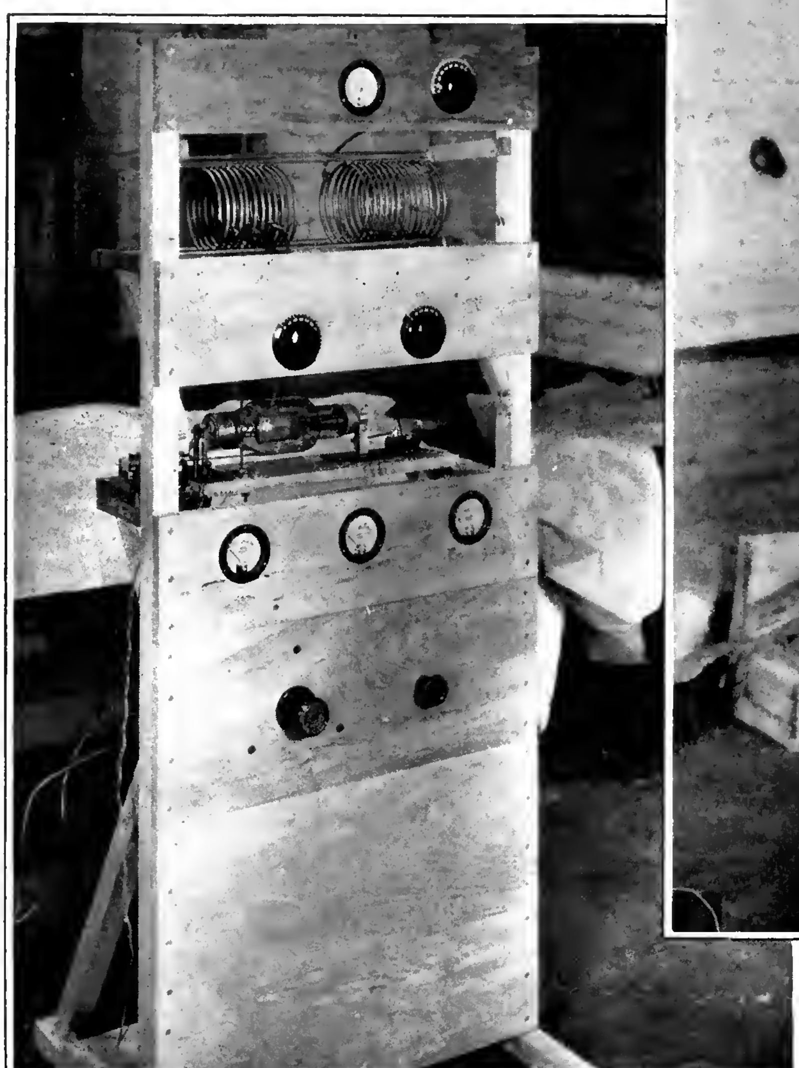
In most of the cities listed, there are rival high grade stations so that the division of this potential audience is dependent upon program attractiveness. Participation in chain programs gives such stations a marked advantage over their rivals.

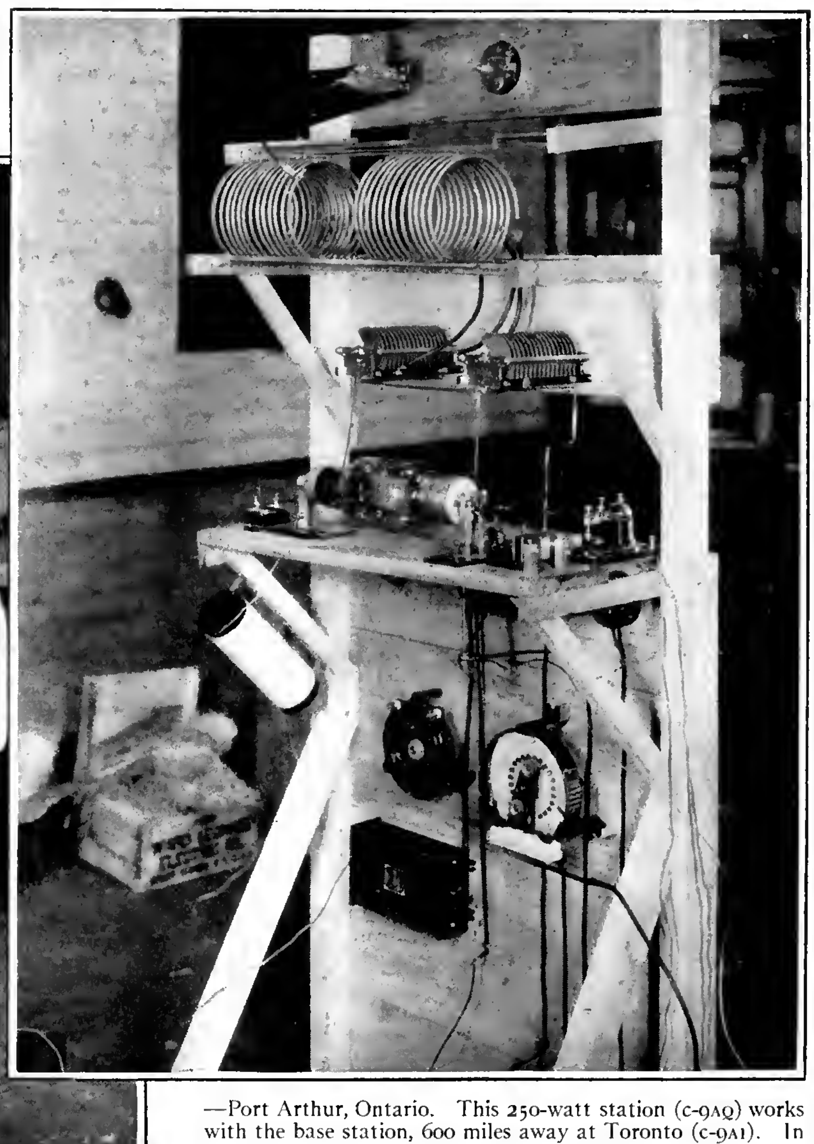
Why Not Hoover as Czar of Radio?

SENATOR DILL, the legislative champion of radio, has announced a change of attitude with respect to the administration of the forthcoming radio law. For a long time, Senator Dill has favored regulation by the Department of Commerce, but he has recently turned in favor of commission rule, a sort of "inter-

SHORT-WAVE STATIONS FOR COMMERCIAL USES IN CANADA

The transmitting panel, front and rear view, of the Cameron Falls station of the Ontario Hydroelectric Commission, near—





—Port Arthur, Ontario. This 250-watt station (C-9AQ) works with the base station, 600 miles away at Toronto (C-9AI). In daytime a frequency of 10,000 kc. (29.94 meters) is used and at night 5996 kc. (50 meters). The Cameron Falls power station supplies the twin cities of Fort William and Port Arthur with electric power state commerce commission" for radio, members of which are to be appointed by the President.

It seems unfortunate that Senator Dill has been convinced of the desirability of this proposal. It should aid him materially, however, in getting his bill passed, because a commission with a good number of appointive ten-thousand-dollar jobs is always popular with congressmen and senators in case of reverses at the polls.

Radio is not of sufficient importance to warrant so dignified and pretentious a commission. If it were to consist of real experts, devoted entirely to the good of radio, with fitness to membership determined by a life long study and interest in radio, it might be better than a political group. Even so, ten real experts would do nothing but argue their heads off.

Radio is not sufficiently important nor are its problems so complex that such a magnificent body must be set up to regulate it. One good fifty-thousand-dollar-a-year executive, having the respect of the industry, could clean up radio's troubles by six weeks of hard work. It is too bad that Secretary Hoover has, or is supposed to have, presidential ambitions, because he would be ideal for the job. In fact, the industry could make it a hundred thousand dollars a year for him and profit thereby. Incidentally, Mr. Hoover, it would be a life job, paying more than the presidency and not be nearly so wearing.

In the meanwhile, where is this radio industry which is so boastful of its powers of self-regulation? Its peerless leaders are still busy passing mere resolutions.

AT THE LOS ANGELES RADIO SHOW

Radiola Hall, one of the exhibits. The Radio Corporation of America, among many other exhibitors, had an attractive display, which helped to make the exposition one of the largest and most interesting of any radio show held on the West Coast

The Dempsey-Tunney Fight —A Dangerous Precedent

THE precedent set by the Royal Typewriter Company in purchasing the broadcasting rights to the Dempsey-Tunney fight at a cost said to be $35,000, including the expense of broadcasting, is one with dangerous consequences. The payment of large fees for the broadcasting of sporting events, which themselves profit by broadcasting, is both unfair and unwarranted.

The prosperity of boxing has been tremendously helped by the impetus which radio has given it and that it should levy a fee upon those who performed this service for it is ingratitude. If this attitude becomes general, the public may expect to be deprived of events sponsored by selfish and shortsighted interests. Presenting the Dempsey-Tunney fight was an excellent stroke for the Royal Typewriter Company, but a rather poor one for broadcasting. If the radio audience had been deprived of the fight because no one had been willing to pay this excessive sum, Mr. Rickard might have lost all the good will he has gained through the broadcasting of previous fights.

Where Short Waves Are Not Needed

THE American Railway Association has announced an experiment in the use of short-wave radio telephony between locomotive cab and caboose on long freight trains. The usual vagaries of short-wave reception were encountered, absorption in the vicinity of steel bridges being especially severe.

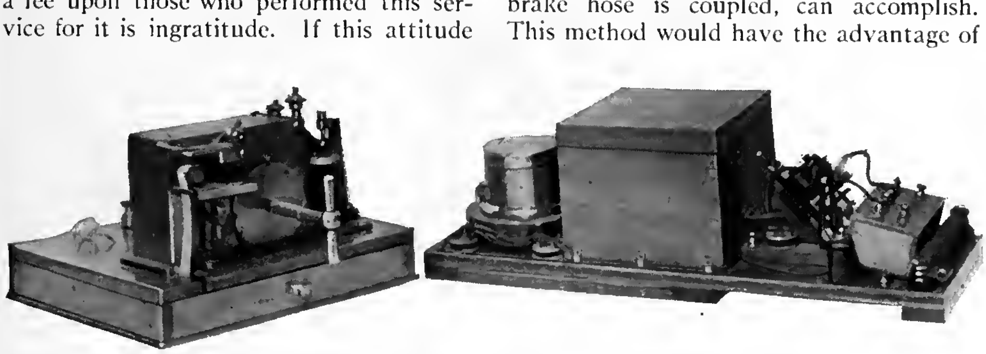
In view of the growing ether congestion, it is unfortunate that radio is being considered for a purpose which a wire line, coupled by plugs from car to car as air brake hose is coupled, can accomplish. This method would have the advantage of enabling the conductor to cut in the line at any car. A break in the car to car chain could actuate an automatic signal, warning the engineer that the cars had uncoupled. At the same time, the wire system would not clutter the ether with radio communication as suitably carried by wire.

The Progress of Radio In Russia

THE Russian Information Service announces some news of the state of radio communication which shows that country is not as backward as we might have supposed. More than a million radio fans in the Soviet Union listen-in on the programs of the government stations every day, it is claimed. Village libraries in four hundred villages of the Moscow and Leningrad provinces have been equipped with powerful receiving sets and loud speakers, while three hundred workers' clubs in the two cities have been similarly fitted out. The big transmitting stations at Moscow and Leningrad are wired to all the principal theaters, concert and lecture halls, and public meeting places.

When the radio amateur in the Soviet Union wants to hear a bit of foreign transmission by way of variety he tunes-in on one of the big stations in Germany, England, or Denmark and occasionally he can receive from Paris.

In addition to the stations in Moscow and Leningrad, powerful transmitters are now operating at Kharkov, Ivanovo, Bogorodsk, Kiev, Nijni Novgorod, Minsk, Voronesh, Tiflis, Baku, and other cities in the Soviet.



ONE OF MARCONI'S EARLIEST RECEIVING SETS

The outfit used by Marconi when he obtained the first signal ever transmitted across the Atlantic. This set, together with other historical equipment, is on display at Marconi House, London. The twenty-fifth anniversary of this remarkable achievement occurs in December of this year

Radio shows are attracting unprecedented audiences, auguring a most successful season. There were 250,000 at the New York show and 100,000 at Los Angeles.

Radio Events in Foreign Lands

THE broadcasting interference tangle which has hampered European broadcasting has been solved by a committee of experts. The American standard of ten kilocycles separation has been adopted and the 99 channels available have been divided into two groups, 83 exclusive and 16 non-exclusive channels. Of the exclusive channels, Germany receives 12, Great Britain and France 9, Western Russia, Italy, Spain and Sweden 5, Czecho-Slovakia and Norway 3, and the remaining countries one or two each. The 16 non-exclusive wavelengths must accommodate 116 stations approximately an average of 7 per common channel. This scheme is quite similar to the suggestions made in the October "March of Radio" for American allocations.

A BROADCASTING station with a maximum power of 9 kilowatts has recently begun operation on a wavelength of 452 meters in Leipsic, Germany. 121,423 listeners are paying monthly fees for the use of their radio receivers, indicating approximately one receiving set for every family in that city.

THE Greek government has prohibited the use of receiving sets tuning to more than two thousand meters. One of the best ways to win listeners on a particular wavelength is to pass a law against listening-in on it.

THE RUSSIAN government, according to a New York *Times* correspondent, has animated a radio war between that country and Rumania by broadcasting revolutionary propaganda on wavelengths assigned to Rumanian stations. By this policy, the Soviet government is demonstrating its total unfitness to regulate radio and, by inference, anything else.

AN UNKNOWN station disturbed the peace of mind of Mexican officials recently by broadcasting anti-government propaganda in the Federal District. The only place that station was easy to find was on the dial of receiving sets.

THE French police are using radio to broadcast, by means of Bélinograph transmitters, fingerprints of wanted persons and criminals. Other countries are planning to join in this effort which will make the job of the international crook somewhat more hazardous.

PRESIDENT DOUMERGUE, vacationing at Rambouillet, spent much of his time with head phones, chasing long distance radio rainbows. According to the dispatches, he has been thoroughly captivated by the radio enthusiasm. His record reception is KDKA, Pittsburgh, "once faintly." If only he knew a few American radio liars! "KDKA? Any time I want it, and on the loud speaker too!"

MR. ALBERT G. LINSIG, foreign representative of the Freed-Eisemann Radio Corporation, estimates that there are 250,000 radio sets in Argentine, 40,000 to 50,000 in Chile, 60,000 in Brazil, 12,000 in Peru, 10,000 to 15,000 in Uruguay, and 5,000 in Ecuador. In Paraguay, Bolivia, and Venezuela, there are only very few, owing to the stringent governmental restrictions imposed.

The Month In Radio

A BULLETIN issued by the Department of Commerce estimates the value of radio equipment exports from the United States during 1925 at ten million dollars, an increase of 18 per cent. over 1924 and ten times the figure for 1921. The report points out that the United States is the only important country in the world where no tax is levied upon the radio fan. Fees range from the nominal sum of one franc per year collected by France to $18 in Salvador and $13 in Lithuania. Apparently the scale is inversely proportional to the desirability of listening to broadcasting. The British fee is two shillings, Sweden $2.70, Japan $.80, South Africa $1.25.

CANADA was our leading market for radio in 1925, absorbing $3,682,980 worth, or 27 per cent. of our total exports, Asia second, Europe third, and Latin America fourth.

IN A statement following closely upon the announcement of the National Broadcasting Company, Mr. M. H. Aylesworth, its president, stated that the programs broadcast by the company through the WEAF and Radio Corporation networks would also be available to other broadcasting stations throughout the country so far as it is practicable.

THE Department of Agriculture announces that more than a quarter of a million farmers have enrolled in its radio farm courses, in which a score or more of broadcasting stations will coöperate. Twenty-four short courses of eight lessons each are being presented before the microphone. An hour for housekeepers has also been arranged, as well as dramatized versions of informative talks given last year.

A sample of the improved radio showmanship being employed is in the manner in which current farm problems will be discussed. Instead of lectures or discourses, the new method is to have two speakers, one a typical farm county agent and the other a representative farmer who asks questions of the former. The Monday program will be devoted to livestock; Tuesday to crops; Wednesday to poultry; Thursday fruits and vegetables, and Friday dairying.

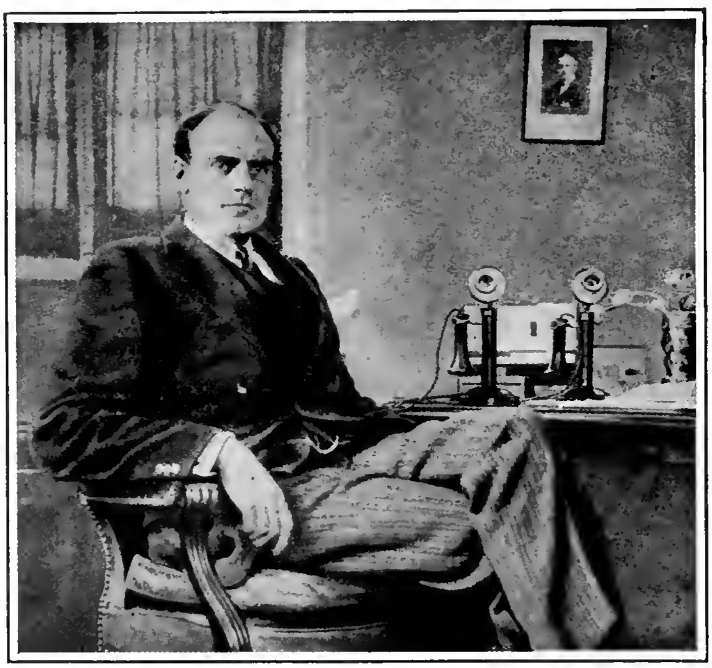
The improved method of presentation will greatly increase the service value of the Home Department of Agriculture radio efforts. Our congratulations to Mr. Sam Pickard, director of the Department's radio activities.

THE schedule of frequencies assigned to the General Electric Company for experimental work in high frequencies is as follows: 2XAW 100,000 to 15,000 kilocycles (3 to 20 meters); 2 XO, 2 XAF and 2 XAD, 30,000 to 6000 kilocycles (10 to 50 meters); 2 XH, 2 XK and 2 XAC, 6000 to 2000 kilocycles (50 to 150 meters); 2 XAK, 2 XAZ, 3000 to 1500 kilocycles (100 to 200 meters); 2 XAG (50 kilowatts) 790 kilocycles (379.5 meters); 2 XAH, 300 to 75 kilocycles (1000 to 4000 meters); 2 XI, general experimental license; 2 XAM, 2 XAE, 2710 kilocycles (110 meters); and WGY, 379.5 meters. 2 XAF is now operating on 9150 kilocycles (32.77 meters) and has furnished programs for re-broadcasting throughout the British Broadcasting chain on one or two occasions, as well as to the Johannesburg, South Africa, station on one occasion.

THE Navy Department is contributing to the encouragement of commercial aviation by extending the service of its radio compass stations. It will soon be equipped to furnish bearings to aircraft in the same manner that they are now furnished to ships at sea. Compass stations along the coast are now calibrated for seaward service only and it will be necessary to calibrate them landward as well.

BY THE merger of the Electric Power Club, the Associated Manufacturers of Electric Supplies, and the Electric Manufacturers Council, there was formed the National Electric Manufacturers Association, comprising the 270 leading electrical manufacturers of the country. Included are the General Electric Company, the National Carbon Company, the Radio Corporation of America, the Stromberg-Carlson Telephone Company, the Western Electric Company and the Westinghouse Electric & Manufacturing Company. The president of the organization is Gerard Swope, President of the General Electric Company. Unquestionably this body will wield great influence in the electric industry and its recommendations in legislative matters, including those affecting radio, will doubtless be considered by our legislators with a sensitive ear.

THE largest tube transmitter now operating is the recent 80-kilowatt installation of the Navy Department at San Diego, California.



J. C. W. REITH

Managing director of the British Broadcasting Company, the only organization allowed to broadcast in Great Britain. A portion of the government license fee, required of every receiving set owner, is turned over to the B. B. C. for maintenance of its service. This illustration is reproduced from the *Wireless World*, London. It is probable that Mr. Reith will hold an official position in the new British Broadcasting Corporation, Government controlled, which will probably come into existence on January 1st, 1927

C. W. HORN

Pittsburgh

Superintendent of Radio Operations, Westinghouse Electric and Manufacturing Company:

"Radio, being something new and fantastic, is highly overrated, and dealers and listeners alike must stop exaggerating the truth if the industry is to be stabilized. People expect too much. They have been misguided by false statements and false advertisements and subsequently when they go to buy a radio receiver they expect it to bring in everything from here to Bagdad. Prospective listeners might as well learn now and take heed to the fact that reception with any set depends very largely on the weather. Some sets are more sensitive and selective than others, but even the best of them cannot penetrate atmospheric disturbances which have not been solved by man, and may not be. A slight change in wind direction, coupled with a few other weather freaks, sometimes makes it impossible for, say, Pittsburgh listeners to receive Cleveland even when other stations miles and miles farther away are booming in. It is a mystery. There is no need of any one, dealer or listener, bluffing or exaggerating the merits of radio, because radio itself is a wonderful thing and any broad-minded person in time will come to realize that, regardless of how prejudiced he might be against radio now."

This replaces the arc set formerly installed at that point. A six-phase vacuum tube rectifier furnishes $7\frac{1}{2}$ amperes of plate current at 15,000 volts. Only a few years ago, half a dozen flashlight cells, laboriously soldered in series, met the need for the largest plate current requirements then known to the radio art.

A RESOLUTION adopted by the Northwest Radio Trade Association with regard to legislation suggests that the new law shall delegate to the power controlling radio

"the authority to issue and revoke licenses, to refuse to issue licenses whenever it appears that the public interest is best served by such refusal"

and also that "the holding of a license prior to the passage of a law shall not constitute a fixed right to it," thus permitting the cancellation of existing licenses. This comes somewhat nearer to the point than some of the asinine resolutions adopted by other trade organizations to the effect that there is no radio emergency.

A SURVEY conducted by the Detroit *News* classifies 290 outlets handling radio in that city as follows: hardware 50, music 44, furniture 32, auto accessories 30, exclusive radio 14, the remaining being divided up among department stores, drug stores, sporting goods stores, etc. It seems unusual that hardware stores should lead the list. Electric stores have the ascendency in most cities.

THE official *Gazette* of the patent office lists a suit brought by the Westinghouse Electric & Manufacturing Company against the Crosley Radio Corporation, citing E. H. Armstrong's patent No. 1,113,149.

Interesting Things Said Interestingly

PAUL B. KLUGH (Executive Chairman, National Association of Broadcasters. In the New York *Times*): "Can the Government reverse age-old fundamental laws and assume control of the channels above and below a man's property in order to regulate radio, when heretofore they have been man's inalienable right to control? And what about priority and vested rights? How can the owner of a broadcasting station establish a vested right to a channel of transmission which transgresses the rights of every property owner in every direction so far as the waves of his station are propagated? Yet, on the other hand, how can he be denied such right when, after years of effort and thousands of dollars' expenditure, that station owner by use of a certain transmission channel establishes a public service which public opinion stamps as essential?"

LLOYD K. GRENLIE and GEORGE H. JAMES (Radio Operators of the Byrd Polar Expedition, in the New York *Times*): "Amateur stations in New Zealand and a naval vessel off the coast of Chile reported remarkably steady signals even when the ship was rolling and pitching badly. When using other than the main antenna and ship's ground, reports of 40-meter reception were not so good, because swinging and fading signals were experienced by the receiving operators. There was one night in particular when the operator on watch had extreme difficulty staying with the receiver and the transmitting key due to rolling and pitching of the ship. The operator was experimenting with an American amateur station and was transmitting while the ship was rolling badly. The receiving operator said that it was remarkable how steady the signals were."

DR. J. H. DELLINGER (Chief of the Radio Laboratory of the Bureau of Standards. In a statement to the press): "The sun spot cycle is of eleven years, that is, there is a minimum of spots on the sun for a period of time after which they gradually increase and pass through a maximum and return to a minimum, the whole occupying a cycle of 11 years. The last sun spot minimum was in 1922 and it would be inferred, therefore, that radio reception was at its best in 1922, should be progressively worse from 1922 to about 1928, and that, in succeeding years, reception conditions should improve and be at their best again in 1933. It will be interesting to see whether this occurs and whether future observations on sun spots will show a closer correlation with radio reception conditions."

© Bachrach

ORRIN E. DUNLAP, JR.

New York

Radio Editor, the New York *Times:*

"Radio to-day is comparable to a football game—anything may happen at any time. Some research engineer, or an amateur experimenter, of whom there are thousands, may, without warning, plunge through the barriers of science any day with some radical discovery. Nothing of such an exciting nature has happened in radio for several years. Progress since 1922 might be compared with line plunges, resulting in constant gains toward the goal of perfection, but no long runs. It is a question just what this inventor, who skirts the end and evades the tackles Nature places in his path, will place behind the goal posts of achievement, but it is likely to be a revolutionary discovery based upon short wavelengths, a vacuum tube that will do the same work that eight, or nine, tubes can perform to-day, a practical televisor, a radio motion picture system, or possibly a static eliminator. It is still problematical whether or not broadcasting will be shifted from the present wave band channels to those higher than 3750 kc. (below 80 meters). However, if some laboratory is developing a Red Grange for the ether, a discovery may come which will warrant the change. The coming year may witness the beginning of a startling shift play."

CARDINAL DUBOIS, of Paris (interviewed at the Eucharistic Congress): "Radio broadcasting and telephony is a marvelous invention, which attests, perhaps more than all others, the powerful ingeniousness of human intelligence. . . . But, like all other material progress, this one too can serve as well both good or evil. The centers from which these mysterious waves go forth are, at will, foyers of either truth or error, virtue or corruption, moral relaxation or wrongful pleasure. They can, across the continents, do the work of life or death, serve noble causes, or collaborate powerfully with social disorder—mislead the spirit and corrupt the heart."

How a Low Barometer Affects Radio

An Interesting Comparison Between Radio Reception in 1925 and 1926—A Theory Suggesting Why Radio Reception Was Poor From December of Last Year On—The Home Observer Needs a Daily Weather Map and a Receiving Set for His Equipment

By EUGENE VAN CLEEF

Ohio State University

MANY radio listeners who have long been accustomed to many nights with good reception, wondered whether their sets suddenly depreciated during January, February and March and later months of this year. In some instances they requested dealers to refund their money and in other cases tinkered with their sets "either for better or for worse"—often for worse. While complaints of poor reception have been lodged against stations located east of the Rockies and north of the Ohio River, the same listeners have found some consolation in good reception from broadcasting stations located in the south half of the country.

No one knows just why receiving conditions have been so peculiar; but we are convinced that whatever the cause, neither the sets nor the broadcasters can be held responsible. It seems more than likely that our old friend "Weather" must bear the brunt of the blame, although the weather itself probably is the consequence of the vagaries of solar radiation. However, until we have established the exact relation between variation in the atmospheric circulation and the sun's heat, it may be helpful in the final solution of the problem if we succeed in definitely correlating static and atmospheric conditions. We shall therefore first present a theory in explanation of the relation between static formation and the atmospheric circulation, and follow with its application to the unusual conditions during the past winter.

In RADIO BROADCAST for May, 1925, ten points were presented in an article entitled "Do Weather Conditions Influence Radio?" to indicate what atmospheric phenomena affect radio reception as determined by the writer up to that time. To these points an eleventh is now added, which in some respects was implied by the original ten. The new point reads as follows:

11.—Reception is accompanied by static when transmission crosses any part of a warm humid Low or when transmission crosses an area adjacent to an intensely developed humid Low whose surface temperatures are above the freezing point. If the precipitation throughout the Low is rain, static will be pronounced, while if snow or ice, little or no static will occur.

MUCH interest has been aroused by the series of articles published by RADIO BROADCAST *on how weather conditions affect radio receiving. The first article to appear in any national radio magazine was that from the pen of Mr. Van Cleef and it appeared in the May, 1925,* RADIO BROADCAST. *Since that time, we have printed others and the subject has been very generally taken up and discussed. The present article is not an exhaustive examination of a rather large subject. The author tries to show how a positive condition of the weather, attested by the records, may have had some connection with radio reception. The ten points laid down by Mr. Van Cleef appear on another page, together with the eleventh which he adds with this article. Mr. Van Cleef is not primarily a radio man, but he brings to radio an specialized knowledge of meteorology which is of great value and lends authority to what he has to say.*

—THE EDITOR.

THUNDERSTORMS NOT ESSENTIAL TO STATIC

THE new point implies that if a Low is dry and either warm or cold, or if it is wet and cold, reception across it may be good, although as indicated in point 4 in the series above referred to, transmission across Lows tends to be weaker than across Highs. This statement differs from those of other investigators who have recognized Lows as static breeders, in that thunderstorms are not set up as a requisite for static formation. In an unsigned article in *Tycos-Rochester* for January, 1926, a similar theory is expressed but its author seems to require precipitation, moderately high temperatures and preferably thunderstorms. Point 11 does not include thunderstorms as essential to static development. On the other hand one must not infer that local rains will produce static in sufficiently large quantities to affect radio reception. Precipitation in a Low, so far as it affects transmission or reception must be interpreted in terms of the pressure area as a *unit* and not as a local phenomenon. Still further, we should note that our point does not even require *precipitation* for static building. This will be explained later.

STATIC ELECTRICITY AND CONVECTION

MOST meteorologists are agreed that the electrical charges formed in the upper air are the result of convection and consequent condensation of moisture into over-sized drops which are torn asunder when they encounter the strong up-draft of air from the earth. The disruptive action produces positive and negative ions, positive charges collecting upon the larger drop-fragments and negative charges on the smaller drops. The fine negatively charged particles are carried back into the clouds or even above them, while the large positively charged drops may continue to the earth as rain or they may be carried back to the cloud to form a positive cloud base as opposed to a negative cloud top. It is not essential that the condensed water vapor reach the earth in order that electrical charges be formed. In other words, precipitation, as stated above, as far as the earth's surface is concerned, is not a requirement to static building. When temperatures are such as to condense the water vapor into snow crystals, the same method of potential building applies as to raindrops, but because convection at low temperatures usually is weaker than at high temperatures, and since the flakes offer slight resistance to the air, the breaking up of the snow crystals is not a vigorous process and therefore an inconsequential accumulation of electrical charges takes place.

We must recognize in all this development of a large difference in potential between the earth and the upper atmosphere, that a state of equilibrium exists normally and that the mechanical action of the Low merely induces an excess of charges which we interpret as static electricity

THE WEATHER IN 1925 AND 1926 COMPARED

A COMPARISON of the weather maps for January, February, and March of 1926 with those of the corresponding period of 1925, reveals certain differences among the Lows and Highs which, in the light of the above discussion, will account for the differences in reception.

A—The number of warm humid Lows, that is, areas with much precipitation at temperatures above freezing at the earth's surface, showed a 15 per cent. increase for 1926* over those for 1925. (*Reference to 1926 or 1925 hereafter will mean only the months of January to March inclusive and not the whole year.)

B—The number of Lows in which precipitation was general throughout the area was 32 per cent. greater than in 1925.

C—In the region east of the Rockies, the Lows in 1926 were more intensely developed than in 1925 and the pressure at their centers was, on the average, lower. The number of Lows in 1926 whose pressure was 29.6 inches or below, exceeded that of 1925 by 50 per cent.

The excess of 15 per cent. of warm humid Lows, on the basis of the theory advanced under point 11, favors an increase in the frequency of static formation by the same percentage. This frequency alone, if distributed evenly over the three-month period would mean a reduction of good reception amounting to one day per week, less than normal. If to this be added the effect of an increase in all wet Lows—point B, represented by the difference between 32 per cent. and 15 per cent. or 17 per cent., then there is the possibility of an additional day per week of poor reception. Conservatively, we may reduce the effectiveness of the latter factor to one-half day per week.

The fact that there were 50 per cent. more Lows in 1926 than in 1925 whose pressures were below 29.6 inches at their centers, points to further unsatisfactory atmospheric conditions in the former than in the latter year, for, the more violent the convection, the more favorable the opportunity for the accumulation of electrical charges. Strong convection tends to increase the number and thickness of clouds, and, the stronger the updraft of air into these cloud bases, the more readily will the large globules of water in them be disrupted. Alarge number of positive and negative charges will concentrate in the cloud layer and play havoc with radio reception.

As previously stated, many listeners have the impression that thunderstorms are basic to the formation of static. Within certain limits this conception is correct, yet a comparison of thunderstorm frequency in 1925 and 1926, brings to light an important exception. In 1925 there were 18 per cent. more days than in 1926, when thunderstorms occurred. If these storms alone were an index of static, then reception in 1925 should have been worse than in 1926, but just the converse was true. The thunderstorm which we recognize by the flash of lightning or the peal of thunder, is only an indicator of the fact that electrical charges have grouped themselves in a position favorable for a discharge. Lightning as a manifestation of a discharge is not a *cause* of static electricity; rather it is a sign of the return of the atmosphere to a state of electrical equilibrium. Equilibrium may be maintained quite as well by numerous small discharges, both invisible and inaudible, and not classifiable as thunderstorms in the popular sense, nor for that matter, as construed by meteorologists. It seems more than likely, that the Lows of the past winter were of the small discharge type and for this reason created trouble for us. There is no reason to suppose that numerous diminutive discharges may not be as effective as a few large discharges. The more intense Lows of 1926 were highly favorable for the development of small discharges and for the building up therefore of a substantial difference in potential between the upper atmosphere and the earth's surface. The total adverse effect, measured in days of poor reception, is difficult to determine so far as this phase is concerned. Perhaps a half day per week would not be an exaggeration.

SECTIONAL RECEIVING CONDITIONS

THE effect of all the factors cited above as contributors to the difficulties experienced in reception during 1926, totals at least 2 days per week. In a week of 7 days, during which good reception normally might be anticipated 50 per cent. of the time or about 4 days, an incursion of 2 days of bad reception is certainly sufficient to cause consternation among the listeners. Radio reception reduced to two nights per week and sometimes to one night, is not particularly attractive.

In the first part of this discussion, reference was made to the poor reception in the northern and eastern part of the country with respect to the programs broadcast from within the territory. This is exactly what might have been expected, had we known in advance what the paths of the Lows and their frequency of succession would be. The weather maps of the period under consideration show that the number of days of low pressure along the Atlantic seaboard, either over the land or immediately offshore, was 23 per cent. greater in 1926 than in 1925. In other words, the succession of days with low pressure along the Atlantic coast was, in 1926, far in excess of that during 1925. Here again is reason for disturbed reception. Since low pressure favors static building, and since the static influence may be felt upward of 1000 miles and even 1500 miles from a Low, it follows that the greater the number of days a Low lingers near our station either *en route* toward it or passing beyond it, the more likely are we to experience trouble.

Why should reception from Southern stations have been relatively good during the breakdown in the North? The answer may be found in the set of conditions just described. While the pressure distribution in the North favored an excess of Lows it likewise contributed to the maintenance of high pressure in the Gulf Region. High pressure opposes the formation of static producing conditions. In Highs, moisture is evaporated by a descending current of air and carried along the earth's surface toward a Low. In place of condensation and cloud building we have evaporation and cloud dissipation. The weather maps of 1926 are impressive for the persistance of high pressure in the south. Hence we should logically expect favorable transmitting and receiving conditions.

The above is offered only as a suggestion of what may have happened and not with the idea that it possesses finality. Since discussion often makes for progress, it is hoped that the writer's theory may serve to stimulate others to further research along similar lines which may lead to a solution of this perplexing but fascinating problem.

How to Forecast Radio Receiving Conditions

THE list of points below, originally set forth by Mr. Van Cleef in his May, 1925, article in RADIO BROADCAST, show the bases on which he calculates radio receiving conditions. Although other investigators do not grant that these points are final, and dispute some of them, at least they serve a very useful purpose in giving something to the amateur investigator to work with. Many of these points are referred to in the accompanying article.

1. If a line connecting the receiving station with the broadcasting station crosses the intervening isobars at right angles, reception is at its best.
2. The steeper the isobaric gradient (that is, the closer the isobars to each other) the stronger the reception.
3. The more nearly the transmitted waves approach parellelism with the isobars, the weaker the reception. Under these conditions, fading occurs.
4. Reception in a Low pressure area tends to be somewhat weaker than in a High of corresponding intensity.
5. Reception is weaker when the transmitted waves cross from one pressure area into another than when they travel only within one area.
6. The strength of reception for any station is a factor of both its location within a pressure area and its position with respect to the broadcasting station.
7. "Bad weather" does not affect reception, excepting as it may be the index of an unfavorable pressure distribution.
8. Reception can be as good in "bad weather" as in good weather if the pressure distribution is right.
9. Temperature does not influence reception, excepting as it may be the index of pressure distribution as follows:—
   (a) Reception is better in winter than in summer because the cyclones and anti-cyclones are more intense in the winter period.
   (b) Reception is better when temperatures are low than when high, because low temperatures usually indicate intensive High pressure areas, that is, areas with steep isobaric gradients.
   (c) Low temperatures accompanying poorly defined High pressure areas make reception poor.
10. Shallow or flat pressure areas result in much static-noise in the receiver.
11. Reception is accompanied by static when transmission crosses any part of a warm humid low, or when transmission crosses an area adjacent to an intensely developed humid Low whose surface temperatures are above the freezing point.
    If the preciptation throughout the Low is in the form of rain, static will be pronounced, while if snow or ice, little static will occur.

(An "isobar" is a line which passes through all points whose barometric pressure is the same.)

The author's remarks in this article should not lead one to think that the presence of static is a sign of poor reception. Poor reception may obtain without a trace of static. But Mr. Van Cleef says that if the signals go through a low pressure area, there will be static. During the winter months of this year, reception has not been good in the United States and conditions have been marked by a general diminution of field strength, due to causes as yet positively undetermined.

The New "Universal" Receiver

How the Popular "Universal" Receiver May Be Re-Wired to Include Many New Features—Capacity Controlled Regeneration Permits Smoother Control and Better Quality—Roberts Neutralization System Replaces Rice's—Provision Is Made for Power Amplifier, to Be Described

RADIO BROADCAST Photograph

THE "UNIVERSAL" IN A CABINET

Made by the Corbett Cabinet Company. This is the final result of several months of experimenting in RADIO BROADCAST Laboratory. The Trimm cone speaker is of the free edge type

By HOWARD E. RHODES

UNIVERSAL, many readers will recall, was the name of a receiver described in the January, 1926, issue of RADIO BROADCAST. This name is taken again for the receiver described in this article, not so much because of a resemblance between the two circuits, but rather because many of the same parts are used, which makes it possible to easily change over the old "Universal" into a set identical with the one described herein.

This is the first of two articles, and it will cover the construction of the receiver. The second article, to follow very soon, describes a power amplifier working directly from the a.c. mains. This power amplifier uses a full-wave rectifier to supply plate and grid voltages for the 171 tube which is an integral part of the unit. The filament of the 171 is lighted by raw a.c. The amplifier unit will also supply B-battery voltages for the operation of the receiver.

The receiver illustrated in this article, combined with the power amplifier, will make an excellent all around outfit. All of the power, with the exception of the filament current for the receiver, will be drawn directly from the power mains, and if the storage battery is operated in conjunction with a trickle charger, the set-up will be almost ideal from the operating standpoint, since it will require practically no attention.

It will of course be possible to change over one of the old style "Universal" receivers so as to make it conform with the circuit diagram of the new model by merely rewiring the old set and replacing whatever parts are necessary. However, this is hardly to be recommended, since the receiver will not be as stable in operation as it will be if the parts are relocated in accordance with the diagrams accompanying this article. While a great many home constructors obtained very good results from the original model, there were some who found it difficult to satisfactorily neutralize the radio-frequency amplifier and, consequently, in these cases, the operation of the receiver was somewhat unstable so that the point of highest efficiency could not be obtained. This later model has been designed to give perfectly stable operation. The r.f. amplifier, using Roberts neutralization, is very easy to neutralize, and the control of regeneration by means of a variable condenser evidently gives smoother operation than can be obtained using a resistance across the tickler coil. The circuit diagram of the original "Universal" model is given in Fig. 2, while Fig. 1 is a diagram of the receiver described in this article. Any one desiring to revise his receiver will find it necessary to purchase the following parts:

1 Samson Choke Coil, Type 125.
1 General Radio Midget Condenser, type 368.
1 Yaxley Double-Circuit Jack.

The Facts About This Receiver

Name of Receiver	New "Universal" Receiver.
Type of Circuit	Tuned radio frequency with regeneration in the detector circuit.
Number of Tubes	Four: 201-A in the r. f. stage, 201-A or 200-A in the detector circuit, 201-A in the first audio stage, and a 112 or 171 in the last stage.

This receiver is a revised model of the "Universal" which was originally published in the January, 1926, issue of RADIO BROADCAST. This later model uses Roberts neutralization, condenser control of regeneration, and a two-stage transformer-coupled audio frequency amplifier. The original "Universal" is easily changed over to conform with this new model.

The rheostats used on the old model can be used in place of the fixed filament control resistances specified for the new model. It would hardly be worth while to purchase filament resistances when those rheostats already in the original receiver will do the job just as well. One rheostat should control the radio frequency tube and will act as a volume control, while the other rheostat should control the other three tubes. All of the parts used in the old model, such as coils, condensers, transformers, etc., may be used in the new model with quite satisfactory results.

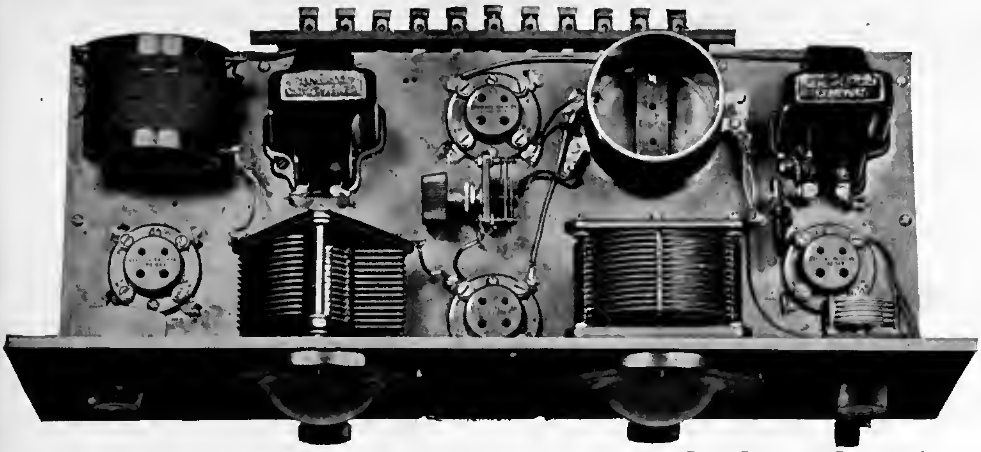
In the construction of this receiver it was kept in mind that the final model must have the following qualifications: First, sufficient selectivity to satisfactorily discriminate between the various broadcasting stations; secondly, an r.f. amplifier capable of being accurately neutralized, so as to completely prevent radiation; thirdly, a high quality audio output.

The circuit of this new "Universal" receiver, given in Fig. 1, consists of a regenerative detector preceded by a neutralized radio frequency amplifier, and is capable of a high degree of selectivity sufficient for even the present-day congestion. The r.f. amplifier in this receiver is neutralized by the Roberts method, neutralization being practically complete over the entire broadcast band, so radiation cannot take place. It is thought by some that, provided a regenerative detector is preceded by an r.f. amplifier which does not self-oscillate, radiation will not take place. This is not so, however; a

RADIO BROADCAST Photograph

THE SYMMETRICAL LAYOUT

Of the front panel of the "Universal" gives a very pleasing effect. The center jack is connected in the first audio circuit and the left hand jack is for the loud speaker. The dials are made by the Kurz-Kasch Company



Radio Broadcast Photograph

LOOKING DOWN ON THE "UNIVERSAL"

The arrangement of parts as seen from the top. Notice how short are the leads that connect to the neutralizing condensers. Various arrangements of parts were tried before this final layout was decided upon

using the new General Radio type 285D transformers, which have an unusually high primary impedance—about 375,000 ohms at 1000 cycles. If this primary were to be shunted by a 0.001-mfd. condenser with an impedance of only 160,000 ohms at 1000 cycles, a large part of the audio currents would flow through the condenser instead of through the transformer primary. The shunting effect of a 0.001-mfd. bypass condenser is bad enough at 1000 cycles but is very much worse at higher frequencies. However, using a midget condenser for regeneration, no such shunting condenser is necessary. The midget condenser affects the circuit in the same way but, since its value is considerably less than 0.001 mfd., its effect is not as detrimental.

VOLUME CONTROL

THE volume control is a variable rheostat in the radio-frequency amplifier's filament circuit. It modulates the volume very satisfactorily and has practically no effect on the tuning.

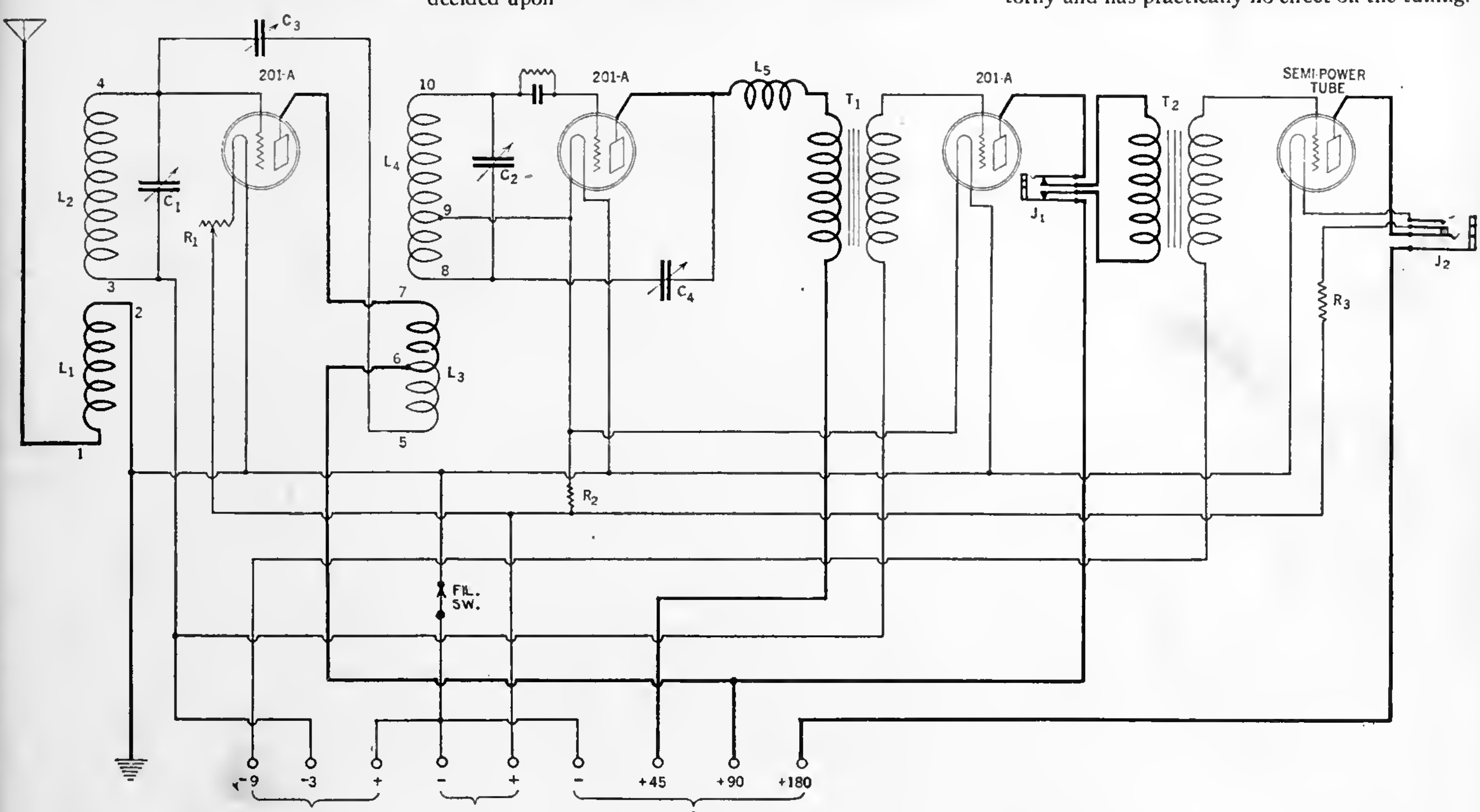


FIG. I

The circuit diagram of the new "Universal" receiver described in this article. This circuit differs somewhat from that formerly described in Radio Broadcast, as will be evident from a study of Fig. 2, but the parts used in the original model are practically the same as employed here

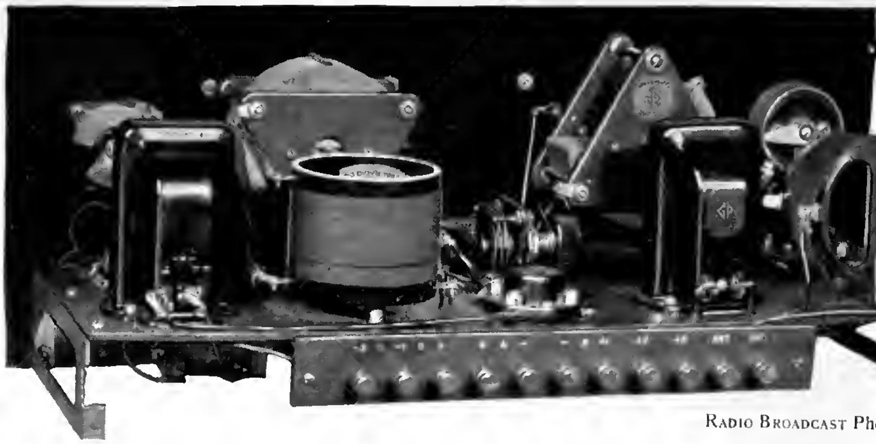
receiver will radiate unless the r.f. amplifier is neutralized. The bridge circuit in a neutralized amplifier prevents the flow of any currents in the grid inductance capable of inducing voltage in the antenna. On the other hand, an unneutralized amplifier may not break into self-oscillation, but it is still capable of allowing currents to flow in the grid inductance that will cause radiation. The importance of a properly neutralized amplifier is quite evident.

Regeneration is controlled by a small variable condenser connecting between the detector plate and the end of the grid coil, in the usual manner. This method of feed-back has two advantages over the old-style movable tickler coil. In the first place the control is very much smoother and, secondly, it tends to somewhat better the quality, by lowering the value of shunt capacity across the first audio transformer. This is a significant point, and is especially important in this receiver,

Radio Broadcast Photograph

THE REAR VIEW

Of the "Universal" Receiver, showing the binding post strip and arrangement of the sub-panel brackets. The following B battery voltages should be applied to the terminals: + 1, 45 volts; + 2, 90 volts; + 3, 135 to 180 volts. The C battery voltages are; Minus 3 volts to terminal - 1 and minus $27\frac{1}{2}$ to $40\frac{1}{2}$ volts to terminal minus 2



Radio Broadcast Photograph

BEHIND THE PANEL

Another view of the "Universal," showing the arrangement of parts as seen from the rear

It is not always possible to use only the regeneration condenser for volume control since it may sometimes be necessary to boost regeneration considerably to obtain sufficient selectivity, and the volume made greater than is desired. In this case it can then be reduced by varying the filament rheostat, still retaining a high degree of selectivity.

The dials used are the product of the Kurz-Kasch Company. They are especially suited to the "Universal" since they are made completely of bakelite. If a metal dial were to be used, there would be noticeable hand capacity when tuning the second condenser, but using a solid bakelite dial, there is no hand capacity at all. The dials are of the vernier type with a friction drive.

There is nothing unusual about the audio amplifier. Both of the transformers are the new General Radio type 285D. A jack is provided in the output of the first stage. When the switch is turned on, only the first three tubes light. The last tube lights when the plug is placed in the second stage jack. If the receiver is to be operated in conjunction with the power amplifier unit later to be described, the plug is placed in the first stage jack since one stage of audio amplification is incorporated in the power amplifier. In fact, those home constructors who decide to make up both units can put together the receiver with only one stage of audio, entirely omitting the second stage.

In constructing the receiver illustrated in this article, the following parts were used:

1 Micarta Panel, $\frac{3}{16}$" x 7" x 18".
1 Hard Rubber Sub-Base, $\frac{3}{16}$" x 7" x 17".
2 Kurz-Kasch Dials—Clockwise.
2 Benjamin Brackets.
1 Yaxley Double-Circuit Jack.
1 Yaxley Single-Circuit Filament Control Jack.
1 Carter Switch.
1 Samson Choke Coil, Type 125.
1 Elkay Filament resistance, Type $\frac{4}{8}$.
1 Elkay Filament Resistance, Type 2.
1 Micamold Combined 4-megohm Grid Leak and Condenser.
Coils Celatsite Wire. One coil each of the following colors: Yellow, Red, Black, Green, and Brown.

And the following General Radio parts:

2 Type 277D Coils.
2 Midget Condensers, Type 368 and 368B.
4 Type 156 Sockets.
1 30-Ohm Rheostat.
2 Type 285D Audio Transformers.
1 Type 138A Binding Post Strip.

If it is desired to use home-made coils, they may be made up with the necessary taps in accordance with Fig. 4. If General Radio coils are purchased, it will be necessary to tap the interstage coil at the exact center of the primary winding, and also tap the secondary at the 15th turn from that end of the secondary nearest the primary. Both of these taps are made on the same coil unit. No taps at all are necessary in the coil employed ahead of the first tube.

PREPARATION FOR ASSEMBLY

WHEN the necessary parts have been collected together, the first thing to do is to drill the panel in accordance with Fig. 3. The mounting holes for the condensers have not been shown. Drilling templates are enclosed with the condensers when they are purchased, and it is very much easier to spot the holes using a template.

The next thing to do is to lay the sub-panel flat on the table and place the various parts on it. The location of these parts can easily be determined by reference to the top-view photograph on page 155 and to the picture diagram,

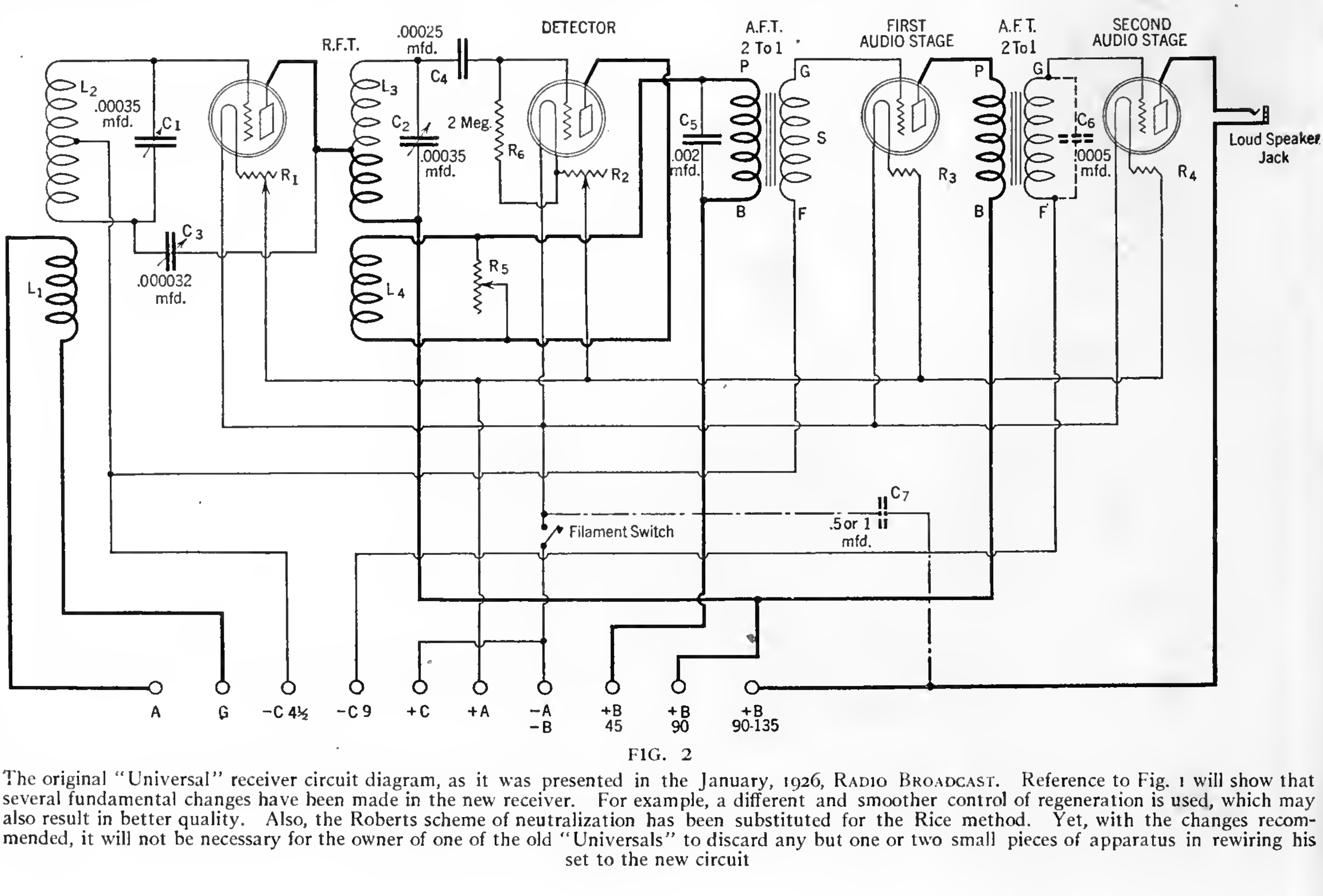


FIG. 2

The original "Universal" receiver circuit diagram, as it was presented in the January, 1926, Radio Broadcast. Reference to Fig. 1 will show that several fundamental changes have been made in the new receiver. For example, a different and smoother control of regeneration is used, which may also result in better quality. Also, the Roberts scheme of neutralization has been substituted for the Rice method. Yet, with the changes recommended, it will not be necessary for the owner of one of the old "Universals" to discard any but one or two small pieces of apparatus in rewiring his set to the new circuit

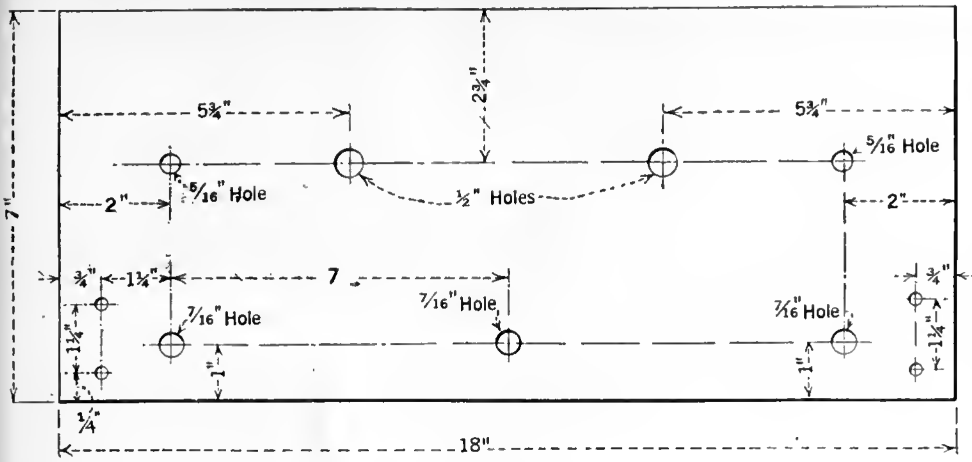


FIG. 3

The holes to be drilled on the front panel are here indicated. The condenser mounting holes are not shown. The drilling template supplied by the manufacturers will supply these data

Fig. 5. One of the coils can be placed vertically, raised off the sub-base by two small brass collars; the other is mounted by means of a small brass bracket. Both coils must be at exact right angles to each other. It is strongly recommended that the apparatus layout as shown, be strictly adhered to. It has been carefully thought out and, when used, results in very short leads in the important parts of the circuit. For instance, examine the picture diagram with reference to the various leads in the plate circuit of the radio frequency tube. Notice how the plate lead goes directly to the coil and how the lead from the other end of the coil passes to the conveniently located neutralizing condenser and hence to the grid. Neutralizing is at best a rather delicate job and an endeavor should always be made to make all the leads that have anything to do with it as short as possible. There are some fairly long audio leads, but they will not be bothersome in the least. These facts were all considered in laying out the parts and the arrangement shown is known to give good results.

The parts having been carefully placed, the various mounting holes are spotted with a prick punch. The parts are then removed and all of the holes drilled with a No. 28 drill. The supporting brackets should also be located and the holes drilled for the fastening screws. Don't forget to mount the binding post strip on two small right angles and spot two holes where it is to be mounted on the sub-base. Mount it far enough back from the sub-base so that when the set is put in a cabinet the strip will project through a slot cut on the back of the cabinet and be just even with the outer surface

The brackets and parts can then be screwed in place, but these former should not yet be fastened to the front panel. Before this is done, small holes should be drilled in the sub-base at various points so that leads can be brought up through them and soldered to the various terminals on the sockets and other parts. Practically all of the wiring is done under the sub-base so that a lot of exposed leads will not be visible from the top of the panel to detract from the final appearance of the receiver.

Now mount the various parts on the front panel and put the dials in place. In putting on the dials, take care to catch the little friction driving wheel under the dial proper before pushing the mounting screws of the cover into the holes in the panel. Now screw the brackets to the front panel and the first part of the job is done. Next we come to the wiring.

WIRING

IN THE wiring of the receiver we used the insulated flexible wire made by the Acme Wire Company and known as Celatsite. Flexible wiring has several advantages over bus-bar. In the first place, many persons will find it is easier to work with than bus-bar. An example

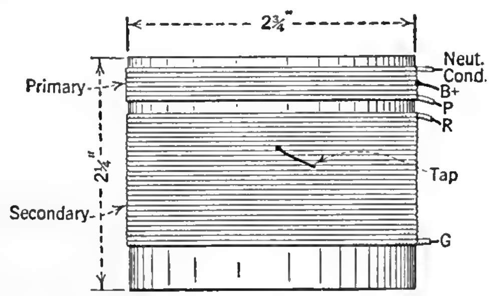


FIG. 4

The taps on a General Radio coil, for use between the r. f. and detector tubes, are indicated here. The secondary consists of 50 turns of d. s. c. No. 26 wire. The primary, spaced ⅛" away, contains a total of 13 turns of the same size wire The tap on the secondary connects to filament while that connection designated by the letter "R" goes to the regeneration condenser rotor plates.

of a good bus-bar job can be seen by referring to the photos in the September issue of the Browning-Drake receiver. But many fans who would find it difficult to do as good a job with bus-bar will be quite capable of doing a good job with flexible wire. In the second place, with flexible wire, it is possible to cable many of the battery leads. In this way the capacity between certain leads is increased, which is desirable. Also, when leads are twisted, the effect of alternating current flowing in one lead tends to neutralize the effect of current flowing in the other lead in the opposite direction. This helps to stabilize the receiver.

All of the battery leads should be twisted together into one cable; in fact, practically the only leads that cannot be cabled are those connected from the grids and plates of the various tubes to the different pieces of apparatus. In wiring, do not run any leads directly under or close to the neutralizing condenser which is fastened to the sub-panel by means of two small screws. The wiring should be arranged so as to keep all the leads at least one inch from this condenser. Flexible wiring, twisted into cables, has been used for quite a while by a great many large companies, and they have found it essential in obtaining stable operation from high-gain amplifiers.

The actual wiring of the receiver is very simple. It is recommended that the colors of Celatsite be used as follows: Yellow, all positive A-battery leads; Black, all negative A-battery leads, and for connections between negative A and C plus, and B minus and ground; Red, plate leads for the second audio tube, for leads between B-plus terminal to second stage jack, and from jack to plate terminal on the last tube; Green, plate leads for the r.f. and first audio tubes. These leads include those from the B plus terminal to center tap on the General Radio coil, from B plus terminal to interstage jack, from jack to plate, and leads between primary of first audio transformer and jack; Brown, plate circuit of detector tube.

There are no other colors for the C-battery circuits so it is suggested that brown also be used for these. There is one disadvantage in sub-base wiring which is that, in wiring under the base, we are likely to forget what apparatus is mounted just over the wire. In such an accidental manner a lead might be run which would very effectively couple together two parts of the

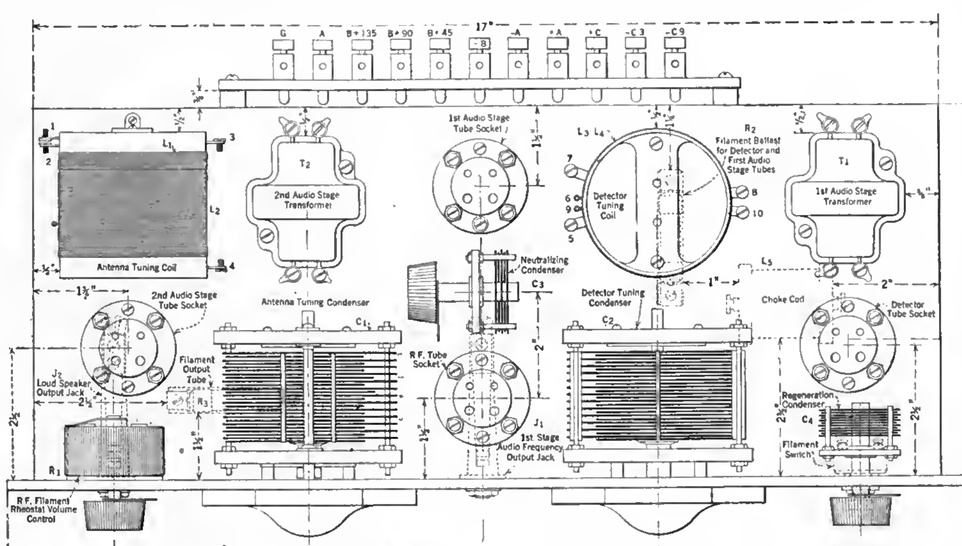


FIG. 5

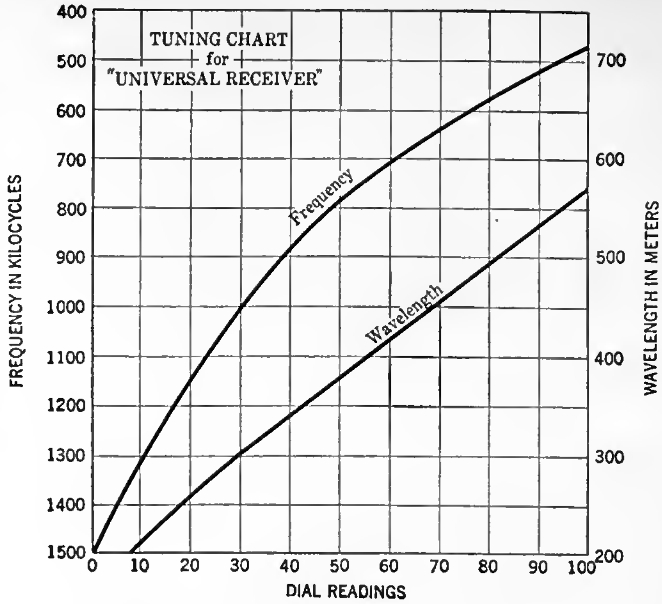
On the sub-base the apparatus is laid out according to the arrangement here shown. Note that, so that it will protrude sufficiently when the receiver is placed in a cabinet, the binding post strip has been arranged to stand from the sub-base circuit, and perhaps make it difficult to obtain perfect neutralization.

When the wiring is done (and it won't take very long) the batteries can be connected. The various voltages are marked in Fig. 1. Put the phones or loud speaker in the correct jack and place the regeneration condenser at the maximum position. Now revolve both dials.

Do you hear a squeal? That's fine. Now, as you listen to the squeal, slowly rotate the first dial back and forth. Perhaps the squeal changes in pitch and at one setting it may disappear altogether. This indicates that the set is not properly neutralized. Vary the setting of the neutralizing condenser with one hand as you move the first dial. At one point, you will find that, although the squeal varies in strength, it does not change in pitch. This indicates correct neutralization. Leave the neutralizing condenser as it is and see what other stations you can "pull in."

TROUBLE SHOOTING

PERHAPS you are not so fortunate; possibly, in your case, when you connected the batteries nothing at all



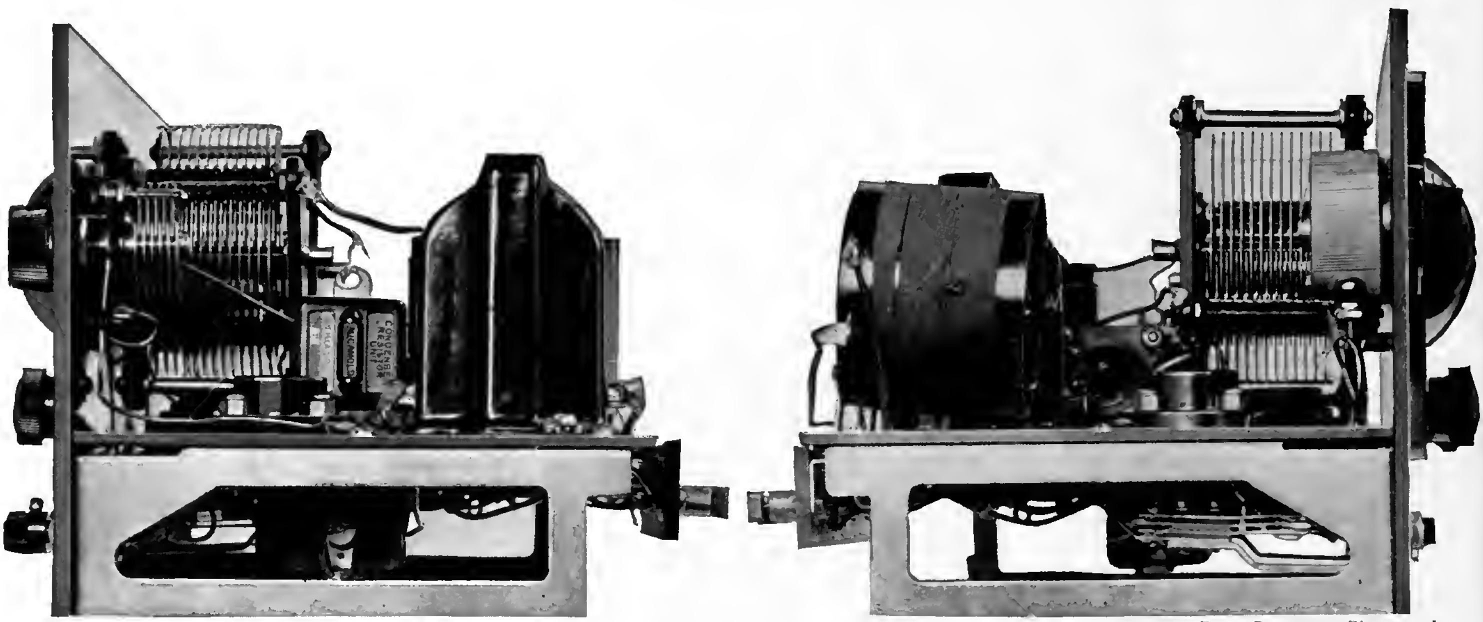
A TUNING CHART FOR THE "UNIVERSAL"

The dial settings are plotted against frequency in kilocycles and wavelength in meters. To approximately set your dials for a certain station, look up its frequency or wavelength, find this point on either the frequency or wavelength curve, and from it drop a perpendicular to the horizontal axis, the point of intersection being the approximate dial setting

about two mils., while a 171 in the last stage, with 135 volts of B battery, will take 10 or 12 mils. If, on inserting one of the tubes in a socket, there is no increase in plate current, check through the plate circuit of that particular tube and find the open circuit.

If, on the other hand, a microphonic ring can be heard in the output when the detector is tapped, the trouble is then to be found in the detector tuning circuit or in the r.f. amplifier circuit. Connect the antenna directly to the plate of the r.f. socket (the r.f. tube being removed) and operate the receiver as you would an ordinary three-circuit affair. If reception is satisfactory with the antenna connected to the plate of the radio frequency tube socket, the r.f. tube should be replaced, and the antenna connected in the normal position. If reception cannot be obtained now, one may be sure that the trouble is in the grid circuit of the first tube, and it should not be very difficult to locate. Look at the various connections very carefully and be sure that all the joints are solidly made.

If, upon turning on the receiver, there is an audio howl, it can often be eliminated by reversing the prim-



Radio Broadcast Photograph

LOOKING EAST—THEN WEST

Two side views of the "Universal." The coil to be seen in the right-hand view is tilted—by mistake. It should be parallel to the sub-panel. These views show clearly how the brackets are mounted. The volume control, a rheostat in the filament circuit of the radio frequency tube, can be seen in the right-hand view. In this view there can be seen the tap on the first coil which should be used if the receiver is to be operated on a short indoor antenna. On a very short indoor antenna, connection should be made directly to the grid of the radio frequency tube

happened, and so we have to begin to "trouble shoot." The first thing to do is to very carefully check over the wiring. Do a thorough job of it, going over the entire receiver. Trouble of this sort is almost invariably due to an incorrect connection and a careful check should show it up. Some simple tests can also be made which will more or less localize the trouble so that the difficulty can be cleared up somewhat easier. A simple test is to connect the loud speaker into the second stage jack and lightly tap the detector, first audio, and second audio tubes. A microphonic ring should be heard in the loud speaker if the audio amplifier is functioning correctly. The noise should be especially loud when the detector tube is tapped. If no such sound is heard it is indicative of trouble in the audio amplifier. If you have handy a milliammeter, connect it in series with the negative B lead, and then insert the tubes in their sockets one at a time, and be sure that each tube takes plate current. The r.f. and first audio stage tubes should take about 3 milliamperes each. The detector should take

ary winding of the second transformer. Also, it is generally best to ground the cases of the transformers. This can be done by soldering connections to the mounting screws on the cases and connecting the lead to the ground binding post.

If the receiver is operated on a short indoor antenna, louder signals will be obtained if the antenna is connected to the center tap on the first coil rather than to the primary winding. The receiver, as designed, is for use on an outdoor antenna about one hundred feet in length.

The Listeners' Point of View

Conducted by — John Wallace

Kind and Unkind Words About Our Friends, the Announcers

THERE should be a law forbidding announcers to do any announcing during six months of each year. The law should further stipulate that no announcer should be allowed to so much as cross the threshold of a studio during that period of exile. Announcers should likewise be enjoined to read no syllable concerning radio during this off period and a penalty of a one-year suspension should be invoked for each and every time an announcer is discovered, during his days of retreat, talking to any one having any connection whatsoever with a broadcasting station. In short, the announcer should spend half of every year simmering the poisons of the studio out of his system.

To what profitable use an announcer could put the six months of leisure is a bit uncertain. Some of them might, with great benefit to themselves, spend it at touring in vaudeville, conducting a Lonesome Hearts column in a newspaper, or posing for advertisements of insidious diseases and Stay-Stuck hair preparations.

The benefits to the listener accruing from such an enforced vacation would be very great. It is not at all difficult to understand the dangers of ingrowth to which an announcer submits himself by a too prolonged period in the broadcasting studio. Nor, to be charitable, is it really surprising that his point of view should become horribly warped.

For such is the fact of the case: the announcer, unless he be a bigger man than his job (which a few of them are) soon, from viewing said job too closely, loses all sense of perspective and is unable to subject it to any objective criticism.

His every day association with fellow members of the studio staff and the intimacy resulting therefrom, gives him a grossly distorted and exaggerated view of the staff. When this sorry state has come to pass then we, the listeners begin to be treated to a back yard view of the studio's wash and other lingerie. It is then that we are privileged to glean such highly interesting bits of information from his announcings as:

Well, ladies and gentlemen, Charlie has just come in. Old Charlie Benzing, the smiliest studio manager that ever was. And Oh Boy! is Charlie wet? The water's just dripping off his brand new plush hat. Must be raining pretty fierce outside. And now folks we're going to hear a program of songs from Mabel McGillicudy. Micky's all dressed up so nice and pretty tonight. I just wish you could see her. And for her first number she's going to sing If a Rose Had Wings. And believe me that's a pretty song. We boys in the studio like it better than anything else she sings. All right Micky. . . .

Now let's not be too harsh with such an announcer. He's really interested in the fact that the studio manager came in with water dripping off his hat. For perhaps six or seven hundred nights he has watched Mr. Benzing come in that very same door at that very same time without ary a drop of water dripping from his hat. Is it any wonder that he is delighted to see him come in for a change, doubling as an overworked fountain statue? It is an event, a wondrous break in the studio's monotony. And he feels that he is doing his listeners quite a favor in sharing with them this fascinating bit of news.

Of course as a matter of fact, we listeners don't give a whoop whether Mr. Benzing comes into the studio at all. It's really nothing in our lives whether Mr. Benzing even exists or not. But of such a broad point of view, this sort of announcer is incapable. For him Mr. Benzing is one of the world's outstanding personages. And why? Because his vision has gone out of focus from a too-prolonged stay in the close confines of the studio.

Manifestly, only an idiot would allow his sense of proportion to become so lop-sided. But idiots are not confined to the loud speaker end of the wireless arrangement.

This same weakness, resulting from over-familiarity with the job is to be observed even in the workings of a newspaper. For instance your County Building reporter will come back to the city desk with lengthy stories on some utterly trivial doings of the coroner or the county sheriff. To him they seem news of great import and he is grieved when the city editor cuts them down to five-line mentions. By the time the paper is printed such manifestations of "staleness" are generally absent. Nor does a paper, outside of the village *Bugles*, ever relax its restraint to such an extent as to exhibit to the public the machinery behind the scenes. Even the editorials are anonymous. When the Columnist refers informally to the Copy Reader or to the Man at the Next Desk, it is the very fact that this is a highly indecent procedure that gives it much of its humor.

In general, no matter what be the goods it is purchasing, the dear public is not the slightest bit interested in the personnel behind them. When a leading manufacturer of pickles publishes from vanity or some other absurd motive, a full-page advertisement picturing the handsome visages of himself and his lieutenants with a story concerning how long and efficiently they have been working together toward the goal of bigger and better pickles, we venture to guess that the pulling power of the ad' does not result in the sale of enough pickles to garnish three hot dogs.

It is our conjecture that it is due to staleness, rather than to any malignant wish to inflict pain on listeners, that announcers mingle bad puns with their proclaiming of the titles of a series of dance numbers. This is an offense of widespread prevalence. Stations which otherwise exhibit the utmost reserve and dignity break down completely when it comes to titling their dance selections. An example:

And now maybe some of you listeners take a bath once in a while. And maybe

CHARLES B. POPENOE

It takes more than an announcer to run a broadcasting station, and, too, not only the engineers are the important men behind the scenes. The program manager is responsible for every item of entertainment which courses out over the ether. Mr. Popenoe, program manager of WJZ, is one of the pioneers in the broadcasting field, and was attached to that station when it was located in Newark and owned by the Westinghouse Company. As every listener knows, WJZ broadcasts regularly some of the best features on the air some of you don't. Haw! Haw! Haw! But anyway for the next number the boys are going to play "Turkish Towel."

Crimes like that are committed by almost all stations—even up to the mighty WEAF. The reason is obvious: the announcer has been ushering in perhaps a couple thousand dance numbers during his past year on duty. It has become a gruesomely monotonous chore. He feels he must break the sameness somehow or go crazy. By some strange process of extension he comes to the conclusion that his listeners feel the same way about it. And this is where he exhibits the distortion of his vision. For to the listeners, the formula type of introduction has not become overly monotonous since no one of them has consciously heard the several thousand dance numbers titled during the past year. The most of them don't pay much attention to the names of the pieces anyway. And this fact the fatuously facetious announcer might learn in the course of a six month's vacation. Hence we advocate the half-year lay-off.

The Requirements of a Football Announcer

THE football season is with us again—or will be by the time this appears in print—and with it, the great annual boom in radio's stock. The great army of non-listeners, whose number is legion, perks up its ears and invites itself to some neighbor's house to listen to that much maligned contraption for which it protests utter disdain the other ten months of the year.

Batteries are brought up to normal, antennas are shaken free of bird nests and branches, an extra dozen camp chairs is set up in the front parlor, and through the autumn afternoons an additional million or so listeners gathers to feast its ears on the one remnant civilization has left to us of the good old bloody jousts of Roman days.

Football is easily the biggest event in the radio year. It is the great Revival Meeting. The Tabernacle is crowded to the doors with Lost Souls, errant males who own no receiving sets, who pay no tribute to the tube manufacturer, to the battery maker, or to the parts dispenser, Recalcitrant Outsiders who poke fun at the Great God Radio for the most part of the year. Now is the opportune moment for high-powered Evangelism, for the winning into the fold of these Scoffers.

We do not think that it is without justice that football lays claim to being the best item of the whole year on radio's bill of fare. As we have before pointed out, music you can hear on a phonograph, speeches you can read in the newspapers, vaudeville you may find in the humorous magazines, but a football game permits of no such substitution. There is small thrill in reading the account of a football game the Sunday after. However you can't always get to a football game that is being played half way across the continent, nor can you for love or money get a ticket to a game if the last seat has been sold. But an ably reported football game is an awfully close second to the real thing. In fact, if you happen to be possessed of a potent, well exercised imagination, it may occasionally be even more vivid than the actual scene itself—and infinitely cheaper in this day of $40 seats.

And so we trust that the 1926 season will be—is being—ably broadcast. It is radio's chance to make an impression on the thousands of new listeners. The better the impression the better for radio. The colleges can be relied upon to furnish some interesting games. The only additional item necessary is for the broadcasters to furnish interesting announcers. Two or three individuals have already shown themselves capable in this rôle. Sad to relate, the dozen or so others have been thoroughly mediocre in past seasons.

The ideal announcer of football games must be more than reporter, more than an orator, more than a comedian—he must be a football enthusiast. For if an individual listens to a football broadcast he, or she, is by that sign a football enthusiast (as who indeed is not from the wash lady to the button king?) And the dyed-in-the-wool fan can easily detect whether the announcer is really a "fan" himself or simply putting up a bluff.

The great secret of the success of football broadcasts is that the listener does his share, coöperates, puts in real creative effort to make it a success. Your every-day listener seldom if ever goes half way; he really doesn't care much whether he listens-in or not. He demands to be shown. But the football fan listener goes more than half way. He is eager and voracious; he is what the artist on the boards refers to as a "responsive audience." As such he ought to stimulate the announcer to put forth his sincerest efforts, as in truth should the game itself, unless it be a hopelessly dull one.

But if the announcer isn't genuinely an ardent lover of football he will inevitably fail at the simulation. Altogether the situation is a difficult one to fill. The requirements in brief are these: the football announcer must be first a football fan; secondly, intimately acquainted with the complex technique of the game; thirdly, a nimble-eyed reporter; fourthly, an experienced handler of the microphone, and finally, a craftsman of words—which means that he must be able to describe rather than recount.

THE HOTEL BOSSERT ORCHESTRA
Broadcast from that hotel in Brooklyn through WEAF during the summer

Evidently no announcer now covering football games comes up to a full hundred per cent. in each of these departments, though several approach it closely. Probably no one will ever receive a perfect rating, but station managers might well be guided by the five suggested requirements in selecting the best man for the position.

WGN's Football Schedule

A MISFORTUNE, indeed that the scheduled broadcasts of football games from WGN, Chicago, were omitted from the list appearing in this department last month. We made request for a schedule many weeks ago, which drew no trace of reply. We make amends, printing below the games that are yet to go:

November 20th,
Ohio–Illinois, at Champaign.
November 27th,
Army–Navy, at Chicago

The Boston Symphony Orchestra

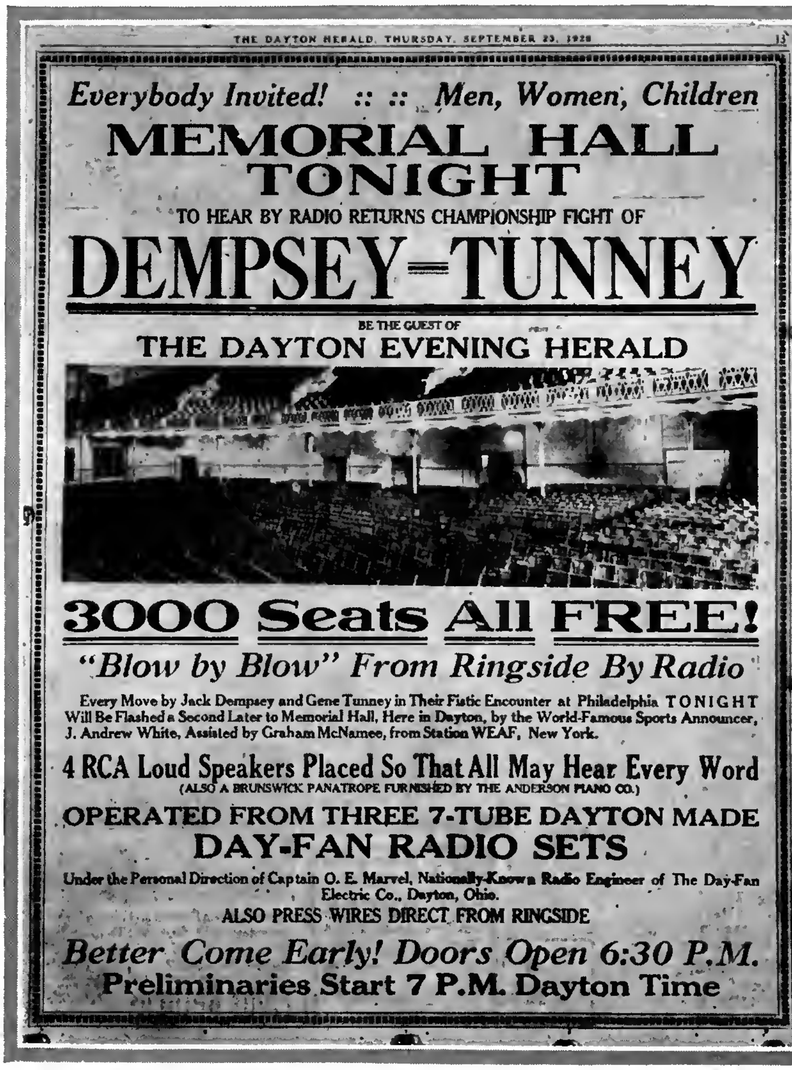
THE event of the winter radio season which this particular listener is looking forward to most eagerly is the series of twenty-four concerts by the Boston Symphony Orchestra. This justly world-famous organization went on the air for the first time in its history on January 23 of this year, in a series of concerts through WEEI. This move, a radical one for such a dignified, conservative old band as that of Boston, was brought about through the efforts of W. S. Quinby, a Boston manufacturer, and WEEI.

The Boston Symphony runs not the remotest risk of losing out in gate receipts because its wares are broadcast, for coveted tickets to Symphony Hall have long been in the class of family heirlooms and are passed down in wills from generation to generation. Another objection the directors originally held forth was that mechanical difficulties might impair the broadcast program. Evidently they have been satisfied that the reproduction is accurate enough or they would not have authorized the present radio season. The loud speaker version of the concerts is, of course, not a perfect reproduction of what is going on in Symphony Hall. Its distortion is particularly acute when the music reaches great crescendos of volume. But since listeners realize the existing shortcomings of broadcasting it does not injure the prestige of the orchestra. Some sort of Boston Symphony concert is better than no Boston Symphony concert at all. Moreover anything as perfect as the results Serge Koussevitzky draws from his 107 musicians can stand a lot of mauling without being entirely shorn of its original beauty. The Venus of Melos is still pretty fair to gaze upon in spite of being dragged over the rough cobble stones by a rope around her neck.

The broadcasting of the present season—the orchestra's forty-sixth—is being sponsored by WBZ with the financial backing of the same Mr. Quinby. Fortunately for us of the Middle West, stations more powerful than WBZ are to join occasionally in a hook-up, so the concerts should be generally available to any one east of the Mississippi. WJZ, WGY, and WRC will assist in broadcasting fifteen of the twenty-four concerts. For your reference we print the schedule:

Boston Symphony Orchestra Concerts

November 13, 20*
December 4*, 11*, 18, 25*


THE DAYTON HERALD, THURSDAY, SEPTEMBER 23, 1926

Everybody Invited! :: :: Men, Women, Children

MEMORIAL HALL TONIGHT

TO HEAR BY RADIO RETURNS CHAMPIONSHIP FIGHT OF

DEMPSEY-TUNNEY

BE THE GUEST OF

THE DAYTON EVENING HERALD

3000 Seats All FREE!

"Blow by Blow" From Ringside By Radio

Every Move by Jack Dempsey and Gene Tunney in Their Fistic Encounter at Philadelphia TONIGHT Will Be Flashed a Second Later to Memorial Hall, Here in Dayton, by the World-Famous Sports Announcer, J. Andrew White, Assisted by Graham McNamee, from Station WEAF, New York.

4 RCA Loud Speakers Placed So That All May Hear Every Word

(ALSO A BRUNSWICK PANATROPE FURNISHED BY THE ANDERSON PIANO CO.)

OPERATED FROM THREE 7-TUBE DAYTON MADE DAY-FAN RADIO SETS

Under the Personal Direction of Captain O. E. Marvel, Nationally-Known Radio Engineer of The Day-Fan Electric Co., Dayton, Ohio.

ALSO PRESS WIRES DIRECT FROM RINGSIDE

Better Come Early! Doors Open 6:30 P.M.

Preliminaries Start 7 P.M. Dayton Time

HOW THE DEMPSEY-TUNNEY FIGHT GOT TO DAYTON

Major J. Andrew White was the first ever to broadcast a fight from the ringside to listeners by radio assembled in halls. The occasion was the Dempsey-Carpentier fight. For the more recent Dempsey-Tunney bout, also broadcast by Major White, the Dayton *Herald*, of Dayton, Ohio, arranged a party in Memorial Hall of that city, and invited the public to hear the announcements, blow by blow. The hall was filled and reports have it that the impersonal loud speakers, giving forth the details of the fight, eight hundred miles away, held the crowd tense

January 1, 15, 22*, 29*
Feburary 12, 19*, 26*
March 5*, 19, 26
April 2, 16*, 23*, 30*

*Stations, WJZ, WGY and WRC will tie in with WBZ to broadcast the symphony concerts on these dates.

On the dates not starred, WJZ will be broadcasting the student concerts of the New York Philharmonic Orchestra, which we pleasantly recollect as one of the best of radio's offerings last winter. In the twelve Student's Concerts, which will run intermittently throughout the coming winter, the last one coming in the early part of April, Willem Mengelberg, will conduct the full orchestra of one hundred and ten men. The concerts are to be given in Carnegie Hall, and are especially designed to fit the needs of the student musician. The entire season's program, which is now being prepared by Mr. Mengelberg, will be built in the form of a musical education, and the history of music will be traced from the days of the early composers down to the latest composers of classical music.

The complete list of dates on which the Student Concerts will be heard is given: November 6th, 13th, and 27th; December 18th; January 1st, and 15th; February 5th, and 12th; March 19th, and 26th; and April 2nd.

With the New York Symphony being heard regularly (in the Balkite Hour at WEAF) as well as the two aforementioned orchestras, prospects look bright for enjoyable Saturday nights in the winter to come.

The Dempsey-Tunney Fight

AND, speaking of sports, perhaps we may be permitted, at this our first opportunity, to comment on the broadcasting of the Dempsey-Tunney fight. This broadcast may be reckoned as an outstanding event in radio's young history in that it was heard by countless thousands more of people than ever listened to a sports event before. Some thirty-odd stations were involved in the hook-up. It is our guess that for those forty-five minutes there was listening-in the largest audience ever attracted by a single broadcast, which, if you like superlatives, means the largest audience in the history of the world.

What we want to get off out chest first is some unstinted praise for J. Andrew White who reported the fracas. His was as perfect a piece of work as we have ever heard over the radio and we hope that every aspiring sports reporter in the country heard it to take a lesson from it. Even the Major's informal remarks before the bout started were effective. For instance, when he laughingly complained that Graham McNamee, his assistant, was using his back as a table to write on, he conveyed a perfect picture of the crowded conditions at the ring side. And from the sounding of the first gong his delineation of the progress of the fight was an almost incredible feat of rapid, intelligible reporting; never a pause, nor a search for words, nor a garbled up sentence. To be sure, we writhed every time he said idea-r-r or jaw-r-r but what was that beside the fact that he employed no more than three "er"'s in the whole thirty minutes.

In contrast to Major White's fine job was the miserable exhibition made by McNamee, whose duty it was to handle the mike during the one minute rest periods between rounds. Never has this star announcer been more off form. He hemmed and hawed and blustered about and got utterly nothing said. This quoted verbatim: "It's still raining. It certainly is raining. Yes it's still raining." Back to the sticks! No sentence he started ever came out right side up and he included such choice breaks as "Ladies and gentlemen of the radio audience and others who may be present . . . ." and referred to Dempsey's returning to his wife and family.

The commercial side of the feature was well handled. As you know, the cost of the broadcast was borne by the Royal Typewriter Company (at a rumored figure of $35,000). The trade name of the machine was worked in a goodly number of times, but probably not too often at that when you consider it was costing about $1000 per mention. And—surprising and commendable exhibition of restraint—it was never once mentioned during the forty-five minutes of the fight.

ALEXANDER MALOOF AND HIS ORIENTAL ORCHESTRA

An orchestra whose programs over WEAF are as interesting as this photograph of the musicians looks

Something for the Farmers

IF YOU be not particularly interested in farm broadcasts—and neither are we—you are cordially invited to move on to the next column; for the benefit of the farmers who may be in our "vast invisible audience" we report the following information from the United States Department of Agriculture.

The fall and winter broadcasting schedule of the department's Radio Service includes twenty special program features each week, covering the full range of interests reached by all bureaus of the department. Approximately 100 effective broadcasting stations will lend their facilities regularly for these programs, which are to be brief digests of the mostly timely, pertinent facts woven into story form and adapted to radio presentation.

The United States Radio Farm School, which has already brought requests for a half million enrollment cards will be conducted from twenty-five stations. Lessons take the form of experience talks and imaginary inspection tours. Radio "schoolmasters" at the respective stations will conduct classes. Material furnished by the Department of Agriculture will be dramatized in such form as to attract and maintain interest through the courses. Printed lessons are mailed to all enrolled students.

Another outstanding service to be released from forty stations, is the noonday flashes. This program will enable a million farmers to listen-in daily to both sides of an intelligent, interesting, telephone conversation between a county agent and farmer who will discuss timely problems.

"Aunt Sammy" will be heard from thirty stations. She is the official radio representative of the Bureau of Home Economics and will divulge all the new wrinkles and fine points in housekeeping.

Special farm features to be scheduled this fall and winter from 50 stations include "A Weekly Letter to Dad," which the son at college writes home telling the folks the high spots in his studies of agriculture which he believes might well be put into practice on the home place; "Autobiographies of Infamous Bugs and Rodents," a ten-minute speciality about "pests that are bothering now," as told by the insects and rodents themselves; "Chats by the Weather Man"; "Primer for Town Farmers"; "An Interview with the Agricultural Economist," and a weekly "Farm News Digest."

Among the stations offering all or part of this government service are: WAPI, WCCO, WDAY, WLBL, WLS, WMC, WOAN, WOS, WRVA, WSB, WCSH, WDAF, WDBO, WGBS, WHK, WOC, WRC, WEAO, WAMD, WAAM, WJD, WHAS, WLW, WKH, WHEC, WBAP, WHB, WMAK, WKAR, WBAK, WEBH, WENR, WFI, WGAL, WGR, WNAC, WOAX, WSMB, WTAM, WEAO, WHO, KOA, KMA, KFAU, KFBB, KFDY, KFJF, KFKX, KFOA, KHQ, KOAC, KOB, KQW, KSL, KTHS, KWWG, KSO, KWCR, KOIL, KPO, KFXF.

THE TOLLEFSON TRIO

Frequently heard through WEAF and the chain on the excellent program of "The Vikings" every Tuesday night at 8, eastern standard time

Broadcast Miscellany

ON THE occasion of the Third Annual Radio Industries banquet at the Hotel Astor, New York, last September, was heard one of the meatiest evening programs of the late summer season. In the course of about three hours were heard, among others, the Victor Salon Orchestra, WEAF Opera Companies, Mary Lewis, Reinald Werrenrath, the Happiness Boys, Sam 'n' Henry, the Eveready Mixed Quartet, the Revellers, and the Ipana Troubadors. This event marked the biggest tie-up of broadcasting stations to date. Nearly forty stations carried the program to all parts of the East and Middle West. Vice-President Charles G. Dawes, the principal speaker, was not at all unaware of the

And all the time radio's real mission was so different!

It's educational—There won't be any textbooks a few years from now—that's the impression I get from the enthused and higher-domed-than-me advocates of the University of the Air idea. A great thought.

That slant would have been so useful, interwoven with some of those 1921 lectures into which crept and was fondled the phrase, "broad dissemination of intelligence" by radio, tied up to the notion that broadcasting educated inductively—establishing appreciation of good things in the arts, to say nothing of putting the ruralites hep to public questions through eavesdrop absorption of opinion. The sages who gather at the rostrum and while away after-coffee hours in the banquet hall—it's those serious fellows who do it.

ETHER-WAVING THE "OLOGIES"

MENTAL astigmatism, that's all that conception was. The broader view, as I gather it from the ecstatic intelligentsia, is that the new generation is to have all "ologies" ether-waved. The syllabus is set; it but remains to cram dogma into the waiting cerebrum via the headphones.

Now that's a pretty good idea; a smart fellow thought that one up.

Education will poke itself into every nook and cranny. All evening I have been thinking about that. Great; why, all along the R. F. D. routes, out on ranches in the great open spaces, in lonely cabins on the mountain top, there are seekers after the truth, alone, neglected, uneducated. Here and now, isolation ends! In the land where all men are born free and equal, learnin' shall be free and equal. Free as the air, one might with originality say, and equal to the task of reaching even the remotest places.

Deeply cogitating on the subject, there came to me the vision of the great struggler for enlightenment. Abraham Lincoln, the youth, by the flickering candle light in his cabin of rough hewn logs poring over his one book. The ideal example. It determined me to write this article.

Always, my heart has been wrung at the thought of the Emancipator scrimping and saving his meagre earnings to get together the price of the succession of books that moulded his, later, massive mind. But no more will the boy without opportunities have to struggle for possession of the printed word. Not even a single book will be necessary; the University of the Air aims to relieve both eyestrain and pocketbook. Just a simple receiving set, assembled from parts bought, perhaps, at the five and ten, mental receptiveness, and the education job is begun.

Something worth while, that; I had decided to write this article anyhow; but filled with the spirit of Lincoln and the general seriousness of the subject, it didn't seem right to dash it off without acquiring a background of practicality. What better way to do that than by actually listening, myself, to contemporaneous broadcasting.

I did. Tuned-in and listened carefully for an hour. The first talk the dial twisting brought was a dissertation on stamp collecting. Which at first blush seemed piffling. But as I listened, the realization dawned that I knew absolutely nothing of this particular intellectual pastime. Ah, this then was just what I wanted; I had never read even a pamphlet on the subject. Exactly in the position of the boy who never had a textbook. I made notes; filled up two pages. It was not wholly satisfactory. But I was persistent; I shifted the verniers around until I picked up a talk on flora and fauna of the tropics; repeated the note-taking process. Here again I was somewhat bewildered by utter ignorance of terms and tendencies. It should have been ideal; but something, too, was wrong; and after careful perusal of the notations made my ardor was appreciably dampened. Finally it was all wet. Three more trys at attempted understanding of subjects on which I was at best but vaguely informed, and I gave it up.

The University of the Air idea seems to have a weakness. That weakness is the lack of visual foundation. That will be a bit of a handicap to the student body.

RADIO GIVES YOU A RESPECT FOR PHONETICS

AIR education advocates must have overlooked a consideration you can discover for yourself in ten minutes—if you have never had it before, radio will give you a wholesome respect for phonetics.

The word "intentions" is hard to distinguish from "inventions," for instance; and "conquering" is liable as not to become "conk herring." The ear is a tricky instrument. Clearest reception on a bang-up receiver and carefully manicured diction on the part of the speaker are rare in combination; but even with these, you get queer results.

To show you how this works out, let's go back to Abe Lincoln. He is chockfull of inspiration for to-day's deserving youths who are log-cabined like he was. Nothing could be finer than to start them off educatively with some of his noble utterances. You know, "That this nation—" and so on. But how would his stuff come over? Figuring they had never seen those same sentiments in print, I'd say from my experience with radio it is wholly possible that they'd be putting down a literal transcription of, say, the consecration of this nation to the Divine Being at the finish of the Gettysburg Address, somewhat after this order:

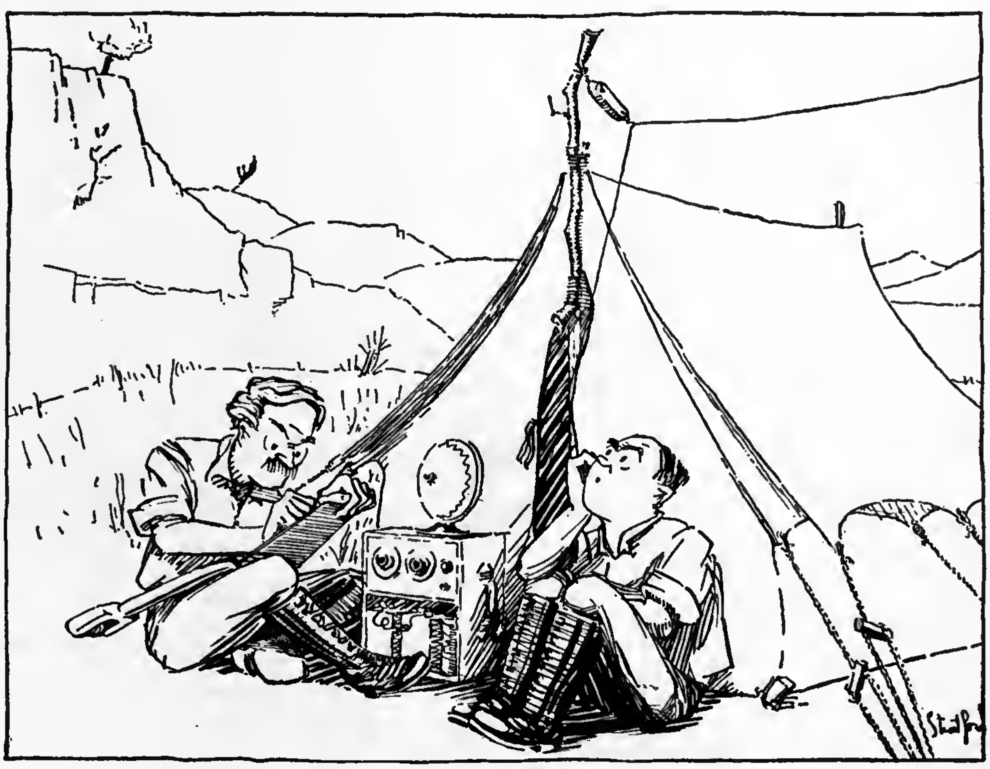
> Vaccination, under guard, shall have a new Bertha Freedman, and come and vamp the people, by the people, for the people, shall not Paris fashions the earth!

A few similar tests will convince you that the more potent the sentiment the easier it phonetically perishes. Educationally, this is a little disturbing.

With Lincoln having always been looked upon as inspirational, it is not wholly comforting to contemplate the risk of having the farm boy or the cattle chaperone appraising him as an utterer of the obvious, because the earphones perhaps gave forth:

> A horse divided against itself, cannot stand.

Or to have the plea for faith in right mak-



"IN THE GREAT OPEN SPACES, THERE ARE SEEKERS AFTER THE TRUTH—ALONE, NEGLECTED" ing right, lose some of its kick by coming over:

Lettuce half ate, that Mike makes right!

Nor is it to be expected that the tolerant viewpoint will be materially fostered by the admonition:

Wood mallets toward none, with chair or tea for all.

Difficulties here unquestionably. And examining into the proposition, they appear to multiply inversely as you go down the line.

Now to be fully pedagogic, the little children, bless 'em, certainly have to have theirs. When I was a kid, anyhow, we acquired much of our wisdom and absorbed character-building axioms by speaking pieces. The method, I am informed, has not been abandoned. Wherefore comes consideration of the business of memorizing things. Pictorial illustration was always helpful in committing verse to memory—*Casabianca*, a noble piece, being one of the earliest in my recolection. So let's take that, exclusively from the how-it-sounds position: What, it may be inquired, is to prevent juvenile bewilderment regarding the immature hero of Mrs. Heman's verse as to why he did so nobly stick to the ship should the initial situation phonetically disclose:—

Sea foisted on the boy Ringbeck
When salt buddie had fled.

The moral effect is of consequence; and irrespective of how quickly we dismiss the detail of childhood's portion there are few reassurances that the adolescents will fare better. It might even be advanced that the phonetics of ether-wave education might materially accelerate flapperish wisecracking, with Don Quixote perhaps declaring:

"A man's word is as good as his blonde.'

And totally aside from the question of elevation of morals, there might be some biological confusion over:

Summer born great, some sneeze at greatness, and some have great nests thrust upon them.

MORE PROBLEMS FOR THE RADIO EDUCATOR

WITH these mere elementary things we appear to be getting beyond our depth. The subtleties to be encountered in even a smattering of science thus may give us pause. What chances for phonetic transcription, I ask you, have the isobaric and isothermal charts of physical geography, to say nothing of the diurnal inequality of the tides?

Yet if I remember correctly the chronological sequence of earnest but futile attempts of teachers to add to my knowledge of things academic, the study of physical geography came early, preceding the sciences. This must be considered in an estimate of a future wherein the young student will be rolling his own from five and ten parts and thus acquiring a new nomenclature and a radio receiver—with the praiseworthy object that other education may come after.

Then through the headphones along comes the physical geography lesson dignifiedly asseverating that the soft mud or ooze at the bottom of the ocean is called, "radiolaria" . . .

A little explanatory straightening out may have to go along with this.

But without further recourse to the foregoing fundamentals of education (although a slow smile accompanies the thought of how the word, "hypothesis" would come over the air) the broader conception must allow that certain difficulties may be foreseen, and a way found to overcome them. Meanwhile I await with passionate expectancy some advance dope on what disciplinary measures are to be devised to outsmart recalcitrant intelligences on off days. I have not forgotten how the opening of the baseball season, for example, always had a retarding effect on concentration, even under the watchful dominance of an agile-eyed professor. Our future student, as I gather it—or a large percentage of him, at least—will be strictly on his own. Surely he must be dubbed a super-seeker after knowledge who will be able to abide with, say the postulate, the lemma, corollary and scholium on geometry's opening day, when with a turn of the dial he can tune-in the opening game of the World Series.

This generation might have acquired an additional ignoramus or two under that handicap.

Undoubtedly, though, there are many subjects that can be taught quite easily through broadcasting. The favorable aspects must be looked into.

Now for example—

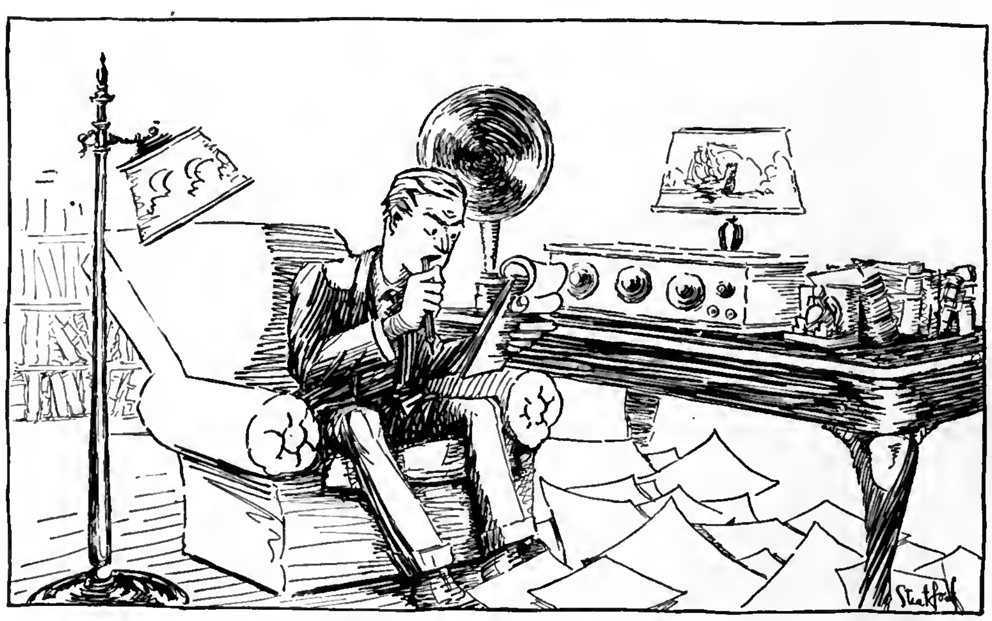
For example. . .

Well, I can't seem to get the inspiration right off. But there must be; just plenty to write about; probably many inspiriting addresses on the air right this minute. A radio receiver here at my hand; and the newspaper programs.

It's 9:30 let's see . . . Um, what's this? Paul Whitman's outfit; that means some pretty good symphonized jazz—and Olga Steck, my musical comedy favorite; a few zippy songs. Sounds good. Don't like to miss it.

Perhaps I've written enough, anyhow.

For it can readily be seen how easy it is to educate the Masses. Especially, in the old-fashioned way.



"THE UNIVERSITY OF THE AIR AIMS TO RELIEVE BOTH EYE STRAIN AND POCKETBOOK"

A Single-Tube Receiver That Won't Radiate

THE PANEL LAYOUT
Of the one-tube non-radiating receiver is well balanced despite its simplicity. The single condenser dial, rheostat knob, filament switch, and jack are the only visible pieces of apparatus on the front of the panel

Constructional Details for an Ideal Beginners' Receiver Employing the "Equamatic" Principle—Tickler Coil Coupling Is Automatically Varied as Condenser Knob Is Turned—Coil Data Are Presented

By ZEH BOUCK

IT IS the author's experience and belief that there exists a very definite demand for a "perfect" beginners' home-made receiver. Though the last few years have seen many receivers placed on the market which, ultimately, could be purchased far more cheaply than the average enthusiast could build a similar set, these receivers have by no means filled this particular bill. The amazing cheapness of these sets has generally been due to the inability to dispose of them at higher prices in competition with better equipment.

The ideal beginners' receiver for home construction should comply with the following requirements:

1. It should be a simple receiver, particularly in reference to wiring. There is nothing more discouraging to the incipient experimenter than the failure of his first attempt—and ninety per cent. of these unhappy trials are due to wiring complications. Consideration of this recommends a one-tube receiver for the fan's first efforts.

The receiver also should present no great mechanical complications (though this is a less important consideration because the radio beginner is often an experienced mechanic), which postulates the possibility of obtaining the various coils and sundry parts especially prepared for use in the circuit he will employ.

And with final but consistent simplicity, the set should be easily tuned, a factor that favors one-dial control.

2. The receiver should be inexpensive to construct—a condition that runs more or less hand-in-hand with the idea of simplicity.

3. The receiver must be non-oscillating. An oscillating single-tube set (and most multi-tube sets for that matter) radiates interfering signals, which are annoying at all times, yet rendered more so when the offending set is operated by a beginner.

4. The receiver should be a permanent one. It should exhibit such qualities of selectivity and sensitivity that it need never be discarded. When the enthusiast desires more elaborate equipment, he should need only to add an audio amplifier (and perhaps a stage of r.f., if he craves DX) to have a thoroughly satisfactory receiver.

The once very popular three-circuit regenerative tuner filled these requirements with the exception of that very important commandment—"Thou shalt not oscillate"; and these sets were not always so easy to tune. Until recently, the three-circuit tuner was indubitably the most selective and sensitive of one-tube receivers, and it gained wide popularity before propaganda exposed the iniquities of its oscillations. In the last two years, various reflex and other circuits have been offered as substitutes for the three- and single-circuit arrangements. However, while these substitutes were non-radiating, they fell down on one or more of the other points outlined above, and never attained the popularity of the receiver whose place they would usurp.

The Facts About This Receiver

Name of Receiver	King "Equamatic."
Type of circuit	Single-tube regenerative receiver.
Number of Tubes	One UV-199; other types of tubes may be used.
Frequency range	545 kc. to 1500 kc. (200 to 550 meters).

This receiver is excellent for local reception. It uses regeneration but if correctly adjusted, cannot oscillate and cause interference. The amount of regeneration is automatically controlled by a movable coil mounted on the shaft of the condenser. In this way the circuit is maintained at a point of high sensitivity throughout the entire broadcast band. It is an ideal single-control receiver.

WILL NOT RADIATE

THE beginners' receiver we have undertaken to describe fulfills every stipulation, above outlined, imposed upon the ideal set. This receiver is nothing more than a three-circuit regenerative tuner that will not radiate, and it is controlled by a single dial (the coupling between the tuning and tickler controls being automatically varied). Regeneration is automatically maintained at close to the optimum degree over the entire tuning range (the optimum degree being that amount of feedback that will give maximum signal strength and selectivity without distortion). This combination is secured by the application of the King "Equamatic" system of coupling variation which was described by the writer in the September and October, 1926, issues of RADIO BROADCAST. This system, briefly, recognizes the necessity of varying the coupling between circuits, as different wavelengths are tuned, in order to maintain maximum efficiency over the entire tuning range, and offers a simple but effective means of automatically securing this correct adjustment, under individual conditions.

The coils employed in this system were designed for use in non-regenerative circuits. However, their efficient application to regenerative arrangements is fairly obvious, and the receiver here illustrated and described was an early and logical by-product of the original King system. This single-tube receiver was designed jointly by Mr. King and the author.

THE COILS

THE beginner may wind the coils for this receiver himself if he possesses the inclination and mechanical ability.

There are three coils in the receiver—the antenna primary, L_1 (in Figs. 1 and 2), the secondary, L_2, and the tickler coil, L_3. The primary coil is hinged to the back of L_2. The tickler coil is mounted on the extended shaft of the condenser. As the condenser is turned, the coupling between L_2 and L_3 is varied, and in this variation lies the application of the "Equamatic" system.

LOOKING DOWN

Behind the front panel of the single-tube receiver described here. An approximate idea of the coil arrangement may be gained from a study of this picture. The support brackets for the sub-panel can be seen in the space between the main and sub-panels

The various possible motions of the coils, as well as their mechanical construction, are indicated in the chart, Fig. 3. For the sake of clarity, L_1 has been omitted from this drawing. However, the hinged arrangement of L_1 is clearly shown in the photographs.

Coil L_1 is wound on a 2-inch diameter bakelite tube, $\frac{3}{8}$ inch long, with 14 turns of number 24 double cotton covered wire. Coil L_2 has 60 turns of the same wire on a $2\frac{1}{2}$ inch tube 2 inches long. The tickler, L_3, is wound with 12 turns of the same wire on a two-inch tube $\frac{3}{8}$ inch long. These three coils can be wound with 26 wire, or wire of a different insulation than that specified if more convenient, the same number of turns being used.

A baseboard may be substituted for the subpanel if desired. In this case it will be necessary to raise the bracket supporting the secondary coil with a block of wood so that its axis (line C in Fig. 3) coincides with the center of the condenser shaft. This centering, as well as the drilling of hole E in Fig. 5, directly under screw I on the condenser shaft (drawing C, Fig. 3) are essential to the correct adjustment of all "Equamatic" receivers.

The mechanics of securing this arrangement are illustrated in Fig. 3. Drawing A shows the dimensional characteristics of the stationary coil mounting. The front panel is designated by "a", the sub-panel by "b"; "c," in all drawings, is a line passing through the center of the condenser shaft; "d" is a machine screw with a square washer holding the coil bracket, e, to the sub-panel; "f" is a bracket of $\frac{1}{8}$-inch brass strip, such as a Karas, six inches long, holding the sub-panel to the control panel. Drawing B continues the details of the coil bracket, e, and the manner in which it slides through the swivel screw and washer d, on the sub-panel, b.

Drawing C suggests the moving or tickler coil arrangement. A brass sleeve is fastened to the extended shaft of the condenser G, by screw H. A bakelite or hard rubber strip extends from the brass sleeve, to which the tickler is mounted by a simple L bracket. The coil has been turned slightly to illustrate this idea.

Photographs of several home-made mountings will be found in a preceding article which appeared in the September, 1926, issue of RADIO BROADCAST.

The holes for the condenser, bracket e, and swivel d, are drilled according to the panel and sub-panel layouts. The various hole sizes are indicated in the drilling charts, Figs. 5 and 6.

With the coils either made at home or purchased, and the panels drilled, the assembly of the parts is the next step in the construction of the receiver. The sub-panel should now be joined up with the front panel by means of the two brass brackets, with screws through "A" and "B" in Fig. 6, and through "A," "B," "C" and "D" in Fig. 5. These holes are all countersunk. The condenser is then mounted on the front panel at hole C, the rheostat at "D," the filament switch at "E" and the jack at "F."

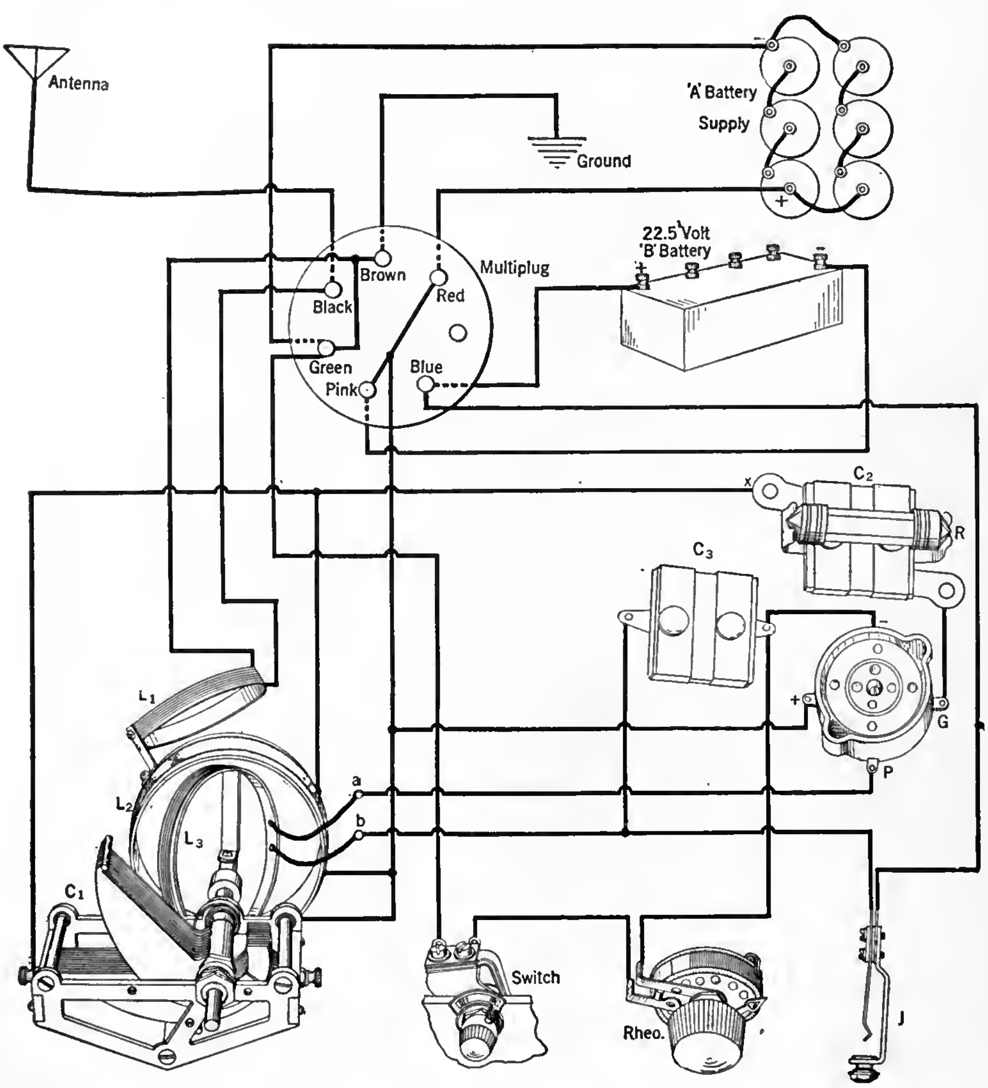


FIG. 1

On the sub-panel, the secondary coil is mounted with a screw through hole E. Holes F, F mount the floating socket; G, G, G mount the Multiplug. Six-thirty-two machine screws, with nuts, pass through holes H, H and I, I, holding firm the flexible leads from the secondary and tickler coils. These details are made plain in the photographs.

PARTS LIST

THE following is a list of the exact parts used in constructing the photographed receiver. Other makes of equal merit and similar design can be substituted with satisfactory results. The letters following the names of the parts refer to the symbols by which they are represented in the wiring charts, Figs. 1 and 2.

1 Karas 370 mmf. (17 plates) Variable Condenser (C_1) with Extension Shaft	$ 7.00
1 Karas "Equamatic" Three - Circuit Tuner (L_1, L_2, and L_3)	4.50
1 Amsco Floating Socket	1.00
1 Electrad Grid Condenser (C_2)	.40
1 Amsco 1-Megohm Gridgate (R)	.45
1 Electrad 0.002-Mfd. Bypass Condenser (C_3)	.45
1 Yaxley Open-Circuit Jack (J)	.75
1 Yaxley Filament Switch	.75
1 Amsco Tom Thumb 30-Ohm Rheostat (Rheo.)	.75
2 Karas Sub-Panel Brackets	.50
1 Jones Multiplug and Cord	4.50
1 Karas Micrometric Dial	3.50
1 7" x 8" Bakelite Panel	.80
1 7" x 6" Bakelite Sub-Panel	.70
Necessary Screws, Wire, Etc.,	.50
Total	$26.55

To the above list should be added extra equipment as follows:

1 199 Type Tube
6 Dry Cells for A Battery
1 22.5-45 Volt B Battery
1 Pair Telephone Receivers
1 Phone Plug
Antenna Equipment

Reasonable substitutions may be made in the above list although such may necessitate some deviations from the author's instructions, especially as regards the panel drilling, etc.

THE WIRING

THE receiver is now ready for wiring according to Figs. 1 and 2. Fig. 2 shows the general schematic layout, employing standard symbols, with which it is recommended that the beginner famili rize himself. Fig. 1 is the same circuit in "picture-drawing" style.

The Multiplug is a substitute for binding posts, and connects through a flexible lead with the antenna, ground, and the various batteries. The wires and plug connections are colored or "coded" to facilitate wiring and connections, as designated in Fig. 1.

The antenna or primary coil is wired to antenna and ground. The ground connection is "bridged" across, on the Multiplug, with a short piece of wire, to the minus A battery connection (green). Either connection from L_1 may lead to the antenna.

Coil L_2 is wired as follows: One terminal is wired to the grid condenser and leak. This same terminal is also connected to the stationary plates of the variable condenser, C_1. The rotor plates are connected to the remaining terminal of the coil, which is also wired to the plus filament post (marked +) on the tube socket. The remaining side of the grid condenser and leak combination is wired to the grid terminal on the socket (marked G).

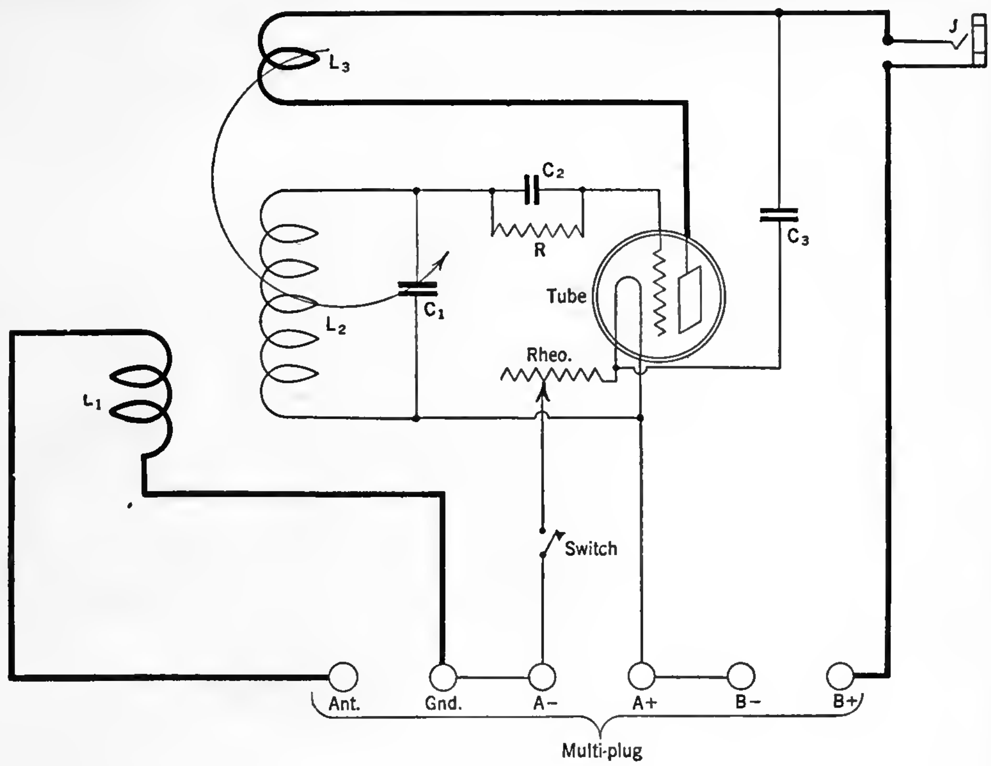


FIG. 2

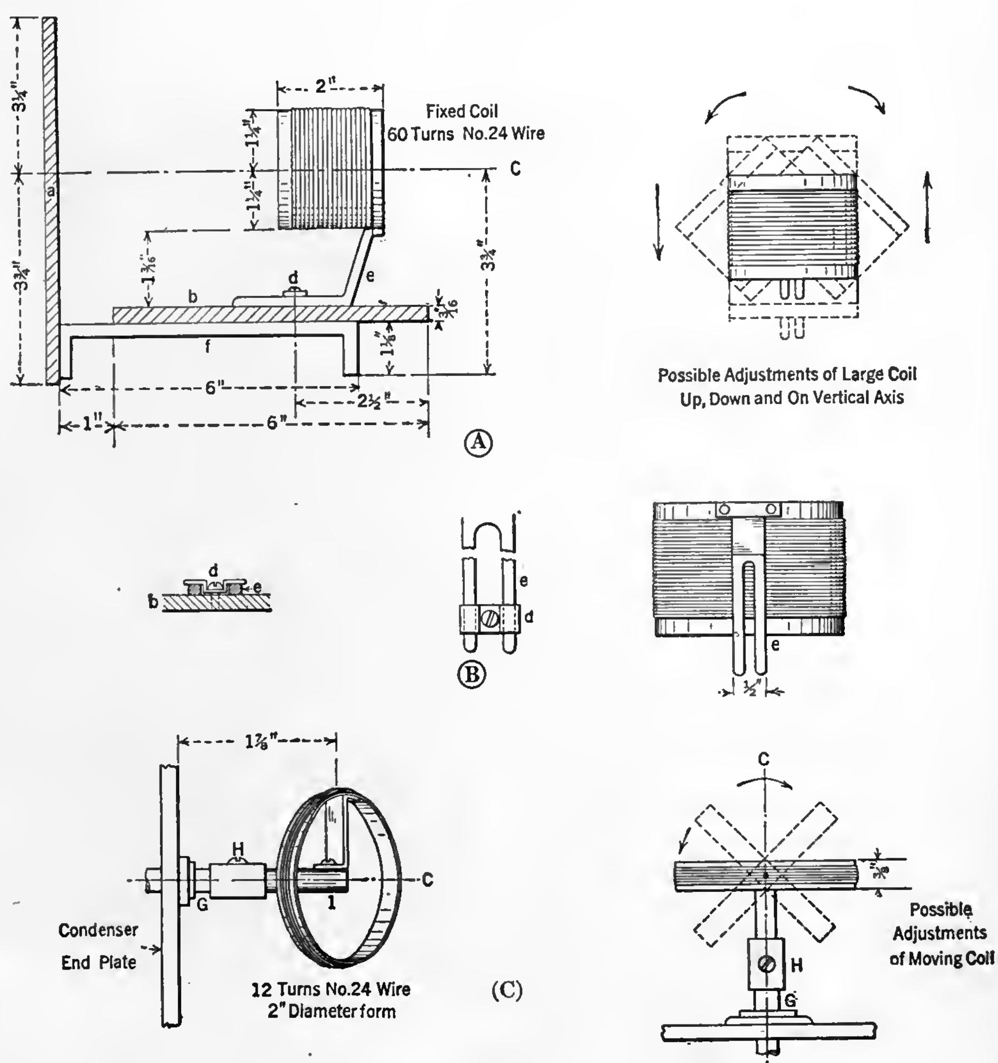


FIG. 3

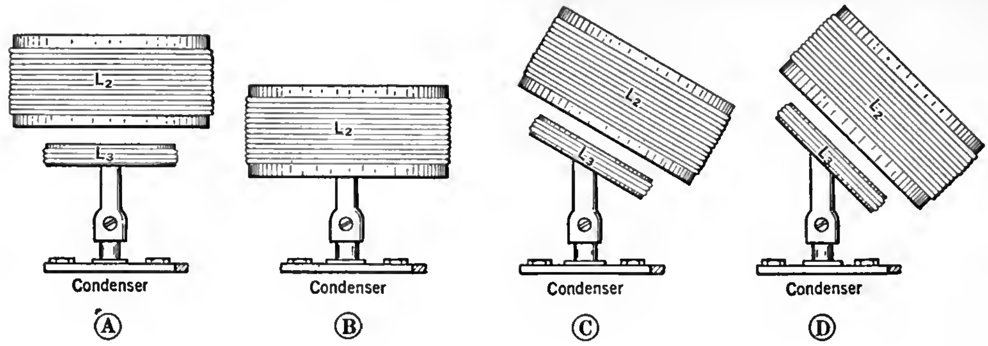


FIG. 4

The plate connection on the socket (P) is led to one side of the tickler coil, while the remaining connection to L_3 is wired to one side of the jack. The bypass condenser, C_3, is connected from this side of the jack to the minus filament post on the socket.

Only the battery posts now remain to be wired. B battery plus is wired to the free terminal on the jack. The minus B connection on the Multiplug is bridged to the A plus connection which is wired to the A plus post on the tube socket, or to any other wire connecting to that post. From the A minus connection on the Multiplug, connect a wire to the switch, S, and from the switch to the rheostat, and from the remaining post on the rheostat to the minus post on the tube socket. All joints should be soldered. The receiver is now completely wired.

The receiver must, of course, be connected to antenna, ground, and batteries as shown in the picture diagram, Fig. 1. A straight, single wire, 75 feet long, stretched as high and clear as possible, makes an excellent antenna for this receiver. A longer wire may lessen selectivity while a shorter antenna will jeopardize sensitivity. A water pipe or radiator makes an excellent ground.

The A battery must be selected to suit the chosen tube. This receiver will operate with any detector tube. A 199 type tube, with six dry cells, connected as shown in Fig. 1, is recommended by the author. Place the tube in the socket, turn on the switch, and turn the rheostat up slowly. Barring defects in the wiring, parts, or tube, the bulb will light as the rheostat knob is turned from left to right. Turn the rheostat three quarters on, plug in the telephone receivers, and the set is ready to receive.

OPERATION AND ADJUSTMENT

AS THE adjustment of the receiver coils consists in so arranging them that the circuit will be slightly below the oscillation point at all wavelengths, it will be well to make clear just how we can tell when the receiver is oscillating. Oscillations will occur when coil L_2 is too close to coil L_3, *i.e.*, when coupling is too tight. If the grid condenser terminal X, in Fig. 1, is touched with the finger when the circuit is oscillating, a loud, definite click will be heard in the telephone receivers. Also, if a station is tuned-in when the receiver is oscillating, a squeal or whistle will be heard as the station wavelength is approached.

It takes less coupling between L_2 and L_3 to produce oscillations on the short waves than on the long waves. The idea in adjusting these two coils is so to arrange things that the coupling at no time is sufficiently great to make the circuit oscillate, for obviously it is impossible to receive enjoyable signals when the set is in this condition. If the circuit is not actually oscillating, but is very close to the point, signals will still be unsatisfactory, suffering from a muffled distortion.

Fig. 4 shows a series of various coil positions to which we shall refer in our endeavor to make clear the manner of adjusting the coils, which, after all, is really a very simple process.

Move coil L_1 on its hinge until it makes an angle of about 45 degrees with L_2. This is the right primary coupling for the average antenna.

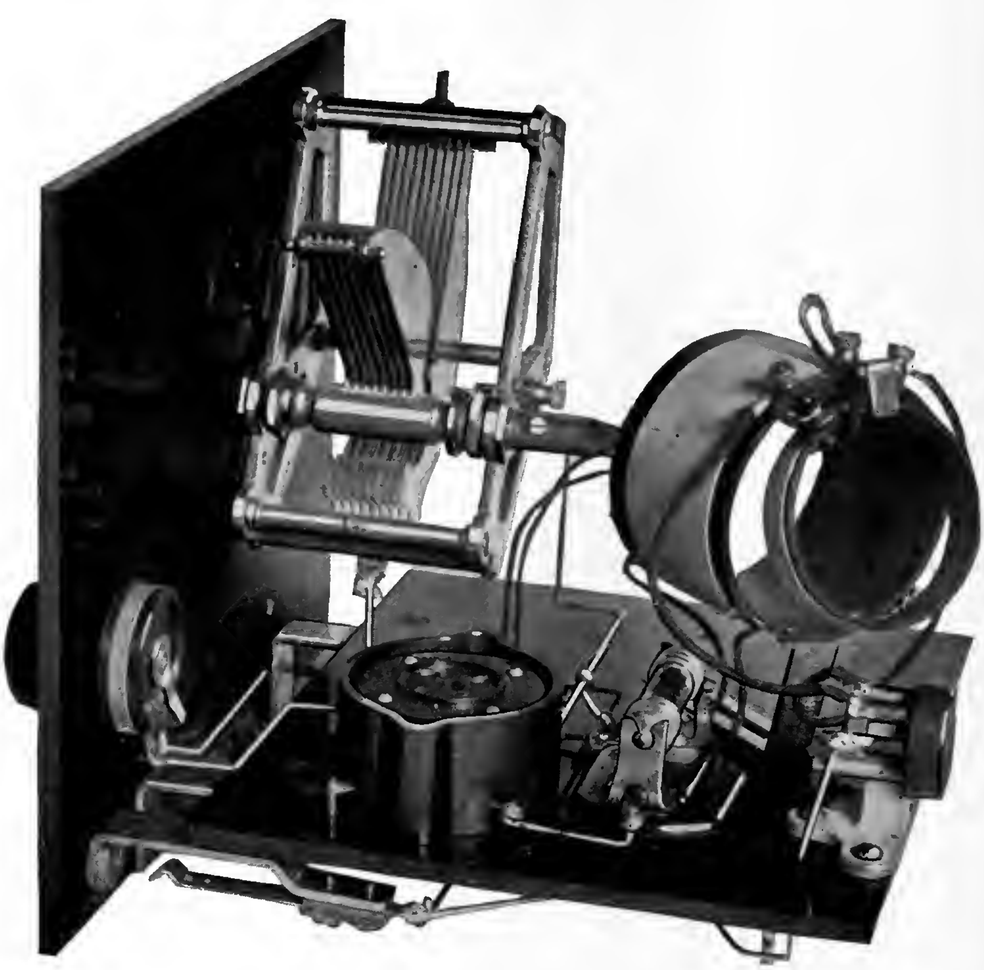
Turn the condenser all the way in, *i.e.*, so that the rotor plates are completely inside of the stationary plates. Now adjust coil L_3, by means of the set screw fastening the support to the extended condenser shaft, so that it can be turned on a vertical axis, as shown in the lower right hand illustration in Fig. 3. Tighten the set screw, it need never be touched again. Place L_2 as shown in A, Fig. 4. Now push it down over L_3 as shown in B. The circuit should now oscillate. If it does not oscillate, reverse the connections ("a" and "b" in Fig. 1) to the tickler coil.

Pull coil L_2 away from L_3 until oscillations stop—no further. Now turn L_2 and L_3 slightly to one side as in C, Fig. 4. Turn the condenser out. As the wavelength shortens, the set will probably spill over (oscillate) for coupling has not been sufficiently loosened by the turning of the tickler with the condenser to stabilize the circuit on the shorter wavelengths. This being the case, return the condenser to its long wave position, and turn the coils a little more, say as in D. Go down to a short wave and test for oscillations. As long as the set spills over, return to the long wavelength and decrease the angle between the coils and the panel. The circuit must not oscillate at any wavelength. Always make coil adjustment with the condenser all the way in, at which position the coils L_2 and L_3 should be parallel. Tune-in several stations, and listen for distortion. If signals sound muffled or drummy, pull coil L_2 out an eighth of an inch in its slide, without changing its angular relation to the panel.

Selectivity can be increased by still further loosening the coupling between L_1 and L_2—moving the former coil up on its hinge.

Once these adjustments are made, the positions of the coils need never again be changed, unless operating conditions, such as antenna, tube, or battery voltages, are altered.

The set will now tune, giving you maximum volume without distortion, with the simple motion of the single dial. The output of this receiver can be inputted into any conventional amplifier. In the writer's laboratory, it is operating into a three-stage resistance-coupled amplifier using a power tube in the last stage, a combination which has been found ideal.



COMPARE THIS WITH FIG. 1
And you will see how simple the receiver is. The primary coil arrangement is clearly shown here

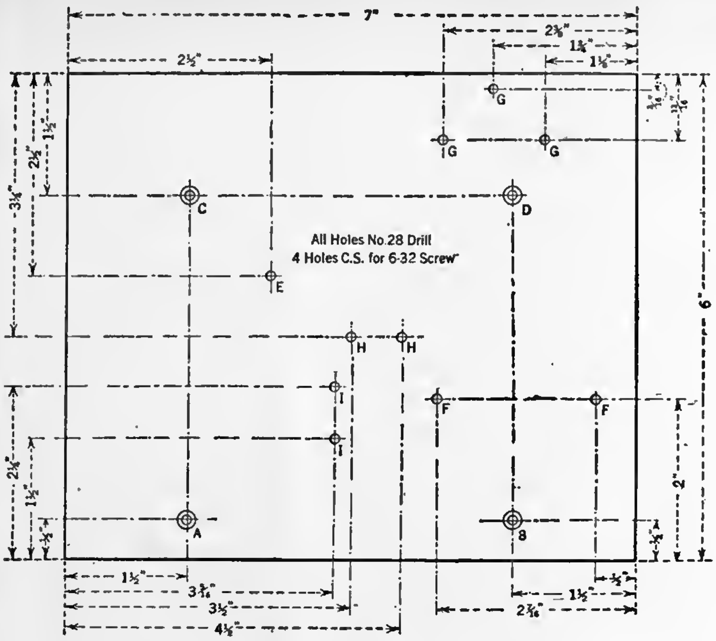


FIG. 5
The disposition of the holes to be drilled in the sub-panel are indicated. On page 171 the purpose of the various holes is told

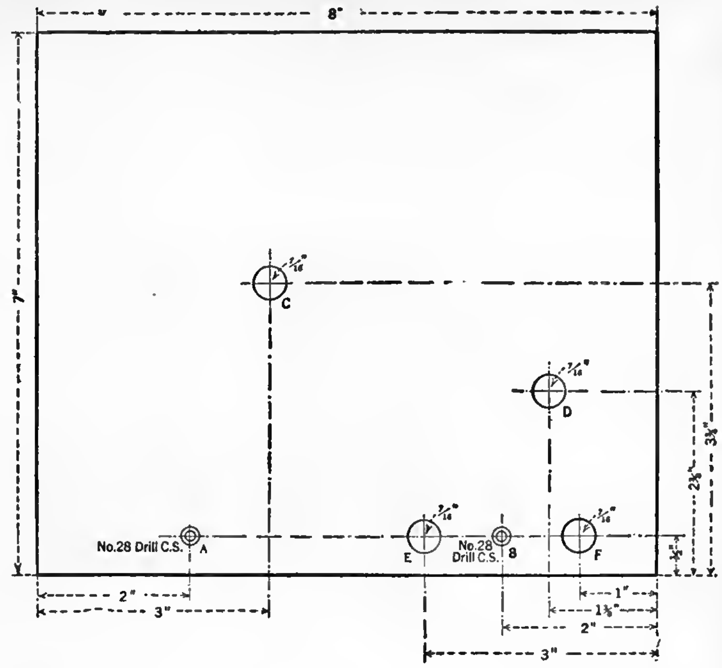
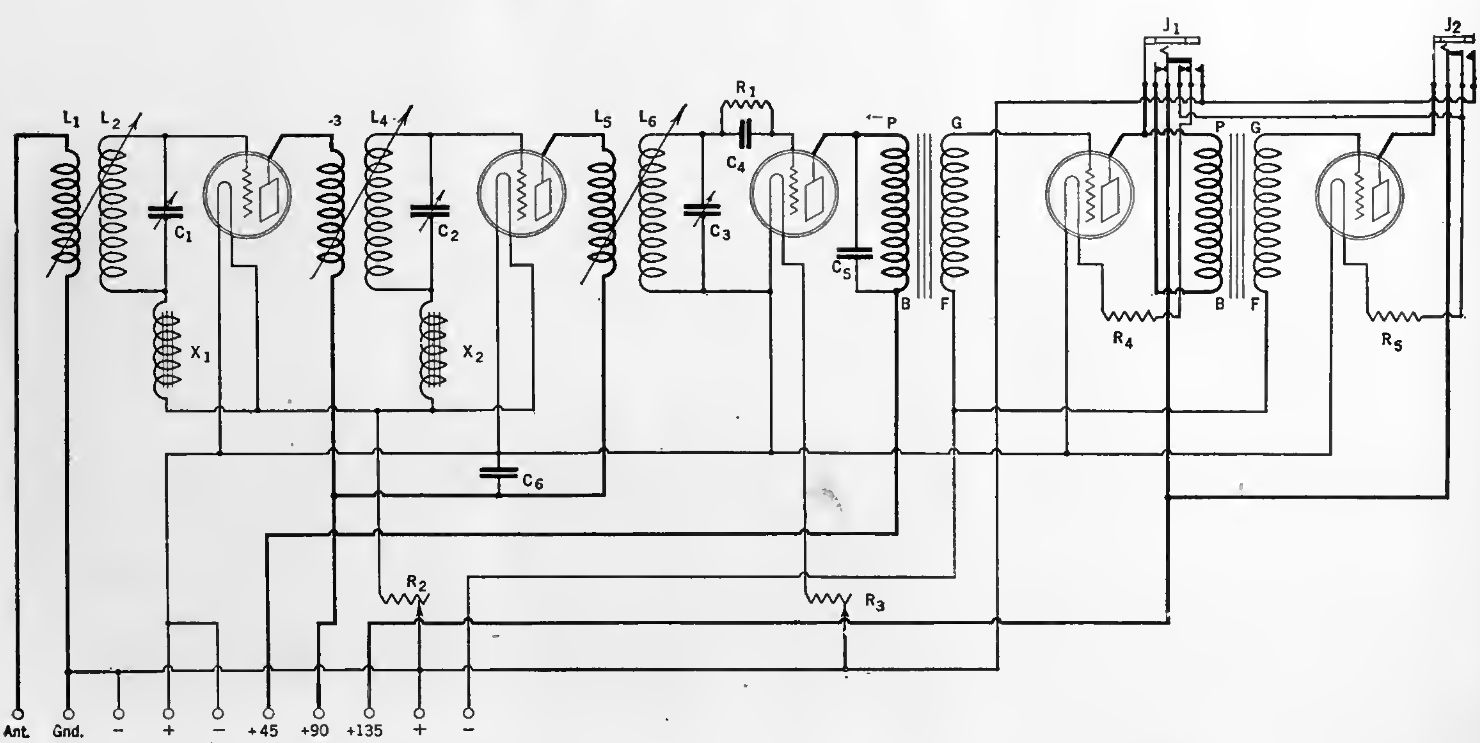


FIG. 6
This diagram gives the data for the drilling of the main panel of the receiver described here

RADIO BROADCAST Photograph

A COMMERCIALLY-MADE COIL UNIT FOR THE "EQUAMATIC RECEIVER"



A FIVE-TUBE CIRCUIT
Employing the system of automatic variable coupling described in this article. Such a receiver was fully described in the October RADIO BROADCAST

Short-Wave Activity at the Laboratory

How Station 2 GY Maintains Communication With Expeditions—The MacMillan Arctic Expedition—Working With Dyott in Brazil—Reports on 2 GY Signals Are Asked

By KEITH HENNEY

Director, Radio Broadcast Laboratory

COMMANDER DONALD B. MACMILLAN
At the wheel of the *Bowdoin*

ACTIVITIES at 2 GY, the experimental station of RADIO BROADCAST, working on 7688 kc. (39 meters), for the last few months have been chiefly concerned with the problem of maintaining communciation with the various Arctic expeditions, notably the MacMillan expedition to Greenland.

As stated in the October RADIO BROADCAST, the operator on the Schooner *Sachem III*, Mr. Austin C. Cooley, who built and installed the equipment on that ship in coöperation with the technical staff of RADIO BROADCAST Laboratory, was a member of the staff at 2 GY, and naturally the Garden City Station has been most interested in KGBB, the call letters of the *Sachem*. The log at 2 GY is most interesting from the time the expedition left Wiscasset in June until its return to that port about the middle of September. The log reveals nights when communication was impossible due to swinging signals, for example when the schooner crossed from Labrador to Greenland, and when going up the Newfoundland coast. Again there were times when communication was most reliable and messages to and from the vessel were handled at great pace.

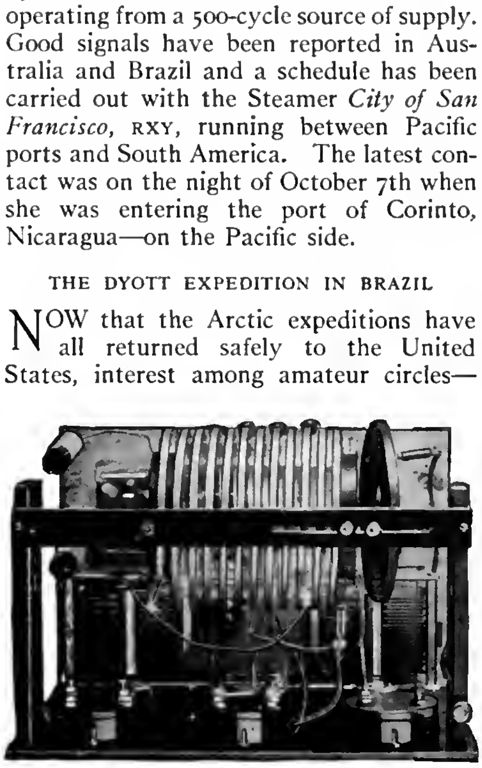
Mr. Cooley's equipment consisted of a single 250-watt tube, powered from a motor generator which secured its power in turn from storage batteries charged from the ship's Diesel engine. The wavelength of KGBB was 8103 kc. (37 meters) and 15,000 kc. (20 meters). KGBB's receiver was constructed in RADIO BROADCAST Laboratory and utilizes a set of Silver-Marshall coils tuning from 18748 kc. to 1499 kc. (16 to 200 meters).

From 2 GY more than 200 private messages were handled with KGBB, not counting service messages to and from the two stations regarding radio matters. Stations 1 AAY and 1 AKZ also handled considerable traffic with KGBB and when 2 GY was out of communication, relayed messages to the expedition.

During the time the *Sachem* was en route to and from the Arctic a new station was put on the air at 2 GY. It uses two 250-watt tubes in a self-rectified circuit operating from a 500-cycle source of supply. Good signals have been reported in Australia and Brazil and a schedule has been carried out with the Steamer *City of San Francisco*, RXY, running between Pacific ports and South America. The latest contact was on the night of October 7th when she was entering the port of Corinto, Nicaragua—on the Pacific side.

THE DYOTT EXPEDITION IN BRAZIL

NOW that the Arctic expeditions have all returned safely to the United States, interest among amateur circles—



THE DYOTT EXPEDITION'S PORTABLE TRANSMITTER

as far as expeditions are concerned—centers about the Dyott venture in Brazil. As mentioned in the October RADIO BROADCAST, this party sailed on the S. S. *Van Dyke* on July 24th to re-explore the River of Doubt originally mapped by Colonel Theodore Roosevelt. Two amateurs of Yonkers, Mr. Arthur Perkins, 2 APQ, and Mr. Eugene Bussey, 2 CIL, are the operators on this trip.

The portable set taken by Mr. Arthur Perkins up the River of Doubt uses the Hartley circuit and the photograph on this page shows clearly the REL inductance, which has secured such favor from amateurs, as well as double spaced Hammarlund condensers for tuning. Mr. Perkins used Sangamo condensers since they are completely enclosed, wherever possible in his set.

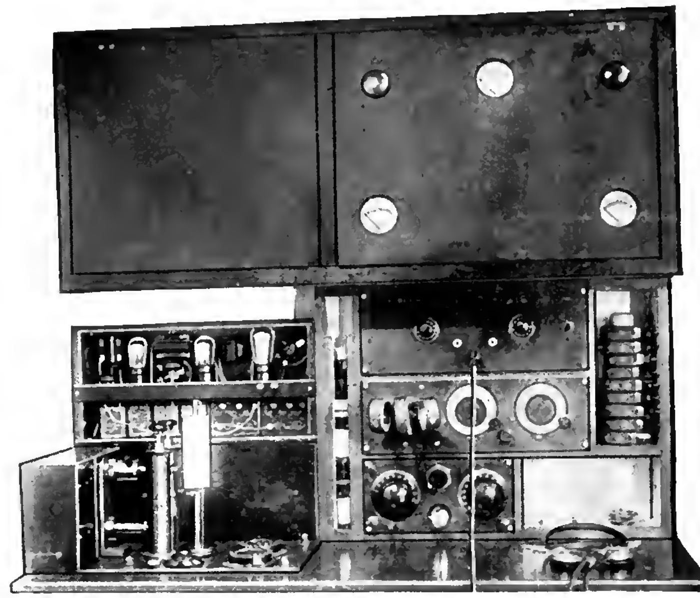
The large Cardwell set used at the base station, GMD, uses two 250-watt tubes in a self-rectified circuit which is powered from a 500-cycle generator run from a kerosene engine.

Two contacts have been reported with this expedition. On the voyage to Rio de Janeiro, the portable station with 24 watts input from Eveready B batteries worked stations in the United States until 1700 miles south of Florida, when communication ceased, to conserve batteries. On the night of September 17th, station 1 CMX at Fall River "clicked" with a station in Sao Paulo which purported to be the expedition station. Several messages were taken for the operator's families. It is thought that Brazilian 1 AB handled the Expedition's traffic in this instance for GMD was not then in operation.

The base station signing GMD should be heard in the United States by the time these lines appear, and amateurs are requested to report contact with 2 GY. The station will be located at the head waters of the River Paraguay at San Luiz de Caceres, 16° 30′ S, 58° W, and should be able to put good signals into this country. With less power than GMD will use, 2 GY has had good reports from England, Denmark, Chile, Australia, and Brazil. Our station transmits on 7688 kc. (39 meters) nightly to the Dyott expedition at 9 p. m. Eastern Standard Time.

THREE OF THE CREW

Of the schooner *Sachem*. Included in the group is Mrs. Rowe B. Metcalfe, wife of the owner of the Arctic exploring vessel



KGBB'S EQUIPMENT

In addition to the short-wave equipment, the radio installation on the *Sachem* included an all-wave tuner for communication with ships, etc.

2 GY'S SHARE

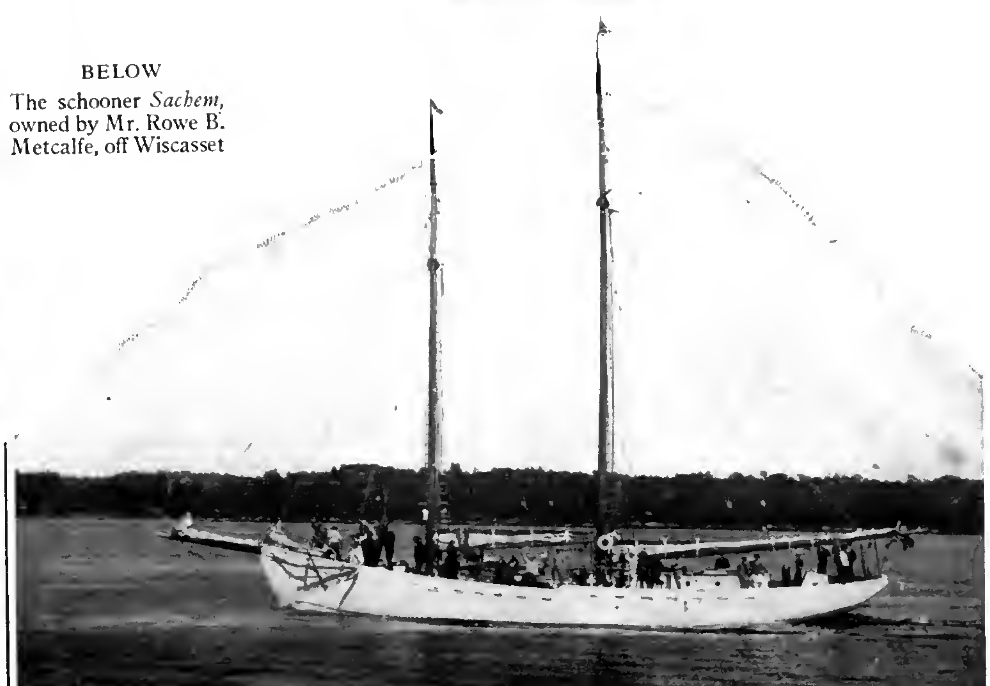
Some of the 200 messages transmitted, and received from KGBB by 2 GY at Garden City

EUGENE BUSSEY, 2 CIL

Who will pound brass at the base station of the Dyott Brazil Expedition

BELOW

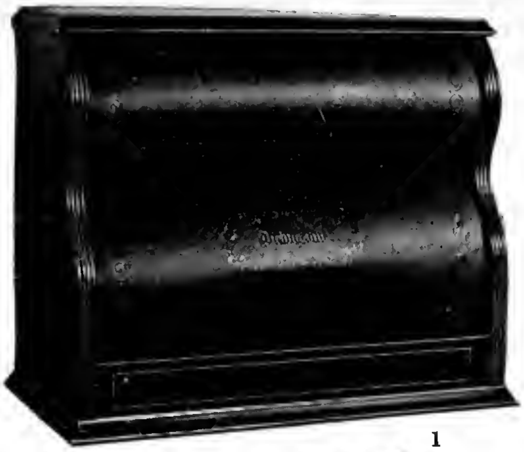
The schooner *Sachem*, owned by Mr. Rowe B. Metcalfe, off Wiscasset



NEW APPARATUS

Equipment of the Radio Industry Submitted to the Radio Broadcast *Laboratory for Test and Approval*

Radio Broadcast *Photographs*


1


2


3


4

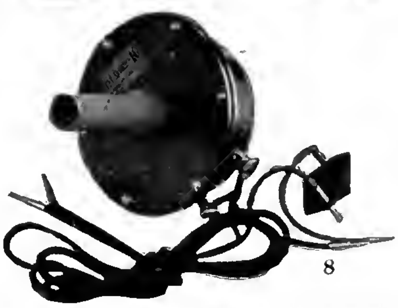

5

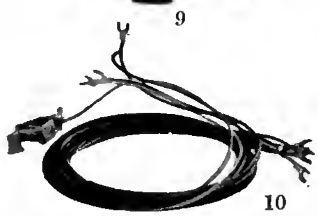

6


7


9


11


8


10

No.	Name of Apparatus	Manufacturer	Use of Product	Price	Remarks
1.	Loud Speaker	Dictograph Products Corp., 220 West 42nd Street, N. Y. C.	Sound reproducer for receiving sets.	$25.00	A loud speaker built under new mechanical principles.
2.	Truphonic Audio Amplifier	Alden Mfg. Co., 52 Willow Street, Springfield, Mass.	Complete three-stage audio amplifier channel.	$20.00	An interesting three-stage audio amplifier employing dual impedance coupling. The tone quality is good.
3.	Tube Charger	Jefferson Electric & Mfg. Co., 507 South Green Street, Chicago, Ill.	Renews life of vacuum tubes.	$3.50	A simple device to which tubes may be connected for the purpose of renewing the emission of the filament.
4.	Portable Voltmeter	General Electric Co., Schenectady, N. Y.	Measures voltages of batteries, line supply devices, etc.	$16.50	This is a double-range type voltmeter, 0-7 5 and 0-150 volts.
5.	Audio Transformer	Benjamin Hughes Co., 298 Lagauchetiere Street, W., Montreal, Canada.	Amplifier of audio frequencies.	$3.50	An inexpensive audio transformer of good frequency characteristics of Canadian manufacture.
6.	Inductors	The Allen D. Cardwell Mfg. Co., 81 Prospect Street, Brooklyn, N. Y.	Inductances for use in tuning circuits.	Set of 3 $4.00	Especially intended for use with Cardwell condensers, these inductance units may be very simply mounted on the end plates of the condensers.
7.	Variable Condenser	General Instrument Corp., 477 Broadway, N. Y. C.	Variable capacity element in tuned circuit.	0.0005 Mfd. $5.50	A ruggedly constructed variable condenser.
8.	Loud Speaker Unit, Hi-Lo	American Electric Co., State & 64th Streets, Chicago, Ill.	Loud speaking attachment for use with horns, phonographs, etc.	$13.00	This loud speaker unit is of the adjustable type, is excellently constructed, and has good tone characteristics.
9.	Rubber Socket	Moulded Products Corp., 549-551 West 52nd Street, New York City.	Resilient vacuum-tube socket which prevents microphonic noise amplification.	$0.60	By the use of a shock-proof socket, much noise may be prevented from reaching the loud speaker. The one illustrated has good shock-proof qualities and will not lose its resiliency.
10.	Battery Cable Connector, Acid Proof	De Jur Products Co., 199 Lafayette Street, New York City.	Used in connecting batteries to receiver.	$1.50 5 ft., 5 way	This battery connector is so shielded as to prevent attack by acid.
11.	Six-Tube Receiver	Mu-Rad Radio Corp., Asbury Park, N. J.	Broadcast reception.	$195.00	An excellent single dial six-tube receiver designed for the use of an UX-112 and similar tubes in the output. Each receiver is individually calibrated.

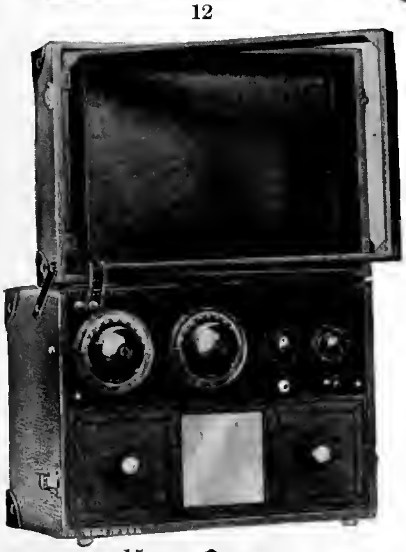
The correct price of the Burns No. 205-B loud speaker shown in this department last month is $22.50, and not $10, as incorrectly listed.

The cabinet loud speaker indicated as No. 1 in the "New Apparatus" section last month, is a product of the Musical Products Distributing Company of New York City, and not as listed. It retails at $65.

12

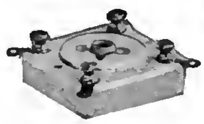
13

14



15

16



17

18

19

20

21

22

23

24

No.	Name of Apparatus	Manufacturer	Use of Product	Price	Remarks
12.	Trouble Finder.	First Aid Specialty Co., Inc., 67 Wall Street, New York City.	Locate interfering and disturbing transmitted noises.	$100.00	A portable four-tube receiver with built-in loop, excellent for the detection of disturbing noises. Excellent as a portable broadcast receiver.
13. & 14.	Loud Speaker, "Peerless."	United Radio Corp., 15 Caledonia Ave., Rochester, N. Y.	Sound reproducer for use with receiving sets.	$35.00	A loud speaker employing a heavy wood housing evidently intended as a baffle. The driving mechanism actuates a cone whose edge is supported on leather. The quality produced is fine.
15.	Portable Six-Tube Receiver	Mohawk Corp. of Illinois, Diversey at Logan Blvd., Chicago, Ill.	Broadcast reception	$135.00	This portable six-tube receiver employs 3-volt tubes. An adjustable loop is contained within the lid. Loud speaker and batteries are self-contained. Three r. f. stages are employed.
16.	Double-Range Voltmeter	Jewell Electrical Instrument Co., Chicago, Ill.	Measure voltages of batteries, line supply devices, etc.	$10.00	A double-range voltmeter suitably housed in a decorative base.
17.	Porcelain Socket	Hart & Hegeman Mfg. Co., Hartford, Conn.	Receptacle for vacuum tubes.	$0.50	Especially suitable for short-wave receivers, where good insulation is desirable.
18.	Variable Resistance Unit, Clarostat	American Mechanical Laboratories, Inc., 285 North 6th Street, Brooklyn, N. Y.	Current and voltage regulator in line supply devices, etc., or wherever variable resistance is desired.	$2.25	An improved variable resistor entirely housed in a metal container. Smooth and permanent in regulation and adjustment.
19.	Fixed Resistance Units Kroblak	C. E. Mountford, 467 Greenwich Street, N. Y. C.	Current and voltage regulator in line supply devices, etc.	$1.00 (up to 10,000 ohms)	A sealed fixed resistor of the wire-wound type, capable of handling 10 watts. Other values at other prices.
20.	Tube Renewer	Sentinel Co., 504 S. State Street, Chicago, Ill.	Reactivates vacuum tubes.	$1.50	A handy device for "flashing" tubes to renew filament emission.
21.	Cone Loud Speaker	Trimm Radio Mfg. Co., 24 So. Clinton St., Chicago, Ill.	Sound reproducer for use with receiving sets.	17", $16.00 14", $12.00	A cone loud speaker, supplied in two sizes, with good tone characteristics.
22.	Set Tester	Hanseom Radio Devices, Woonsocket, R. I.	Sets up local signal with which to test receiving sets.	$10.00	With this device it is possible to provide a local signal adjusted to any frequency within the broadcast frequency spectrum for use as a test of receivers.
23.	Tube Tester, Hoyt	Burton-Rogers Co., 26 Brighton Ave., Boston, 34, Mass.	Measures characteristics of vacuum tubes.	$175.00	A device for measuring amplification constant, plate impedance, and other characteristics of vacuum tubes.
24.	Six-Tube Neutrodyne Receiver	Howard Radio Co., 451 East Ohio Street, Chicago, Ill.	Broadcast reception.	$200.00	A receiver for broadcast reception contained in a burled walnut cabinet.

Additional Notes on the R. B. "Lab" Receiver

Hints on the Use of a Metal Panel—Obtaining the Correct Grid Bias for Power Tube Use—How to Provide for Short or Long Antennas—Suggestions for Home Constructors

By JOHN B. BRENNAN

Technical Editor

FOR the benefit of those who may be interested in experimenting with the R. B. "Lab" Receiver, which was described in this magazine for June, September, and November, 1926, the following additional notes on operation, etc., are presented. Especially do these notes refer to the four-tube model which was described by the author in the November RADIO BROADCAST.

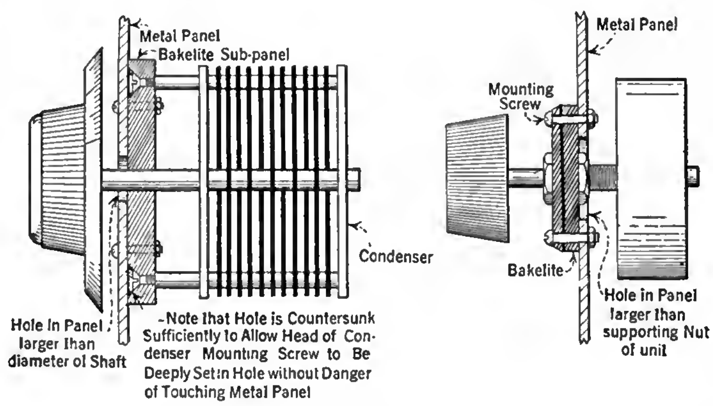


FIG. 1

The use of a metal panel makes necessary the utilization of bushings made of some insulating material to support the instruments mounted on the front panel. This diagram clarifies the method of supporting such instruments

The investigational work leading to the final construction of this receiver was considerable as far as the coils were concerned, many well-known and some obscure forms of winding being tried. Needless to say, perhaps, unshielded solenoids were discarded early in the work; their unconfined fields tended to interact, and thereby upset the balance of the receiver. However, since this type of coil possessed many admirable qualities, its inclusion in the circuit has received more than mere passing attention, and very shortly it is hoped to present to our readers a construction wherein the solenoid type of coil is employed in a completely shielded "Lab" Receiver. Various forms of commercially made binocular coils were tried too, and found wanting. The main fault with these was that the primary coil in the antenna unit was situated at the wrong position with respect to the secondary for best operation in the "Lab" Receiver.

Yet, after considerable experiment, it was decided that the binocular type of coil would give excellent results in this receiver and so a suitable one was designed in the Laboratory of RADIO BROADCAST, its specifications for home winding being detailed in the November article. Suitable binocular coils, compact, and with confined electromagnetic field, are now available for the "Lab" Receiver from the General Winding Company. They are known as Gen-win R. B. "Lab" set coils.

So much for the coils.

A METAL PANEL

IF, INSTEAD of the panel specified, the builder obtains a metal panel for the purpose of providing a very efficient shield, it will be necessary to mount insulating bushings on the panel to support the various instruments located on it. Thin panel material, of bakelite or other such material, will do excellently for these bushings. The insulating material should be $\frac{1}{8}$ inch thick.

Fig. 1 shows how the bushings are adapted to the metal panel. To the left of this diagram is shown the method of mounting a condenser or other instrument not of the single-hole mounting type. Such a condenser is first of all mounted on a suitably sized piece of bakelite in the usual manner, care being taken, though, to see that the screw heads are countersunk well into the material so that they will not come into contact with the metal panel in the final assembly. This point is made clear by reference to the diagram which shows that after the condenser is mounted on the bakelite, the latter is screwed to the metal panel by means of machine screws.

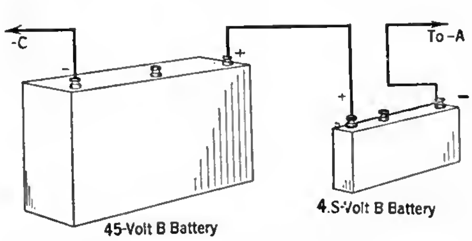


FIG. 2

By bucking together two batteries, one of forty-five volts and the other of 4.5 volts, a resultant 40.5 volts grid bias potential may be obtained

The sketch to the right in Fig. 1 shows an example of the supporting of a single-hole mounting piece of apparatus. The hole in the metal panel is sufficiently large so that the shaft of the unit mounted will not make contact with the metal. The bakelite has been bevelled to improve its appearance.

Completely drilled and engraved composition (non-metal) panels for the R. B. "Lab" Receiver are obtainable from the Insulating Company of America, New York City.

TUBES

IN THE matter of tubes, the R. B. "Lab" receiver was designed primarily for use with standard 5-volt tubes in the first four sockets and a 171 or other semi-power tube in the last audio stage. There are a few tube manufacturers who make special tubes for various uses in a receiver; some make radio-frequency amplifier tubes, special detector tubes, high-mu tubes, etc. The first and second named might very well be employed in the R. B. "Lab" receiver. The number of turns employed in the plate inductance of the r.f. tube will depend upon the plate impedance of the tube, as explained by Keith Henney on page 123 of the June, 1926, RADIO BROADCAST.

If the UX-171 is to be used in the last audio stage with its full rated 180 volts of B battery, the 22-$\frac{1}{2}$ volt C battery must be substituted for one having a total of about 40$\frac{1}{2}$ volts. Such a battery is obtainable from the Burgess Battery Company. Com-

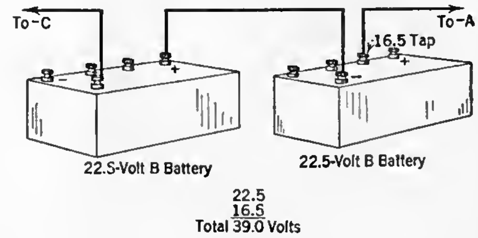


FIG. 3

Two twenty-two and a half-volt batteries, connected in series will no doubt be found satisfactory for use with an UX-171 tube with 180 volts plate potential binations of several of the new Eveready batteries may also be used to obtain the desired C voltage. It is possible also to obtain this 40½-volt potential by bucking a regular 4½-volt C battery with a light duty

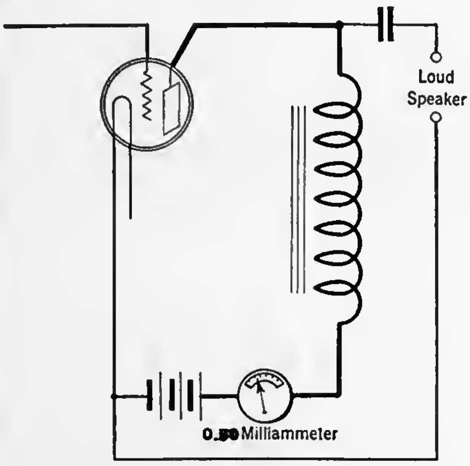


FIG. 4

The connection of a milliammeter in the plate lead of the output tube provides a visible indication as to whether the amplifier is satisfactorily handling the signals or not. Overloading will make itself manifest by a badly fluctuating needle on the meter

45-volt B battery. That is, the positive terminal of the 4½-volt battery connects to the positive terminal of the 45-volt battery. The negative terminal of the large battery connects to the F minus post of the last audio transformer, and the minus terminal of the smaller C battery connects to the minus A lead of the A battery. Fig. 2 illustrates these connections, while Fig. 3 shows how to obtain an approximately correct value by the use of two 22½-volt batteries.

Voltage recommendations are always approximate and, for best results, the home builder should experiment with various voltages. If a milliammeter is obtainable (0-50) it should be connected in the plus B lead to the loud speaker unit. See Fig. 4. Then, when reception is taking place, any distortion which may be present in the receiver will manifest itself in an unsteady, fluctuating reading of the milliammeter. The B and C battery voltages should be adjusted until a minimum fluctuation of the needle from a normal current reading takes place. This normal reading will approximate about 25 mils. It must be remembered, however, that a certain amount of fluctuation can take place before distortion is noticeable. In other words, the fluctuation should be as small as possible, at most not over five milliamperes in twenty-five.

ANTENNAS

With a high, long antenna it is not to be expected that the selectivity of this receiver will be as marked as when a shorter antenna is used. The ideal antenna is one of about 75 feet in overall length. Where a longer antenna is used, a fixed condenser of about 0.0001 mfd., inserted in series with the antenna and coil, will aid in sharpening the tuning. Naturally too, a long antenna will prevent the dials of the receiver reading similarly for a given station.

It is not to be expected that the receiver, when built according to the constructional specifications outlined in the November Radio Broadcast, will immediately fit in with any and all conditions. The R. B. "Lab" receiver was built to meet average conditions, and when it is used under adverse conditions, such as are imposed by the use of an extremely long antenna, some means must be resorted to in counteracting these unfortunate circumstances.

The method employing the fixed condenser, as explained above, is one form of remedy. A variable condenser can be used if desired, and its connections are shown in Fig. 5. To do the job completely, though, the antenna circuit might best be tuned to resonance with the incoming signal, rendering the receiver exceptionally sharp and obtaining a maximum transfer of signal energy from the

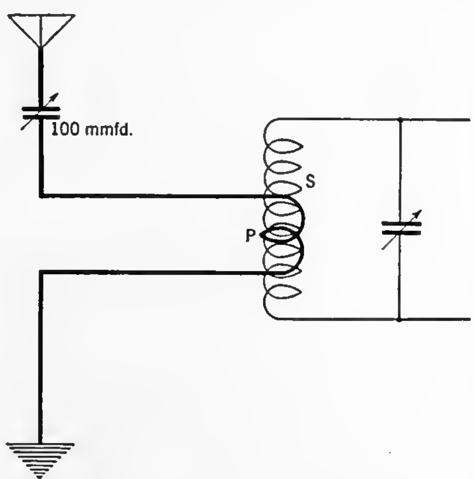


FIG. 5

A condenser (it may be variable) will help to increase the selectivity when a long antenna is used

antenna to the radio-frequency amplifier circuit; even with a small antenna this additional control is worth while from the standpoint of selectivity and volume. The circuit diagram, Fig. 6, shows the additional tuning unit. It consists of an inductance and variable condenser. C_1 is a 0.0005-mfd. variable condenser and the inductance L_1, may consist of about 80 turns of No. 24 d. c. c. wire wound on a 1½" form. This coil should be placed at right angles to the antenna secondary coil. The coupling coil, P, may be the existing primary coil in the set.

Worth while information relative to the tuning of antenna systems was contained in an article by Harold Jollife on page 84 of the November Radio Broadcast. It is recommended that this article be closely studied.

Mr. R. S. Danforth, of San Francisco, California, has written a very interesting and informative letter which is here reprinted in part for experimenters and constructors who have built the R. B. "Lab" circuit.

I have been playing with the so-called Hull or Radio Broadcast "Lab" circuit since October, 1925, with very encouraging results. The action of this set was much improved by using an aperiodic antenna primary coil separated about ½" from the secondary, but I found the response and selectivity was greatly improved by using a separate loosely coupled series tuned antenna coil. This antenna coil was about 3" away from the coil ahead of the radio-frequency amplifier tube, and at a slight angle to it, but at the same time kept at right angles to the detector tube coil. I used the Rice System of neutralization and had no trouble in neutralizing the radio frequency tube.

As an audio amplifier, I am using an Amertran De Luxe first stage transformer with two stages of resistance coupling. I employ an UX-200-A detector tube and 201-A amplifier tubes (excepting in the last stage, where I employ a 171) and find this audio combination superior to using all resistances or two transformers. The radio-frequency amplifier tube is a 199.

As regards the efficiency of this circuit, let me state that my present location is very poor yet I can bring in stations that the ordinary set will not get at all, and these with sufficient volume to overload the 171 power tube.

My R. B. "Lab" Receiver is superior in sensitivity to any set which I have ever heard.

The use of the loosely coupled tuned antenna coil, while adding one additional control, shows a very marked increase in volume as well as giving real selectivity.

Our readers are urged to communicate with the author, or with Mr. Keith Henney, director of Radio Broadcast Laboratory, relative to their experiences with this circuit.

From time to time the data collected in experimenting with this interesting circuit will be passed along to our readers.

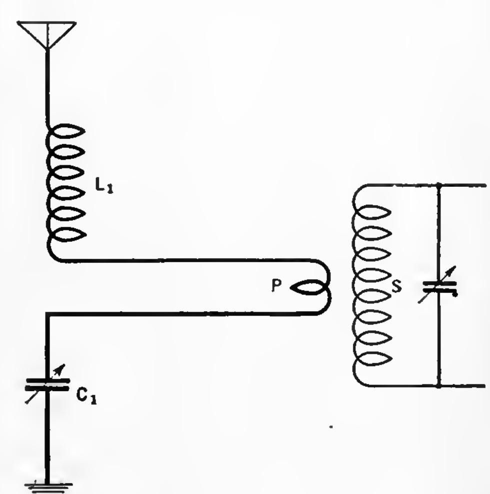


FIG. 6

A better way of increasing the selectivity is to tune the antenna primary circuit. A loading coil and condenser are necessary

Drawings by Stuart Hay

The High and Mighty Place of the Announcer

THE hope has been expressed in some quarters that our most popular announcers may shortly be raised to the dizzy eminence of movie stars. When the day comes, the announcers will be such god-like figures that to tell the truth about them and their trade will be to incur the risk of prosecution for blasphemy. Therefore let us scrutinize them now and hope that the copy gets into print before the ascension.

Almost every man outside of the deaf and dumb asylum believes in his heart that he can announce, just as everybody thinks that the story of his life would make a thrilling novel, which he would be capable of writing with a little practice. What does an announcer have to do? Just talk? Anybody can do that. When a broadcasting station advertises for an announcer, several hundred candidates usually present themselves. Of these, perhaps ten might be considered for the job, after several months of breaking in. Perhaps one out of the lot can be developed into a capable announcer, not a planet of the first magnitude, but merely a tolerably bright luminary. As for the genuine stars, one comes across them by luck; they occur like pearls in oysters. Possibly if ten thousand superficially qualified college men were weighed in the balance, one by one, a single specimen of the really first-rate, polished and gilded, metropolitan announcer would be discovered. And, if he also possessed brains, he could probably make $15,000 a year selling bonds; hence he would not be willing to announce for less than a quarter of that sum. The popular idea that the ability to announce or put one's thoughts across in writing are common traits is true to this extent: anybody can so express himself to his own satisfaction. But it is an altogether different job to do it to the satisfaction of the public and get paid for it.

A capable announcer must, obviously, know the language of the country in which he is to pursue his calling well enough to impress the average auditor. This amounts to saying that his solecisms, errors in speech, and misjudgments in choice of words must not be gross or frequent enough to jar any great number of listeners. I speak now of conditions as they are, rather than as they should be. In this country, announcers who speak correct and beautiful English are rare. Any well-educated listener, spending an evening on the air with many of those who pass as good, can jot down six or eight instances of common mistakes in grammar or obviously unesthetic choice of words. I have heard such mutilations as "Those kind of people" perpetrated in metropolitan stations, without any action being taken against the guilty announcer by either the program manager or the populace. As for some of the small station attachés who take the air, they talk like bootblacks. Taking them by and large, radio announcers do not treat the language nearly as well as junior public speaking instructors in universities, or even high school teachers in English, although I believe the announcers are better in this respect than the general run of elementary grade teachers. There are no doubt a few announcers in the United States who are impeccable most of the time, but if their number exceeds six, I should like to hear their names. There is room for improvement here, and probably standards will gradually be raised. As matters stand, the beneficial influence which radio might exert in raising the standards of spoken English is being realized only in small part.

In foreign languages, the deficiencies of American announcers, as a class, are even more glaring. In pronouncing French names, the rule seems to be that something midway between the actual French sounds and the English equivalents represents the safest course on the air. The subtle differences in vocalization and articulation which constitute part of the flavor, so to speak, of a foreign tongue, are missed ninety-nine times out of a hundred. Most of the announcers remain totally insensible to them, and the fact that few Americans who pass as well-educated are really at home in French, German, Spanish, and Italian, enables the announcers to get away with their barbarities. Even such relatively elementary considerations as the proper value of a French *u* or an umlauted German vowel are sublimely disregarded. British announcers, I have been told, are much superior to our men in this regard.

I do not wish to lay undue stress on the subject of purity in speech, both domestic and foreign, nor to insist on unremitting correctness, which is an impossibility, whether we insist on it or not. A man may make occasional mistakes, and become conscious of them only after the words are out of his mouth; this no doubt happens to every announcer. I believe that the best of contemporary slang, judiciously employed, adds to the force and gracefulness of language, whether spoken or written. Above all, I should avoid stiffness and affectation; it is better to be casual and natural, with occasional grammatical lapses, than to talk like a pedant. But when all this is conceded, the indifference of the average announcer to the qualities of accuracy and beauty latent in his language remains a grave fault, toward the removal of which program directors might well devote a little of their surplus energy, if they have any.

It should be noted at this point that in many of the larger stations, particularly those which specialize in toll broadcasting, the announcer is not altogether responsible for what he says. The material is written out for him, as like as not, and all that remains for him is to read it with an air of spontaneity. He should not be blamed for all his bad jokes and circumlocutions; they may hurt him as much as his hearers.

In general, announcers are not prodigies of intellect; they don't need to be, and if they were they would probably be handicapped in their work. I do not mean that, as a class, the announcers are stupid; on the contrary, most of them are facile and clever, and seem to know more than they actually do. Most of them are confident, amiable young fellows, with plenty of brass in their systems and no tendency toward an inferiority complex. They are the greatest pack of publicity-hounds in Christendom. Do you know why? Simply because they get it so readily. Given the same opportunities, most of the rest of us would chase publicity just as avidly. That is the fault of the age, rather than of the announcers, who have not been at work long enough to exert much influence on the *Zeitgeist*, whatever they may do in the future. Let us not be hypocrites; there are few Spinozas or Oliver Heavisides among us. Nevertheless, personal publicity has a harmful effect on some of the announcing boys; they get it too easily, and fail to realize that they have fallen into a disproportionate share, compared to any other class of workers. The magnification of the ego resulting from this misunderstanding is sometimes alarming, and much good announcer material is ruined thereby. The delusions of grandeur burst with a loud report when the victim gets fired and discovers that once he is separated from his carrier wave, nobody pays any attention to him at all.

What constitutes personality in an announcer —that elusive combination of qualities which divides the merely passable announcer from the star with a great popular following? Broadly, it is the knack of transmitting emotions through the voice only, with the skill of the actor or the elocutionist, confined within narrower limits. Yet these emotions originate, to some extent, in the inherent character of the man himself, and an excess of the theatrical element alienates that portion of the audience whose members are sensitive to pretense. The best symphonic announcer in the East is by no means a facile speaker, but he knows and loves music and possesses a natural dignity which comports with his subject. In other types of broadcasting, theatrical skill and pyrotechnics are more useful, but these qualities must be judiciously handled; the line between entertaining the listeners and enraging all those above the cash-girl level is easily passed over. Genuine wits are few on the air. One thing that is overdone is the "cheerfulness" blather. There is too much insistence on the "happiness" which the next hour will positively generate; one would think that the radio listeners were a mob of melancholiacs.

After all this psychoanalysis and dispensing of advice, I shall probably receive polite inquiries from announcers, or their doting girl friends and mothers, inquiring where I got my dope and whether I have ever faced a microphone myself. I hasten to forestall these comments by admitting that on the one occasion when I wrote an extended piece for presentation via radio I carefully coached one of the young men in my station and let him read it, and if I had to go through with a big good-will feature on the air I should doubtless collapse during the first ten minutes and fall senseless into the condenser transmitter, leaving the mimeograph boy to carry on the great work of the hour.

"I SHALL PROBABLY RECEIVE POLITE INQUIRIES FROM ANNOUNCERS OR THEIR DOTING GIRL FRIENDS"

Taking the Listeners Behind the Scenes

IN THE pursuit of novelties, why doesn't some station put on a "Behind the Scenes" broadcast, giving the radio audience the wire talk, studio conferences, and other preliminaries, before an event is put on the air?

The preparations, sometimes, are more interesting than the actual show. We would hear the command of the control operator to his colleague at the power plant many miles away, "Put on your carrier, Bill, and let's test through"—but the carrier would already be on, and the listeners would enjoy the unwonted intimacy of hearing technical badinage and, if anything went wrong, a damn or two might disturb the calm of an undefiled ether. Next there would be heard the cooing of some beautiful female songster as she entered the studio on the arm of a star announcer, the solicitous inquiries about the health of each by the other, the placing of the microphone, the signal from the control technician to the announcer, and the curtain would rise as usual.

All concerned would know they were on the air, but they would carry on their usual business with as little modification through self-consciousness as they could manage. The audience would like it, I am sure. Everyone likes a peep behind the scenes. If the people in a theater were allowed to go back-stage, in two minutes nobody would be left on the house side of the footlights. As it is, many people who listen to a station night after night, drop in to see the studios and the plant in which their entertainment originates. It is not always possible to accommodate them, for in a busy station the studios, when not in actual use for broadcasting, are generally occupied by orchestras rehearsing for their next performance, artists being put through auditions, piano tuners, and so on. But a little back-stage show along the lines suggested would inconvenience no one and might intrigue the jaded listeners as much as a hog-calling contest, cooking lessons, or a lecture on fighting the boll weevil.

Radio Soaks In

BROADCASTING continues to penetrate the arts and sciences. The newspapers are a good index of its progress. Take the Radio Show Section of the New York *Times*, issued in September. Besides the articles by radio specialists, there were discussions by six prominent orchestra conductors: Walter Damrosch, Willem Van Hoogstraten, N. Sokoloff, John Philip Sousa, Edwin Franko Goldman, and Joseph Knecht. A few years ago these leaders in their respective divisions of musical art never thought of radio except when they wanted to send a wireless message to some passenger on a ship. Now radio concerns them almost as much as the personnel problems of orchestras, the arrangement of programs, interpretations of symphonies, and other matters of direct consequence in their field.

Four metropolitan clergymen, the Rev. Randolph Ray, Dr. S. Parkes Cadman, the Rev. Edwin Keigwin, and Dr. Daniel A. Poling, contribute discussions of radio and its influence on religion to the same issue of the *Times*.

An even more striking item appeared in the New York *Herald Tribune* of August 16th. The music (not radio) critic of the paper, Mr. F. D. Perkins, in reviewing one of the New York Philharmonic Stadium concerts, writes as follows:

> Saturday night's concert in the Great Hall brought, for the first time in this series, Saint Saens's "Carnival of the Animals," and Mr. Van Vliet did excellent work in his cello solo in "The Swan" in the Saint-Saens's varied zoo—judging by a hearing of the concert by radio in Schenectady. Schubert's C major symphony, as heard by the same medium, had a praiseworthy and spirited performance under Mr. Van Hoogstraten's direction.

When music critics base their reviews on what comes to their experienced ears out of a loud speaker, the broadcast program managers and engineers begin to listen for the trumpets of the millennium morn.

"LEAVING THE MIMEOGRAPH BOY TO CARRY ON"

Microphone Symbols

MR. T. R. DAGG, a broadcast technician of Washington, District of Columbia, objects humorously but not without reason to the symbol for a microphone which appeared on Page 246 of the July issue

"YOU CAN HEAR THE MUSIC FOR TWO BLOCKS"

of RADIO BROADCAST. Mr. Dagg concedes that the symbol used is in accordance with the 1926 report of the Committee on Standardization of the Institute of Radio Engineers, but he argues that this picture (repeated here in Fig. 1A), while well enough for the standard transmitter used in commercial telephone practice, does not properly represent broadcast conditions. He proposes the symbol shown in Fig. 1B for a double-button carbon microphone of the type usually found in broadcasting studios.

Brother Dagg's sketch is superior to the I. R. E. symbol in that it shows the two buttons and permits a correct connection, graphically, in the circuit; the fact that we are dealing with a variable resistance is also emphasized. What is less advantageous is that the intersecting arrow is normally used to indicate a manual variation by an operator or user of the instrument in question, rather than the variation of resistance of audio frequency, in accordance with impinging sound waves, which we find in the microphone. Nor does Mr. Dagg's symbol cover electrostatic and electromagnetic transmitters.

Figs. 1C, D, and E show a possible set of symbols for carbon (double-button), electromagnetic, and electrostatic transmitters, respectively. In the first, the two variable buttons, the diaphragm, and the back are shown; the second contains the electromagnet; and the third is obviously a condenser. The variation mark in each case is a wavy diagonal line, to indicate both variation and the generation of an alternating current.

But this is perhaps too complicated to meet the approval of the Committee on Standardization. They might prefer to compromise on something like Fig. 1F, for a double-button carbon microphone, which is simply the standard symbol with the addition of a middle lead; while for electromagnetic and condenser transmitters the original standard symbol would serve, with a printed addition indicating the type. It is a question how far we wish to go in complexity in order to secure a more literal representation, when the primary object of a symbol is to depict by a simple graphical substitute apparatus which is inherently much more complicated, by regarding the principle rather than the machine itself.

A Louisiana Tragedy

REMONSTRANCE of a listener, unaccustomed to the vagaries of August transmission, addressed from New Freedom, Louisiania to WJZ, New York (transmitter at Bound Brook, New Jersey):

I think the programs you give are about the best, and you will realize therefore that I am just a little disappointed when your waves do not come in strong. When it comes in strong you can hear the music for two blocks when the loud speaker is placed on our porch, but now you cannot hear it for more than half a block.

Oral comments of three unfeeling engineers:
He seems all broken up about it.
Please frame this letter.
That's easy. Tell him you have moved the station one and one-half blocks farther away.

The Economic Aspect of Radio Engineering

AFTER some kind remarks about our article in the September issue, "A Lesson for the Radio Class," in which a comparison was drawn between radio and civil engineering design, Mr. Orrin L. Brodie, a member of the American Society of Civil Engineers, and one of the designing engineers of the Holland vehicular tunnel, adds this observation:

Your novel application of the methods of structural design, especially of the tunnel, to the production of adequate power tubes for radio uses, attracted us also, for some of us are radio fans of a mild order. Nevertheless, the possibility occurs to me that the radio engineer is as his civil and mechanical, etc., colleagues are often confronted in higher and better aspirations with the item of *cost*. What is obviously and logically the best in design is often precluded by inability or unwillingness upon the part of those responsible for the finances to provide the funds, notwithstanding that the best is oftenest the cheapest, and the cheapest the costliest in the end, for them.

Of course Mr. Brodie is right. Money makes the mare go, and likewise puts amperes in the antenna and pushes forward the shield behind which the tunnel construction takes place. In the particular instance I cited—the production of power tubes for radio receivers—the economic obstacle was not formidable. That step forward was delayed until a copiously emitting filament material had been developed, and the esthetic evils of output tube overloading were sufficiently realized. But in broadcast transmitter practice, the handicap pointed out by Mr. Brodie is all too often in evidence. There are many small stations operating on a shoe string, as they say down in Wall Street, with the owners demanding technical quality and service comparable to those of the large, relatively wealthy stations, but unable to put up the necessary cash. The position of the engineer in such a plant is most unenviable. The labor of Sisyphus would be a vacation for him. Let him emblazon the words of Mr. Brodie on a sheet of vellum and leave it on his employer's desk some fine spring morning.

Memoirs of a Radio Engineer

XV

IN 1915 and 1916 I took electrical engineering courses at the College of the City of New York under Prof. Charles H. Parmly, at that time a member of the Physics Department. The Department of Electrical Engineering, of which Parmly was the first Professor, was not founded until 1917. Before that date, all technological courses at the College, except for the field of chemistry, were given by Physics professors.

Professor Parmly, at the time I knew him, was a handsome, sparely built man in his late forties. He had a high forehead, penetrating eyes, and hair and mustache just turning gray. He was an engineer (E. E., Columbia University, '92), and he looked and acted the part. Parmly was the most orderly man I have ever known, bar none, and he knocked some of his regularity and logic into me, among others. He hated messy work and messy thinking, and tolerated neither in his students. We stood in awe of him, because he never pretended to know anything he did not know, and what he did know—and that seemed about everything—he had mastered with almost inhuman thoroughness. There was not the slightest hope of bluffing him in a recitation; if there was any portion of the problem wherein you were hazy, Parmly would find it out, and, on the spot,

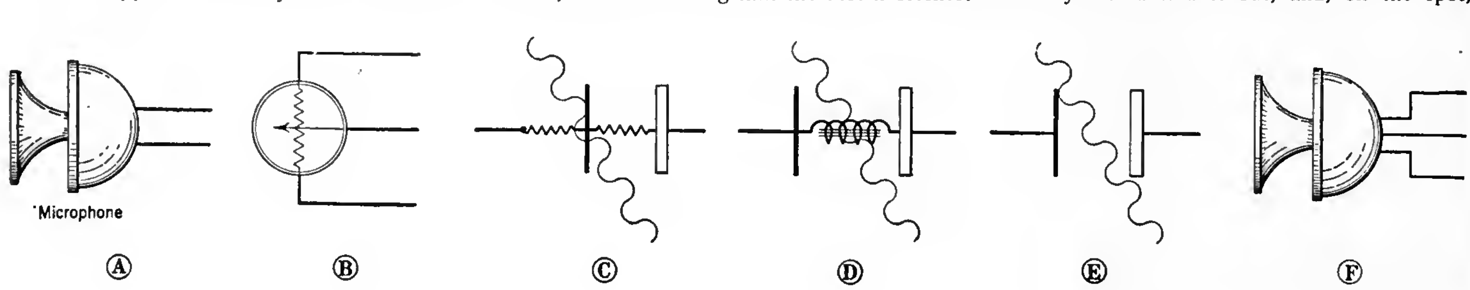


FIG. 1

he would make you clarify your thought, by a method of his own. He never told a student anything, simply in order to get through with the job and on to something else, but, by asking questions in a strictly logical sequence, he would lead him to the correct conclusion. This took time, and when the subject of such a Socratic inquisition happened to be stupid, Parmly would become impatient, but this never impelled him to abandon his method. The only effect was to make him shout his questions in a voice that reverberated through the College halls, while the cowering student stammered his replies in barely audible tones. Finally the correct answer would be drawn out, and then the professor's stern face would break into a smile of startling sweetness, under the influence of which the incipient inferiority complex of the sophomore or junior was transformed into a determination to do better next time.

When Parmly spoke, he fairly etched his words. His clarity of diction and articulation expressed his nature. So did his handwriting, the accounts he kept, and his conduct in all the tasks and responsibilities he had at the College. He had, I believe, a feeling like that of Spinoza for the eternal laws of nature, and the exact quantitative relations of electrical phenomena gave joy to his heart. My radio friends who read this, and who never knew him, may form a picture of a severe and rectilinear character unlike the actual man. He was inflexible only insofar as he knew he had to be to turn out good engineers. He impressed us, by his speech, his precepts, and his methods, with that apprehension of undeviating principles in the behavior of physical things which distinguishes the engineer from the mere rule of thumb, hit-or-miss worker. At heart he was kind and gentle, but he did not shirk the task of the surgeon. He could have sent us on with much less than the pains he took. A man of means and ability, he could have enjoyed an easier and perhaps longer life than the one he chose. After his death, when I was assistant to Professor Goldsmith, I happened to get the task of disposing of some of Parmly's old records. Among other material, there were thousands of inventory cards in his handwriting, in several colors of ink, detailing the apparatus in his charge down to the last screw, with his customary lucidity and order. He did not have to do this. It was simply his way of going about his affairs, without haste, thoroughly, calmly, and efficiently. He made me detest a loose bolt, a poor connection, a sloppy diagram, as an offense, not only against safety and efficiency, but against the esthetic principles of the profession for which he prepared me. Often, in late years, contemplating a dirty shop, or some wretched manufacturing layout, or a test room converted into a shambles, I thought, "Oh for a Parmly, with his determination and his scorn, to tear into this and clean it out, like a wind from the sea!" If you have never seen such a situation in radio, perhaps you have not been in radio long. We have our Augean stables here and there.

The electrical engineering laboratory at C. C. N. Y. in 1916 was not as well-equipped as it is now, but it served the purpose, and a man who could not learn anything from its motors and generators would not be better off at M.I.T. The machines were small, up to perhaps 15 kilowatts, controlled from two main switchboards, with arrangements for stopping and starting individual units by means of clutches in connection with chain drives. We made heat runs on transformers, determined load characteristics of generators, ran Prony brake tests on motors, and went through the whole

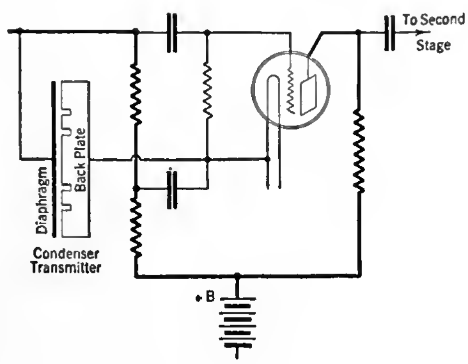


FIG. 2

standard list of experiments designed to prepare the student for the world of industry. At times we mixed up the connections and the breakers would go out with a bang which frightened the men as if they had been so many schoolgirls; it takes years to achieve the nonchalance of the fire-eating engineer who thumbs his nose at an arc and scorns to jump at the crack of the unchained lightnings. Then Parmly would come over and begin catechising us in a gentle and pleasantly sarcastic voice, which gradually rose until it dominated the noise of all the machinery in the building, while we sweated and fumbled for the right replies. When these were at length phrased to his satisfaction, he would look at us for an instant with the bright smile which was like the sun bursting suddenly through clouds, and pass on to the next squad. Not long after, in September, 1917, he died suddenly. If he teaches now in some other sphere, I hope he has better students, but they will not remember him with more deeply felt gratitude than the men he taught last on earth.

All this is not radio, but to those who think of our work as nothing but frequency characteristics, cost data, and the life of power tubes, I should like to remark that such things are based on much else that is outside of radio—on men, in the last analysis.

Technical Operation of Broadcasting Stations

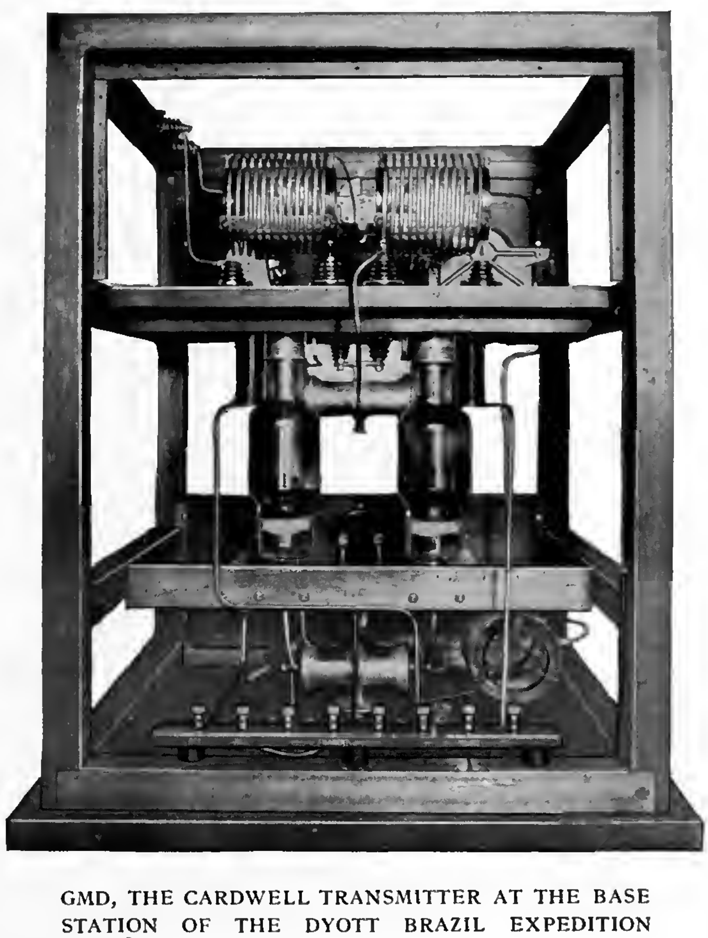
13. The Condenser Transmitter

THIS article is not intended in the strictly practical sense of previous numbers in the series, for very few stations in the United States employ condenser microphones, and the men at those stations have nothing to learn from my description. Nor will any ambitious broadcaster find it possible to build a usable condenser microphone in his home workshop, unless he is a combination of jeweller, toolmaker, and expert electrician; and if he is all those things, his reasons for remaining in broadcasting are quite beyond me. The object of the present discussion is merely to acquaint technical broadcasters with the general theory and characteristics of a form of telephone transmitter in actual use for broadcast purposes, and second only to the common carbon microphone, in practical importance, not only in broadcasting, but in the allied field of phonograph recording.

A valuable description of the condenser transmitter is found in a paper by E. C. Wente: "The Sensitivity and Precision of the Electrostatic Transmitter for Measuring Sound Intensities," in the *Physical Review*, Second Series, Vol. XIX, No. 5, May, 1922. Wente wrote about the condenser transmitter in the same journal for July, 1917; but the later paper gives more up-to-date data.

The condenser transmitter, according to Wente, consists essentially of a thin metal diaphragm under tension, separated by a small distance from a plane metal plate, the plate and the diaphragm forming the two electrodes of an air condenser. The arrangement of these parts is shown schematically in Fig 2, together with the instrument to the associated amplifier. The thickness of the diaphragm is of the order of 0.001 inch (1 mil), and the spacing between the diaphragm and the back-plate is about the same distance. Obviously this construction requires the finest sort of machine work in the first place, and perfect freedom from foreign particles in the space between diaphragm and plate after assembling. A tiny thread of lint or metal cutting will put the transmitter out of commission.

In the design of condenser transmitters, the natural frequency and damping are controlled, among other factors, by annular grooves cut in the back-plate, facing the diaphragm. The sensitivity to ordinary sounds increases inversely as the natural frequency. For broadcast purposes, the diaphragm is generally stretched to a natural frequency of about 8000 cycles per second, a figure sufficiently above



GMD, THE CARDWELL TRANSMITTER AT THE BASE STATION OF THE DYOTT BRAZIL EXPEDITION the audio frequency range normally transmitted to avoid resonance effects. The diaphragm is usually from two to three inches in diameter, which gives a capacity of about 400 micro-microfarads with close spacing between diaphragm and back-plate. This relatively low capacity limits the length of the cable between the transmitter and the input stage of the amplifier system to under 20 feet, and even then it is necessary to devise a special low capacity conductor, since inherently the instrument is a high impedance device, liable to bypassing of the higher sound frequencies if shunted by any considerable capacities. In one form, the transmitter is incorporated in one unit with the first tube, to get around this difficulty. In studio pick-up, however, there is little objection to the more usual arrangement of a compact two-stage amplifier placed on the floor, with a 12-foot length of low-capacity cable running to the transmitter, which is mounted on a concert stand. The vibratory system of the condenser transmitter is essentially the same as that of a high quality carbon transmitter. The latter requires a flow of direct current, in which audio variations are produced through the changes in resistance consequent on the vibration of the diaphragm. Analogously, the condenser transmitter operates with a constant polarizing voltage, which may be as high as 500 volts, but to reduce insulation difficulties, is more commonly set at about 200 volts, supplied by the amplifier plate battery through a suitable resistance. The vibration of the diaphragm of the condenser, when affected by sound waves, varies the capacity of the instrument by about one-hundredth of one per cent., which is enough to produce a slight audio ripple on the grid of the first tube. Fig. 2 shows how the polarizing voltage is connected to the transmitter and the audio output tapped off capacitively.

The instrument has a tendency to be two or more times as sensitive at very low and very high frequencies than in the middle range from 1000 to 5000 cycles. This may be corrected in the associated amplifier.

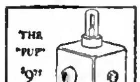
The sensitivity of a condenser transmitter is given by Wente as 0.35 millivolt per dyne of force exerted by the air wave impinging on each square centimeter of the diaphragm. A high quality carbon transmitter will produce over 5.0 millivolts for one dyne per square centimeter of sound pressure, across a 200-ohm load. The carbon transmitter is therefore much more sensitive, since it produces more voltage per unit of air pressure across a low impedance than the condenser across a high impedance. Putting it in terms of telephone levels, we may say that a condenser transmitter, with an output of a fraction of 1 microwatt, is 60 TU's down. A high quality carbon transmitter of the usual sensitiveness is only about 30 TU's down. A gain of 30 TU's means about two stages of high quality amplification. We note, therefore, that the condenser is two stages below the push-pull carbon, while the latter is still two stages below zero level, which may be taken as the average commercial telephone power, involving a power of 0.01 watt. The relatively low quality commercial telephone transmitter is from four to five stages better than a condenser in power output. Unfortunately, it does not provide the quality of output required in broadcasting.

Wente intended the condenser transmitter mainly for reliable measurements in the field of sound, and it continues to be used for this purpose in such highly fruitful measurements as those of Fletcher and Wegel on the sensitivity of the ear, Crandall and MacKenzie on energy distribution in speech, etc. Its more immediate use in broadcasting (a "practical" application, as short-sighted persons would say) provides material for scientific controversy among the more luxurious broadcasters. It is a favorite topic for luncheon arguments among the metropolitan broadcast engineers, second only to analyses of the shortcomings of announcers. The condenser, with its associated amplifier, so placed and padded that it does not pick up microphonically on its own hook, with the best of tubes, and the transmitter itself kept clean and dry, gives a beautiful acoustic output with a practically silent background. The latest and best carbon microphones do substantially the same thing, but expert laboratory maintenance and a large stock to choose from must be available. Some of the early models of condensers were unsuited for broadcast operation, and the troubles to which they gave rise, noised about (*noised* is an unconsciously chosen appropriate word) among the technical brethren, gave the instrument a bad reputation, which, as is usual in such cases, tends to cling to it beyond the proper time. Regarding this, I offer in testimony one condenser transmitter which has given excellent quality without the least disturbance for nine months, although knocked over twice by the studio staff. On the other hand, I should not like to be left without a few good carbons around the station; one sleeps better that way. If Mr. Harry Sadenwater, the champion of condensers among broadcast operating engineers, and Mr. O. B. Hanson, whom I nominate for the same position on behalf of the carbon 373-W and its successors, should care to stage a public debate in Carnegie Hall, I shall be glad to receive a free ticket and to cheer at the ringside. Confidentially, however, I shall continue to flatter both manufacturers with purchase orders, no matter who wins.

DR. L. W. AUSTIN, OF THE BUREAU OF STANDARDS

Doctor Austin is chief of the laboratory for special radio transmission research and the illustration shows him at work in his laboratory, making observations with his double-axis receiving loop which is used in the study of transmission characteristics of radio waves

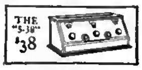
CROSLEY RADIO
All prices slightly higher west of Rocky Mts.



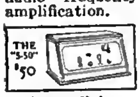
This little double-circuit 1-tube set has made long distance records.

4 tubes. Amazing efficiency, Crescendon equipped!

The 4-29 in portable form.



Five tubes, tuned radio frequency. Two stages non-oscillating radio frequency amplification, Crescendon, two stages audio frequency amplification.



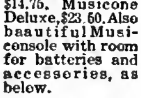
5 tubes, 1-dial control acuminators, Crescendon, power tube adaptability.

5 tubes. True-cascade amplification; non-oscillating and non-radiating.

In a mahogany console. 5-tube 5-50 receiver, Crosley Musicone speaker, ample compartment for batteries.

Double drum station selector! Musicone and room for batteries and accessories.

12-inch size, $12.50. Super Musicone, $14.75. Musicone Deluxe, $23.50. Also beautiful Musiconsole with room for batteries and accessories, as below.



Highly Selective

R.F.L. models

Manufactured under Radio Frequency Laboratory License

Table Model R.F.L.—75

Beautiful two-tone mahogany cabinet—High ratio vernier controlled condensers affording sharp tuning—Recessed dials behind windows—Rich metal trimmings—Power tube adaptability. Appearance and efficiency of this set are out of all proportion to its low cost—the result of Crosley mass production.

$65

6-Tube Console Model R.F.L.—90

Double drum station selector. Mahogany console finished in two tones. Crosley Musicone built-in. Ample space for all batteries and accessories. Power tube adaptability. Comparable in appearance to the highest priced radios, and in performance it has few equals.

$90

Crosley R. F. L. sets represent the highest known development in radio receivers. They will not howl, squeal or re-radiate while tuning—no matter how inexperienced the operator may be.

They are sensitive to a degree rarely attained in tuned radio frequency circuits, cutting out nearby stations with an ease and simplicity that makes them ideal for use in congested broadcasting areas.

Persons technically initiated will instantly understand the perfection of Crosley R. F. L. sets when they realize that true cascade amplification, in addition to absolute balance, is accomplished through the use of Wheatstone bridges in each stage of radio frequency.

To this technical perfection Powel Crosley, Jr. has applied his mass production methods, with the result that nowhere else will the radio buyer find equipment that even approaches Crosley values.

The use of parts in million quantity lots, the simplification of mechanical processes and assembly, and the ownership of wood-working factories which produce exquisite mahogany cabinets at an almost unbelievable low cost, are the means employed by Crosley to make possible the highest type of radio reception at the lowest possible price.

That the public is appreciative of the excellence of Crosley R.F.L. radio sets, as well as the opportunity to enjoy them at small cost, is daily indicated by the tremendous volume of Crosley sales.

THE CROSLEY RADIO CORPORATION, CINCINNATI—POWEL CROSLEY, Jr., President

Crosley manufactures radio receiving sets, which are licensed under Armstrong U. S. Patent No. 1,113,149 or under patent applications of Radio Frequency Laboratories, Inc., and other patents issued and pending. Owning and operating station WLW, first remote control super-power station in America. All prices without accessories.

For Catalogue write Dept. 20

Crosley Features

"CRESCENDON"

When, on ordinary radios, ears must strain to catch a station miles away, a turn of the Crescendon on Crosley radios instantly swells reception to room-filling volume. An exclusive Crosley feature.

ALL-METAL SHIELDED CHASSIS

This truly great radio achievement, found in several Crosley sets, furnishes a substantial frame for mounting elements, produces excellent alignment of condensers, shields the units from each other, prevents interstage, improves the stability of the circuit, increases selectivity and saves costs by standardizing this phase of manufacture.

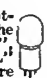
THE SINGLE-DIAL STATION SELECTOR

Nothing in radio equals the joy or the convenience of single dial control. Crosley single drum control enables you to find the stations sought without log book or "tuning"

"THE ACUMINATORS"

Crosley Acuminators permit tuning in—loud and clear—weak stations passed over and entirely missed by ordinary single dial radios. In tuning high powered and local stations they are not used.

USE OF POWER TUBE



Power tube adaptability marks the Crosley "5-50" "5-75" and "RFL" sets. This feature typifies Crosley provision for best radio reception at moderate cost. This feature is in keeping with all that is most progressive.

HEAD PHONES
$3.00

QUALITY AND BEAUTY IN CABINETS AND CONSOLES

The *Radio Broadcast*
LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of Radio Broadcast *have until recently been answered either by letter or in "The Grid." The latter department has been discontinued, and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," appears this series of Laboratory Information Sheets. These sheets contain much the same type of information as formerly appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* Radio Broadcast *of much greater interest to our readers.*

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department. The first index appeared last month.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are requested to send their questions to the Technical Information Service of the Laboratory, using the coupon which appears on page 218 of this issue. Some of the former issues of Radio Broadcast, *in which appeared the first sets of Laboratory Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company at Garden City, New York.*

No. 49 Radio Broadcast Laboratory Information Sheet December, 1926

Trickle Chargers

DIFFERENT TYPES AVAILABLE

IT HAS been customary in general to operate a radio receiver from a storage battery having a very large capacity. However, during the last year or so there has come into rather common use the combination of a storage battery with a trickle charger. This combination consists of a small storage battery which is directly connected to the trickle charger. The trickle charger, connected to the a.c. mains, serves to keep the battery in a constantly charged condition.

There are several types of rectifiers which have been used in trickle chargers. In the bulb type of rectifier, with which we are all familiar, a small vacuum tube is used which rectifies the alternating current and supplies it to the battery. This type is more familiarly known as the Tungar or Rectigon trickle charger, and is very satisfactory and dependable.

The second form of rectifier is the electrolytic type which consists of two electrodes suspended in an electrolyte. It is very simple to construct and works very satisfactorily. It is probably more efficient than the above type since it does not require any energy to light a filament.

The third type, which has only recently come into prominence, uses a crystal. We are all familiar with the crystal detector used in a radio receiver which functions to rectify the small radio frequency currents, and since the trickle charger need only supply a small current it seems quite possible to use a number of crystal detectors in parallel. Several models using this system are now on the market.

The battery used in conjunction with a trickle charger need not be very large since, under normal operation, it need only be large enough to operate a receiver for one day, after which it may immediately be charged. However, it is wise to use a fairly good size battery—a unit having a capacity of about 40 ampere hours should give quite satisfactory operation. With such a battery in use, it will be possible to operate the receiver for several days without charging, and in this way preparation is made for any emergencies that might occur.

When the storage battery is operated in conjunction with a trickle charger the only attention required is to see that the water in the battery is kept above the plates. It will be best to examine the battery about once a month. The rate of charge should be adjusted so as to keep the battery fully charged. This means that, when the charger is first purchased, frequent hydrometer readings should be taken to determine the condition of the battery. If the battery begins to run low the rate of charge should be increased; if the battery gases considerably when on charge, it is an indication that the battery is full and it will then be best to reduce the rate at which the trickle charger supplies current, so as to prevent excessive charging.

No. 50 Radio Broadcast Laboratory Information Sheet December, 1926

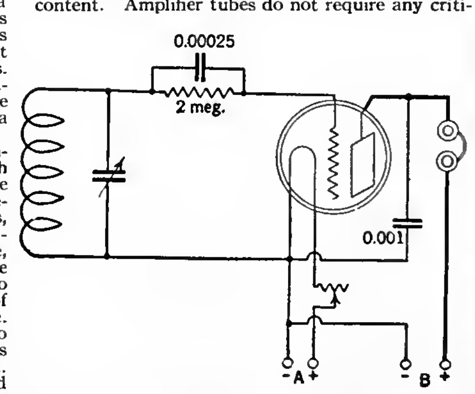
Hard and Soft Vacuum Tubes

SOFT TUBES FOR DETECTOR USE

IF A vacuum tube, during manufacture, has left within its bulb a small amount of gas, or if a small amount of gas is introduced into the tube, it is known as a soft tube. If every particle of gas is removed, the tube is known as a hard tube. Soft tubes are particularly suited for use as detectors. They generally require somewhat critical adjustment of the filament and plate voltages but, once these potentials are found, the soft tube makes a very sensitive detector.

Recently some progress has been made in designing sensitive detector tubes, such as the 200-A, which do not require especially accurate adjustment of the operating voltages. The action of a soft tube depends upon the fact that, at certain critical voltages, the gas in the tube is practically in a state of ionization. Then, when a signal is impressed on the tube, the plate current is caused to change, due to the increase in the flow of electrons from filament to plate and due to the increase in the number of ionized gas particles which also flow to the plate. The plate current is therefore increased by these two effects, so that the total change in plate current is greater than it would be if no ionization occurred. When a soft tube is used for a detector, the grid return must connect to the negative end of the filament instead of the positive, as is done when a 201-A tube is used for detection. Therefore, when changing over from a 201-A to a 200-A, be sure to alter the connections so as to have the return connected to the negative filament.

Hard vacuum tubes are generally used as amplifiers, and structurally, are the same as the soft tubes, the only difference being that they have no gas content. Amplifier tubes do not require any critical adjustment and will operate on from 40 volts up to the maximum that can safely be placed on the tube.



A diagram of connections of a 200-A detector tube is given herewith.

Is *actual* reproduction possible?

ALTHOUGH it is common to hear such claims as "Perfect Reproduction," "Absolute Perfection," "The Living Artist Brought Right into your Home"—in spite of these claims scientists have never boasted absolute *perfection* in radio reproduction.

Let us look at the facts.

At the broadcasting station the music of the violin, for instance, is changed into a radio wave, and is broadcast. It is then detected in your radio set and changed once more into an electric wave carrying the impulses of the music. This electric wave emerges from the detector tube not altogether perfect. However, it is so nearly perfect that radio science has turned its attention from the *broadcasting* and *detecting* phases of reproduction to *the audio amplifying* of the detector tube output.

Reproduction by good amplification has become the most important consideration in the art of radio. The amplifying transformers that were used in radio sets last year are definitely a thing of the past. Almost every set manufacturer has improved upon them. Some have adapted resistance coupling, others large size transformers, and some electric light socket power amplification.

Although these methods of amplification are an improvement, they do not and cannot give *perfect* reproduction, nor do they come as close to perfection as has now been made possible by the recently announced new principle of audio amplification.

The New Amplification

An entirely new system of amplification known as *Truphonic* has been developed. This system more nearly approaches actuality than any other yet devised. Scientific laboratory tests and tests before both the musically trained and the musically untrained ear establish this fact beyond question.

Unfortunately the Truphonic system was not developed in time to be generally used in this fall's production of radio sets—with the exception of a number of the makers of the more expensive sets who have a smaller production, and who were able to incorporate Truphonic amplification into their instruments.

But for radio listeners and lovers of fine music who want this most nearly actual of all reproduction *now* and immediately, the Truphonic Power Amplifier is provided in the simple, compact form shown below—*for instant attachment, without tools, and with no change whatever in your present radio set.*

Whether you bought or made your set this year, last year or five years ago, the Truphonic will give you finer reproduction than you can get in any other way—regardless of how much you can afford to spend.

The Truphonic Power Amplifier operates directly from the detector output. No transformers now in the set are utilized. This pure detector music in every note, tone, and shade and in considerably greater volume, is so beautifully and faithfully reproduced that you will find it as difficult to describe as it is for us to attempt to describe it to you.

The Truphonic with Power Tubes

Besides the fundamentally great improvement in reproduction that the Truphonic brings to radio in such a conveniently applied form, there is the added advantage that for those who want extreme volume without overloading the last stage tube, the necessary extra B and C battery connections for the use of power tubes are provided for in the attachment cord.

We have tried in this space to give you some idea of what you may expect from this new principle of audio reproduction that has come to radio. We realize that we have made some strong claims for Truphonic amplification, but we have made no claim that you will not find more than backed up when you have tried the Truphonic yourself.

We urge you to get the Truphonic *now*—so that you may begin immediately to have an altogether different kind of enjoyment of the splendid programmes that are coming to you over the air.

Your dealer has the Truphonic, or will get it for you.

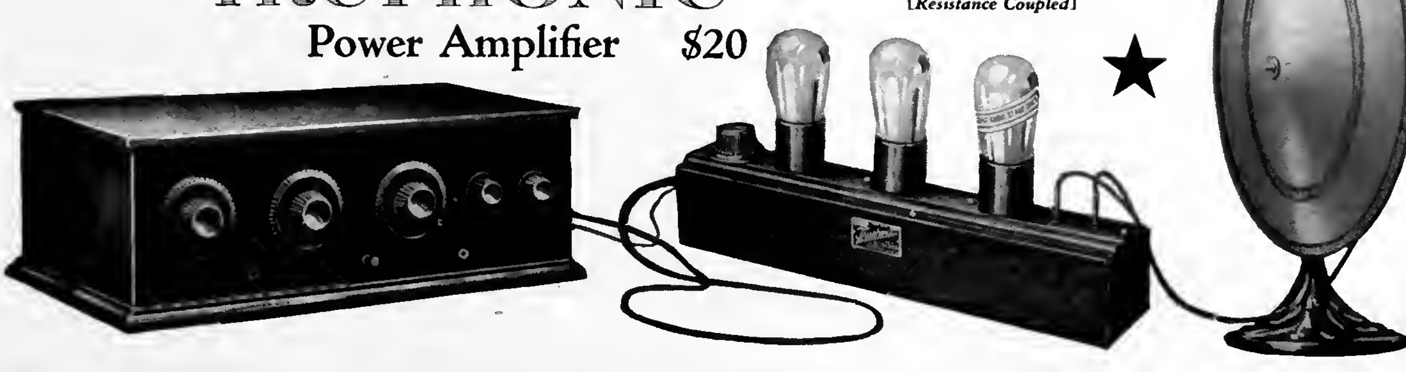
ALDEN MANUFACTURING CO.

Dept. B20 **SPRINGFIELD, MASS.**

TRUPHONIC

[*Not Resistance Coupled*]

Power Amplifier $20 ★



★ Examined and approved by RADIO BROADCAST ★

No. 51 RADIO BROADCAST Laboratory Information Sheet December, 1926

Overtones (Harmonics)

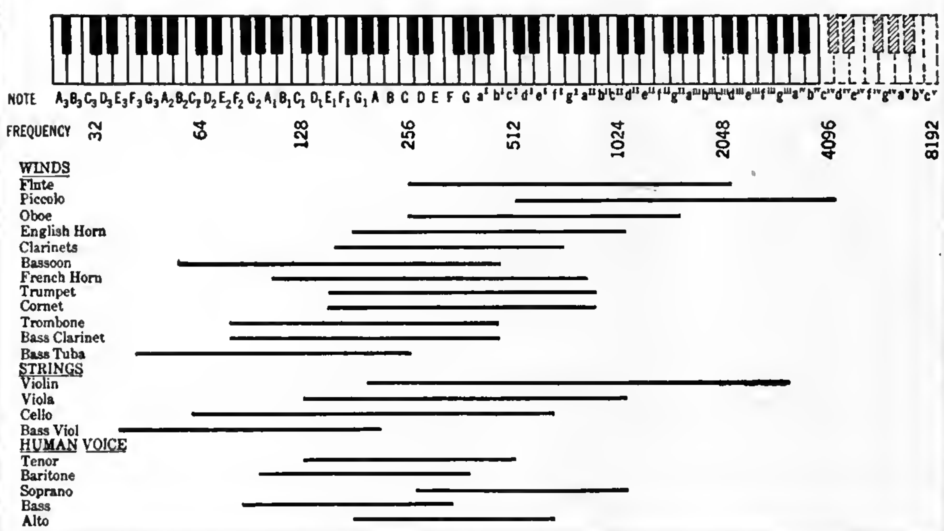
THEIR IMPORTANCE IN RADIO

A GREAT many of the fundamental notes used in speech lie below a frequency of 1000 cycles, but it is the overtones (or harmonics) which determine the quality and timbre of the sound. In order to obtain perfect quality, the characteristics of all the amplifiers and reproducers used in a radio receiving system must be absolutely flat, *i.e.*, they must transmit all frequencies with equal fidelity.

The overtones which were mentioned above are harmonics which are produced by all instruments, including the human voice, and the correct transmission of the harmonic frequencies is essential if the characteristics of the original sound are to be maintained. In many cases it is the prominence of certain harmonics which distinguish the different instruments from others. Quite frequently overtones are confused with octaves. An example will distinguish the difference between these two units. The fundamental sound of, say, 500 cycles has an octave corresponding to 1000 cycles, another octave at 2000 cycles and another one at 4000 cycles, etc.—each octave being double in frequency to the one preceding it. If two octaves are sounded at the same time, it is rather difficult to distinguish between them. On the other hand, the fundamental note of 500 cycles has overtones, or harmonics, corresponding to 1000, 1500, 2000, 2500 cycles, etc. In this case, the various tones are separated by an amount equal to the fundamental frequency. Whereas the difference between two octaves is rather difficult to detect, it is quite easy to distinguish between various overtones. From the above, it is evident that some octaves are also overtones; for example, the octave at 1000 cycles corresponds to the 2nd overtone of the fundamental note of 500 cycles. However, the next overtone is 1500 cycles, but there is no octave corresponding to this pitch. It is evident that, starting with a certain note, all octaves correspond to certain overtones but that all overtones are not octaves. On Laboratory Sheet No. 52 there is reproduced a diagram showing the fundamental frequency range of various instruments. In the diagram given, it will be noted that an extra octave is shown at the high frequency end of the piano keyboard. As experience has shown that at least one harmonic must be provided for when amplifying a signal near the top of the audible frequency scale, to obtain true fidelity, the extra octave is included to indicate the frequency range requirements of an amplifier to successfully reproduce the highest note of the piano, which has a fundamental of 4096 cycles.

No. 52 RADIO BROADCAST Laboratory Information Sheet December, 1926

Frequency Ranges of Musical Instruments

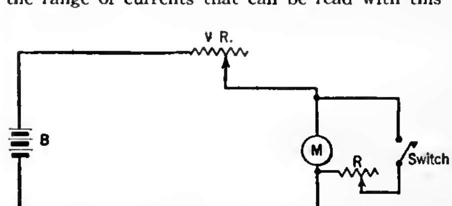


No. 53 RADIO BROADCAST Laboratory Information Sheet December, 1926

Shunts

DETERMINING THEIR VALUE

SHUNTS, as used in an electrical laboratory, consist of an electrical conductor placed in parallel with an indicating meter so as to increase the range of currents that can be read with this



meter. We might have a 10-milliampere meter and desire to read a current of, say, 50 milliamperes; with the aid of a shunt, this can easily be done. The method of calibrating a shunt is indicated in the diagram.

Suppose we desire to calibrate a 10-milliampere meter so that it will read 50 milliamperes. We would connect a battery, B, as indicated on the diagram, in series with a variable resistance, V.R., so as to limit the current passing through the meter (without a shunt) to 10 milliamperes. The resistance would be varied until the meter read exactly 10 milliamperes and then the rheostat R (the shunt) would be switched across the meter and its resistance altered until the meter read two milliamperes. Under such conditions (with the shunt connected), a reading of 2 milliamperes on the meter would mean that 10 milliamperes were flowing through the circuit. Likewise, full scale deflection would indicate a 50-milliampere flow although the needle pointed only to 10 milliamperes. The same procedure would be followed in shunting any instrument, *i. e.*, setting up a circuit which will pass sufficient current to give a maximum deflection on the meter, then shunt the meter and reduce it a definite amount such as one half, one third, or one fifth, then, in order to determine the actual current flowing in the circuit with the shunt connected, it is merely necessary to multiply the meter reading by 2, 3, or 5, depending upon how much the original deflection of the meter was reduced by the shunt.

★

Eveready's exclusive Layerbilt construction *makes this the most economical of* "B" *batteries*

IMPROVEMENT on top of improvement has been the history of Eveready Radio Batteries. Here, in the radically different Eveready Layerbilt, is the "B" battery which tops them all. The ability of this battery to give you unrivaled service and economy is due to its unique internal design. Instead of the usual assembly of round cells, it is built of *flat* layers of current-producing materials pressed firmly together. This construction makes use of the spaces now wasted between the round-type cells and avoids the usual soldered wire connections. Eveready Layerbilt is every inch a battery. This exclusive Eveready Battery development packs more active chemicals in a given space and enables them to produce more current and give longer life.

Tuesday night means Eveready Hour—9 P. M., Eastern Standard Time, through the following stations:

WEAF—*New York*	WTAM—*Cleveland*
WJAR—*Providence*	WWJ—*Detroit*
WEEI—*Boston*	WGN—*Chicago*
WTAG—*Worcester*	WOC—*Davenport*
WFI—*Philadelphia*	WCCO {*Minneapolis* / *St. Paul*
WGR—*Buffalo*	
WCAE—*Pittsburgh*	KSD—*St. Louis*
WSAI—*Cincinnati*	WRC—*Washington*

EVEREADY
Radio Batteries
-they last longer

This HEAVY-DUTY EVEREADY LAYERBILT BATTERY gives twice the service of the smaller Light-Duty batteries and greatly reduces your "B" battery operating cost.

Use Eveready Layerbilts on any set, and get not only this extra service, but also—the greatest "B" power operating economy—the utmost in "B" power dependability—D. C. (direct current) in its purest form, so necessary for pure tone quality. There is an Eveready dealer nearby.

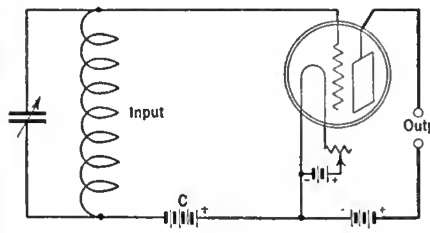
Manufactured and guaranteed by
NATIONAL CARBON CO., INC.
New York San Francisco
Canadian National Carbon Co., Limited
Toronto, Ontario

No. 54 RADIO BROADCAST Laboratory Information Sheet December, 1926

C Battery Detector

FORM OF PLATE CURRENT

IN THIS Laboratory Sheet we are going to discuss some points regarding the operation of a C battery type detector. We are going to consider, in particular, the form of the plate current of this detector tube.



When no signals are being received, the plate current is constant and depends on the adjustment of the C battery. For best operation of a detector of this type, about four volts of C battery should be used on the 201-A when 45 volts are used on the plate. When a signal is received, the plate current varies and is then made up of two components; one of these components is the pure d.c. current that flows in the plate circuit when no signals are being received and the other component is an alternating current which is produced by the audio frequency modulation in the carrier-waves that are being received. Although the detector is a rectifier, the current in the plate circuit is not in the form of a pulsating current as might be obtained from such a unit as a B line supply device, which is also a rectifier.

When the signal is being received, the voltage is impressed across the input on the accompanying diagram. This voltage causes the grid to become alternately more positive and then more negative than the voltage due to the C battery. However, the C battery voltage is such that a greater change of plate current takes place when the grid becomes more positive than it does when the grid becomes more negative; therefore, the current variations in the plate circuit increase more than they decrease and the result is that the average current in the plate circuit is higher than when no signal is being received. These current variations in the plate circuit can be detected if they are permitted to pass through a telephone. Also, if a transformer primary is placed in the plate circuit, the current variations will produce a varying flux in the core and will cause corresponding voltages in the transformer secondary, and these, in turn, can be impressed on a further tube and the signal amplified.

No. 55 RADIO BROADCAST Laboratory Information Sheet December, 1926

Tuning the Antenna Circuit

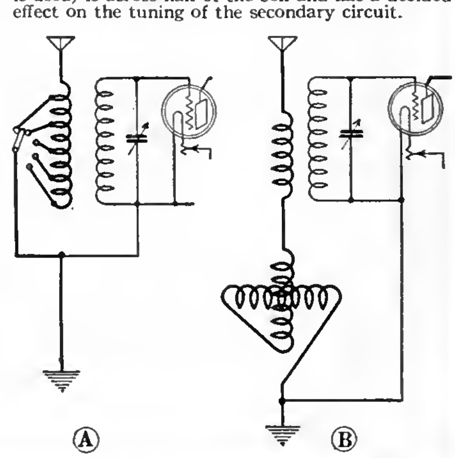
POSSIBLE METHODS TO USE

IN PRACTICALLY all receivers described to-day no tuning is used in the antenna circuit. Generally the antenna circuit is of fairly high resistance and therefore rather broad in tuning and, consequently, it is seldom worth while to accurately tune the circuit. However, some increase in signal strength can be obtained by approximately tuning the circuit to resonance. This tuning can be accomplished in several ways. The simplest method is to use a tapped inductance as shown in sketch A. The taps should be so designed that the antenna circuit is tuned to approximately 1500 kilocycles when the fewest numbers of turns are included in the circuit, and resonant at about 500 kilocycles when the total number of turns are in the circuit.

The antenna circuit may also be tuned with a variometer, as shown in B. The variometer must be capable of being varied in inductance sufficiently to cover the broadcast band of frequencies.

The disadvantage of tuning the antenna circuit is that it adds another control when the trend in design is toward the elimination of controls. Evidently, then, the solution is to design an antenna tuning device that can be automatically controlled, perhaps by attaching some device to the shaft of the variable condenser, such as is done in the "Equamatic" system, to vary the coupling of coils between tubes in an r.f. amplifier.

It should be understood that movements of the condenser across the secondary winding has a tuning effect on the antenna circuit if the coupling between the coils is close. As an example, the coil used in the antenna circuit of a Browning-Drake receiver has a tap at the center for connection to the antenna. Consequently, the antenna capacity (possibly reduced somewhat if a series condenser is used) is across half of the coil and has a decided effect on the tuning of the secondary circuit.



No. 56 RADIO BROADCAST Laboratory Information Sheet December, 1926

Radio Telegraph Transmission

DIFFERENT TYPES OF WAVES

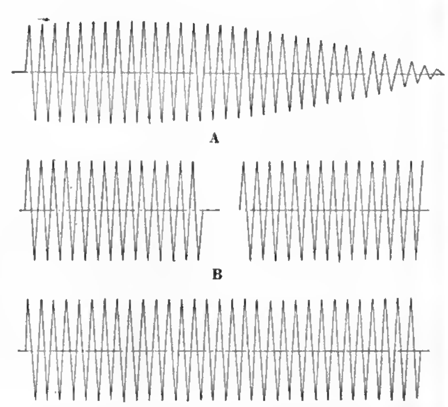
IN TRANSMISSION work by telegraph there are several different types of waves used, these being illustrated in the accompanying drawing.

The drawing A represents the type of wave radiated by a spark transmitter. This form of wave is known as a damped wave since it gradually decreases in amplitude. One of these wave trains is radiated each time that a spark takes place across the electrodes of the spark transmitter. Generally the spark frequency is about 500 per second, so that, if the transmitter was turned on, there would be 500 of these wave trains radiated every second. This type of transmitter is gradually being replaced by apparatus using vacuum tubes for the generation of the high frequency oscillations.

The second form of radiated energy is illustrated in B, and is known as I. C. W., meaning Interrupted Continuous Wave. In this system, the energy is radiated in a series of wave trains similar to the radiations obtained from a spark transmitter, the difference being that the amplitude of the radiated wave is constant and does not decrease as shown in A.

Energy of this form could be obtained by supplying a transmitter from a plate battery in series with which there was arranged some form of interrupter which opened the circuit, say, 500 times per second.

The third type of transmitted wave is known as C. W. or Continuous Wave and in this system, energy is radiated all the time that the key is pressed and it is not broken up as was shown in the two instances given above. This form of transmission is a very common one and is used by the majority of the high-powered transmitter stations and in amateur work.



A Brief Study of Audio Amplification

Type 285
Audio Transformers

Under average conditions two stages of audio amplification are necessary to produce the desired loudspeaker volume.

Usually a combination of 1 to 2.7 and 1 to 6 ratio transformers proves most satisfactory, with the high ratio preferably in the last stage.

The new General Radio Type 285-D transformer has a ratio of 1 to 2.7 and has been designed specifically for use in the first stage of audio amplification following the new type 200A detector tube. Because of its high input impedance, it produces very noticeably better tone quality than is possible with other transformers having a lower input impedance.

This transformer is particularly adapted, therefore, to use in the first stage of audio amplification and gives excellent results in the second stage as well.

		Price
Type 285	1 to 6	$6.00
Type 285-D	1 to 2.7	6.00
Type 285-L	1 to 2	6.00

IN the design of any amplifying device for use at audio frequencies, it should be kept in mind that the curve of voltage amplification against frequency should approximate as closely as possible a horizontal line, if true tone quality is to be preserved in the process of intensifying the audible notes.

Since the purpose of amplification is to effect a considerable increase in volume, the curve representing the character of amplification should be as high as possible as well as a straight line running in a horizontal direction.

While it is a comparatively simple task to design a transformer to have a high and even amplification curve over any narrow frequency band, it is considerably more difficult to maintain the same degree of amplification at very low and very high frequencies as in the middle of the range.

In order that a transformer may function efficiently at low frequencies, its input impedance must be high—several times the plate impedance of the tube at 100 cycles. This is accomplished in the General Radio Type 285 transformers by means of a core of large cross-section of high permeability steel and a primary coil of many turns. Proper coil design, avoiding excessive coil capacity and magnetic leakage prevents loss of notes above the middle register.

Careful laboratory measurements of all General Radio Type 285 Audio Transformers show a high and comparatively flat curve over practically the entire section of the audio range covered by the human voice and musical instruments.

It will be remembered by radio experimenters whose interest in the science dates back to the early days of broadcasting, that in 1917 the General Radio Company brought out the first closed core transformer to be sold commercially. This instrument was the type 166. It established a new and higher standard of audio frequency transformer design. Since that time the subject of amplification has been exhaustively studied in the laboratories of the General Radio Company with the result that transformer design has been constantly improved and today the General Radio Company is universally recognized as an outstanding manufacturer of quality transformers.

Ask your dealer or write for Catalog 925 containing full descriptions of all General Radio Parts

GENERAL RADIO CO., Cambridge, Mass.

Type 369

Coupling Impedance

While the greater amplification that is obtained by a transformer coupled amplifier has much in its favor, slightly better quality can sometimes be obtained by the use of impedance coupling, if one is willing to dispense with the greater amplification per stage of transformer coupled amplification.

The impedance method of coupling is considerably more efficient than the use of resistances because it allows a much larger proportion of the plate voltage to be impressed on the plate of the amplifier tube.

By using a choke of sufficiently high inductance a quality of reproduction may be obtained, which can not be distinguished from that obtained by the use of resistances and a larger amplification per stage produced.

Type 369 Coupling Impedance Price $5.00 each

GENERAL RADIO

PARTS AND ACCESSORIES ★

TWO CARTONS OF "BATTERY REVIVOR"

The contents of these packages were analyzed by a well known institution and were found to consist essentially of epsom salts. As the retail price was $1.00 per carton and the market price for the best epsom salts borders on $2.00 per hundred pounds, it will readily be seen where the profit comes in.

Epsom Salts Offered As Storage Battery Panacea

A Reprint of a Pamphlet Published by the National Better Business Bureau Indicating Their Analysis of Two Advertised Battery Panaceas

SINCE 1887, the storage battery field has experienced periodic epidemics of curative exploitations. It is just now undergoing one of these. Two so-called battery life savers, for which remarkable results are promised, are Sta-Charge and Enrich Battery Saver, marketed respectively by the Kel-Bur Products Company, Salem, Massachusetts, and the Mid-West Sales Corporation, Cincinnati, Ohio. It is claimed that the introduction of these compounds into a lead plate storage battery will correct the majority of ills and troubles to which they may be heir. It is even claimed for one that its use will allow a discharged battery to be fully recharged in from ten to twenty minutes; for the other, that it will keep an automobile battery charged for two years, and for both, that they will double the life of the battery.

In various newspapers, classified advertising like the following has appeared:

Man to Introduce

New, patented process that recharges batteries in 10 minutes, $20-$30 daily. Exclusive territory. I. N. Kelbur, Inc., 21 E. 14th St., New York City.

Those responding to such advertisements have received circular letters over the signature of Jack Pansy, Sales Manager of the Kel-Bur Products Company. According to the letterhead, Mr. Pansy's offices are at 21 East 14th Street, New York City. The Company, of which H. E. Burkhart is President, P. J. Kelleher, Secretary and Treasurer, and L. E. Burkhart, General Manager, has its "laboratory and factory" at Salem, Massachusetts, with additional offices at Sanford, Maine, and at 1625 Sydenham Street, Philadelphia, Pennsylvania. We quote portions of Mr. Pansy's letter:

I am glad you are interested in a process that recharges batteries in 10 minutes. It spells "OPPORTUNITY." Salesmen selling STA-CHARGE are making as high as $40. a day . . . Sta-Charge is put up in 3-ounce cartons retailing at $1.00. We pack 18 cartons to the case. Price to dealers, $11.00 per case, prepaid. . . . If you say the word, I will ship a case to YOU, charges prepaid, C. O. D. $7.00 (or for $6.50 cash with order). Attractive Window Cards, Sales Helps, Pamphlets, Order Blanks, etc. accompany each case. . . . Upon request we will ship a sample carton to you for $1.00, CASH WITH ORDER.

From another of Mr. Pansy's form letters we glean these statements:

Our Salesmen and Managers in many States are "cleaning up" BIG with STA-CHARGE COMPOUND. It is easy to sell a carton to nearly every Battery Owner—and a case or more to live Dealers.

But—you and I are both losing money, because YOUR territory is not being worked. . . . Once a person puts STA-CHARGE in his Radio Battery, he notices almost IMMEDIATELY how much more CLEARLY he hears the voices; he notices that when the Battery DOES run down it can be charged up fully on the "line" in a fraction of the time required when the old solution ALONE was used. . . . Same way with an Auto Battery Owner—when he sees his lights burning brighter, his Battery "FOOL-PROOF"; the resistance to current so REDUCED (by the STA-CHARGE chemical) that his generator alone keeps the Battery always fully charged—naturally he talks about it.

An interested reader of this advertising purchased a case of Sta-Charge. With it he received the window card reproduced on page 198 and a quantity of sales literature. The following claims are conspicuous in this copy:

Keeps your Battery ALWAYS fully charged.
Preserves and lengthens the life of your Battery.
REMOVES and PREVENTS Sulphation.
Will recharge any make of Battery.
Prevents corrosion and shedding of plates.
Prevents plates warping, cracking, and "buckling."
Preserves plates and insulators.
Prevents muddy and soft Positives.
Gives better lights, better ignition, better starting.

Gives more power.
Will not over-charge.
Will not freeze at any temperature.
Batteries filled with STA-CHARGE need not be stored in winter.
Will more than double the life of the Battery.

MR. BURKHART EXPLAINS

FOLLOWING inquiries by battery service-station men to whom Sta-Charge had been offered, the National Better Business Bureau wrote the Kel-Bur Products Company and asked how Sta-Charge could perform so many apparent violations of the laws of electrolytic chemistry. The reply, over the signature of L. E. Burkhart, General Manager, was (verbatim):

"The reason that we make the claims for Sta-Charge that we do, are because those claims are true."

ENRICH BATTERY SAVER

EQUALLY modest are the claims made in advertising by the Mid-West Sales Corporation, formerly at 324 Temple Bar Building, Cincinnati, Ohio, now operating from 3515 Stacey Avenue, Cincinnati, Ohio. Quarter-page newspaper advertisements have carried this message to motorists:

DOUBLE THE LIFE OF YOUR BATTERY

Put ENRICH BATTERY SAVER into your battery and double its life. This newly developed compound will lengthen the life of your battery from two to five years. It does away with sulphation and its accompanying bad effect on the battery plates.

YOUR AUTOMOBILE BATTERY CHARGED FOR TWO YEARS

ENRICH BATTERY SAVER charges your automobile battery for two years, if your generator is working properly. No matter how much current is used for lighting and starting, the generator is able to keep the battery fully charged.

ENRICH BATTERY SAVER IS BATTERY INSURANCE

ENRICH BATTERY SAVER insures you against a host of battery troubles which afflict the battery owner and keep him paying out good money to keep his battery in good condition.

A circular enclosed with form letters issued over the signature of George Henry, Vice-President, contain, among other statements:

Batteries, treated with ENRICH BATTERY SAVER, send a hotter, fatter, spark to the cylinders. The gas is exploded at the proper time, and more power is developed. You get more mileage per gallon of gas. Better combustion prevents the formation of carbon.

ENRICH BATTERY SAVER keeps your automobile battery charged for years, provided your generator is working properly. It doubles the life of automobile and electrolyte batteries—it makes for quicker starting and more effective ignition—it does away with a host of battery troubles.

A small booklet, entitled "Your Storage Battery" advises the battery owner:

"Forget battery troubles—Use ENRICH BATTERY SAVER."

Samples of the two above products were purchased in the open market and analyzed and tested in the laboratories of an institution of national reputation. It was found that Sta-Charge and Enrich Battery Saver are practically the same. They consist essentially of commercial magnesium sulphate (epsom salts) to which some potassium-aluminum sulphate has been added. Undoubtedly, they are made in accordance with the same formula. Several of the Enrich Battery Saver cartons have Sta-Charge labels under the covering which describes them as "Enrich Battery Saver." Each carton contains 3 ounces of the salt mixture and directions for their use are about the same.

We quote below the recapitulations of the findings submitted by the engineer who conducted tests on these products:

Additions of Sta-Charge or Enrich Battery Saver do *not* make it possible to recharge a lead storage battery any more rapidly than under normal conditions.

Additions of Sta-Charge or Enrich Battery Saver do *not* make it possible for a battery to show an increase in energy after standing idle an hour or so greater than with an ordinary cell.

Additions of Sta-Charge or Enrich Battery Saver do *not* make it possible to recharge a fully discharged battery in ten to twenty minutes.

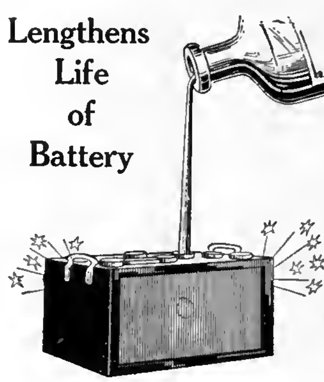
Additions of Sta-Charge or Enrich Battery Saver do *not* prevent formation of normal sulphate on cell discharge.

Additions of Sta-Charge or Enrich Battery Saver do *not* quickly restore the capacity of a sulphated cell.

Additions of Sta-Charge or Enrich Battery Saver do *not* increase the capacity of a lead cell; on the contrary a slight reduction in capacity may even result.

STA-CHARGE

Lengthens Life of Battery



RE-CHARGES RUN-DOWN BATTERIES IN 20 MINUTES

ASK FOR DEMONSTRATION

A STA-CHARGE WINDOW CARD

Additions of Sta-Charge or Enrich Battery Saver will *not* prevent lead cells from freezing.

Additions of Sta-Charge or Enrich Battery Saver do *not* prevent over charge.

Additions of Sta-Charge or Enrich Battery Saver do *not* reduce shedding of active material.

Additions of Sta-Charge or Enrich Battery Saver do *not* prevent buckling or warping of plates.

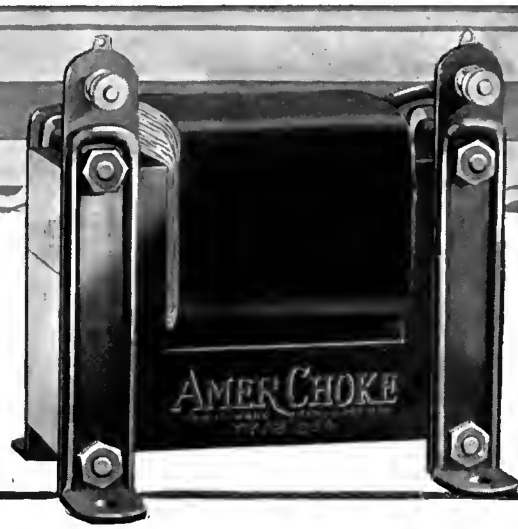
The fact is that additions of either one of these salt mixtures to the lead cell electrolyte accomplished *no* useful effect whatsoever.

Recent quotations on epsom salts were obtained by the Better Business Bureau. Technical grades are quoted at $1.20 to $1.30 per hundred pounds, and United States Pharmacopœra quality is sold at $1.75 to $2.00 per hundred. As Sta-Charge and Enrich were sold to their agents at $6.50 (cash price) for 54 ounces, the margin for these advertisers wasn't so bad. The radio fan or motorist is asked to pay $1.00 for a substance which is sold under its own name at a small fraction of that amount.

YOUR STORAGE BATTERY

A STORAGE battery is not a black box of mystery. It is a compact and sturdy electrical device which performs in accordance with recognized laws of electro-chemistry, just as an

The AmerChoke Type 854 $6.00 each



AMERTRAN RADIO PRODUCTS

A Reliable Choke for Filter Circuits

★

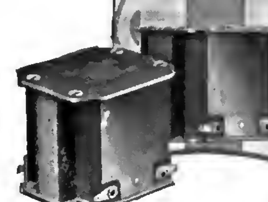
The AmerChoke Type 854 is a choke coil or impedance designed primarily for use in filter circuits. As an output impedance with a fixed condenser it forms an ideal filter for the loudspeaker, insuring tone quality equal to the average output transformer. And it will be *more* economical. For filter circuits in "B" Eliminators, the AmerChoke will give perfect results due to its scientific design and generous proportions.

To obtain even, quiet current supply use the AmerChoke and the AmerTran Power Transformer (described at the left) in the construction of your power amplifier.

The AmerChoke type 854 has a noload inductance of approximately 100 henrys at 60 cycles with average close butt joints. Magnetic saturation from direct current is prevented by two butt joints in the iron core. The AmerChoke shipping weight is about 5 pounds and the price $6.00 each F. O. B. Newark, N. J., or at any Authorized AmerTran Dealer.

The AmerTran Power Transformer Type PF-52

Type PF-52 is intended for use in the best power supply developments. It will convert the standard 110 volt, 60 cycle alternating house lighting current to a higher voltage for plate and low voltage for filament supply. **Price $18.00 Each**



The AmerTran DeLuxe Audio Transformer

This new transformer sets an entirely new standard of Audio Amplification. It makes possible a transformer coupled amplifier that excells all other forms of amplifiers. Made in two types for first and second stages—

Price $10.00 Each

AMERICAN TRANSFORMER COMPANY

178 Emmet Street **Newark, N. J.**

"Transformer Builders for over Twenty-five Years"

Other AmerTran Products:

AmerTran Resistor Type 400 $7.50
AmerTran Heater Transformer Type H-28 (for A. C. Tubes) $10.00.

We shall be very glad to send you upon request a copy of our booklet "Improving the Audio Amplifier" together with other interesting constructional data.

AmerTran Types AF-7 and AF-6

AmerTran Audio Transformers, types AF-7 and AF-6, have been considered for years among the leaders in audio amplification. These popular and efficient models are made in two types—AF-7 (ratio 3½:1)—AF-6 (ratio 5:1)

$5.00 Each

electric motor operates in accordance with the laws of electro-dynamics. Neither can be altogether neglected; yet it is a relatively simply matter to correct minor troubles that may arise, and no great amount of technical knowledge is needed. Just as other items in your car need attention now and then—new oil for the crank case, cold water in the radiator, additional air in the tires—so your battery requires its small share of care. In the case of the automobile battery, if no attention is paid, and it is allowed to become under-charged, if it is allowed to run down and then the driver suddenly calls upon it for maximum discharge by holding down the starter, if distilled water is not added now and then to keep the plates covered, if it is subjected to abuse, any battery will give trouble. But such difficulties are easily avoided by proper care, for which there is no chemical substitute. No solution or chemical will take the place of service. You may service your own battery, or patronize a reliable service station, but service it must have, to perform efficiently.

Advertising of battery panaceas is most harmful in that it encourages battery owners to neglect their batteries—to fail to give them the attention they require, and to create the impression that by artificial means a battery may be made to perform in a perfect manner at all times without human aid.

The tendency of the present age is to look for "short cuts," but there is no "short cut" to battery health and battery efficiency, any more than there are short cuts to human health and long life. Just as many chronic invalids are exploited by vendors of worthless medical panaceas so battery owners are periodically exploited by vendors of alleged cure-alls for battery ills. And just as the medical panaceas fail to provide an effective substitute for rational habits of life, so "secret" battery compounds and electrolytes fail to perform such an office for storage batteries—whether for automotive or radio use. Let your service station dealer diagnose and prescribe for your battery ills, as your physician does for your bodily ills. Give your battery a chance to live and perform and render service. Don't dose it.

BOOK REVIEW

Dreher Answers "What is Radio Broadcasting?"

RADIO BROADCASTING:
From the 13th edition of the Encyclopædia Britannica, 1926. By Carl Dreher.

THE author of the article on radio broadcasting, appearing in the newly published thirteenth edition of the *Encyclopædia Britannica,* was well fitted by experience to answer the questions most frequently asked by the newly interested radio enthusiast. He did more than merely think of the outstanding features of radio broadcast reception as a subject; he carefully considered just which facts a person would want to know who would look up "Radio Broadcasting" in an encyclopædia.

This task was assigned by the editors of the encyclopædia to Carl Dreher, engineer in charge of WJZ, and author of RADIO BROADCAST's department "As the Broadcaster Sees It." In this exposed situation, Mr. Dreher has had every conceivable kind of question of a technical nature asked of him, ranging from, "What kind of receiver shall I buy?" to, "Is green insulated wire better than blue colored wire for a radio frequency coil?"

In his article, Mr. Dreher first of all takes up the all-important point of selecting a receiver by describing its five principal qualities, which are: Sensitivity, selectivity, quality of reproduction, magnitude of undistorted output, and convenience of operation and maintenance. In the section on selectivity, he quotes four standards for that requirement, suggested by Dr. Alfred N. Goldsmith, which seem to be particularly well founded as a classification for various degrees of selectivity. A receiver which must be tuned 80 kilocycles from the frequency of a nearby station before its signals are inaudible is classified as having "poor selectivity." A receiver of "good selectivity" must eliminate the nearby signal 30 kilocycles off its wave; "very good selectivity," 10 kilocycles off tune; and, "excellent selectivity," when 5 kilocycles off tune.

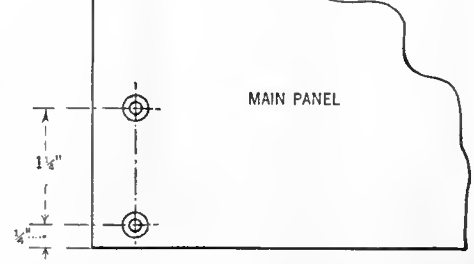
The article then continues with a brief description of various types of receivers classified as crystal sets, non-regenerative, regenerative, radio frequency, and super-heterodyne receivers. Considering the brevity of each of these sections, it is surprising how much accurate information Mr. Dreher is able to place before the reader. Again the thought recurs that only the answering of thousands of questions of curious enthusiasts has enabled Mr. Dreher to pick so skillfully the bare essentials. He does not omit a brief discussion of the sources of power supply, and he pays his respects to the delicate art of home construction in a manner which will not be obsolete or incomprehensible within the next ten years, the average time between new editions of the encyclopædia in recent decades.

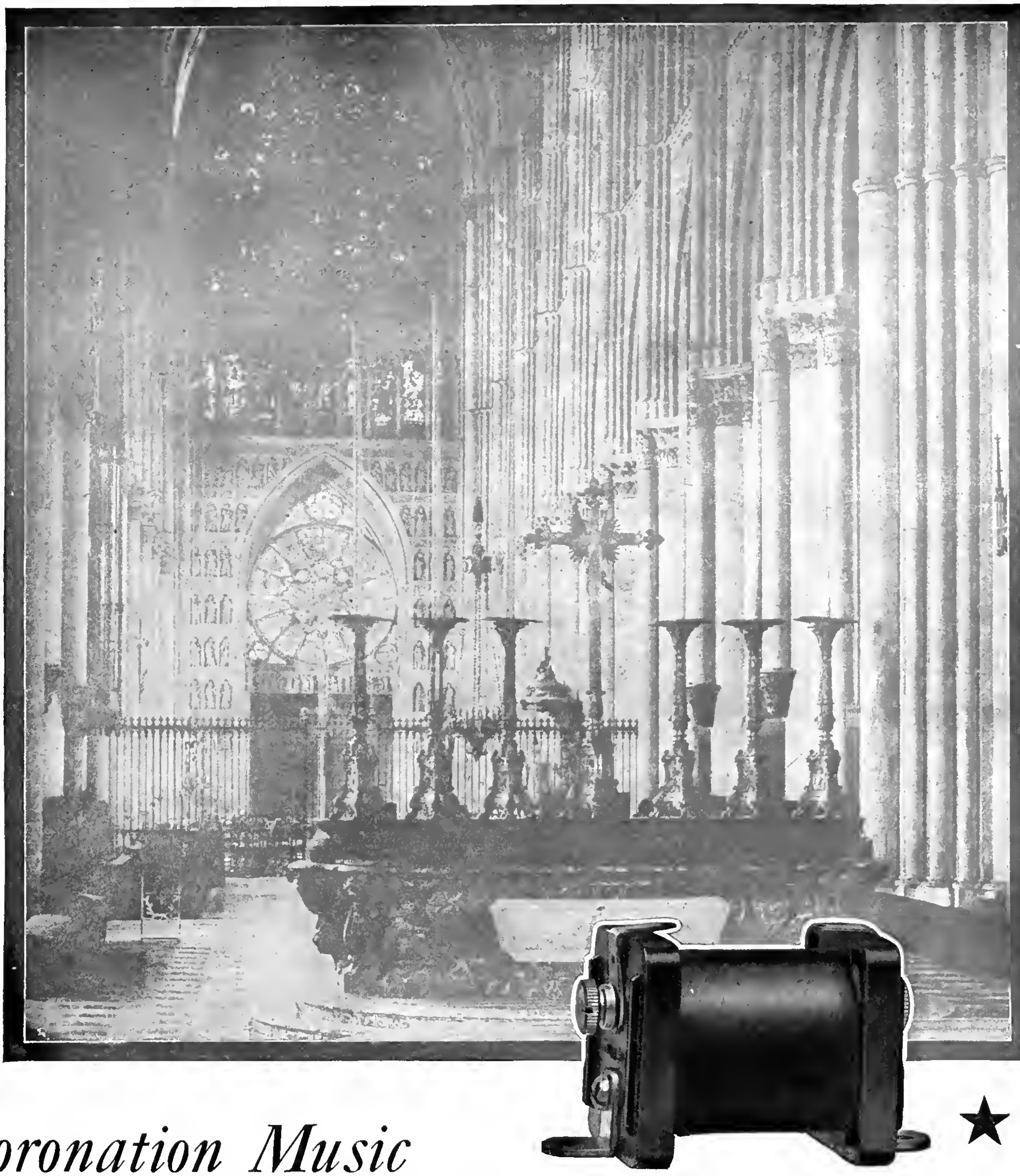
It requires no little courage to write an article on radio to be scrutinized by the curious public from time to time over a period of not less than ten years. Toward the end of that time, Mr. Dreher's illustrations, representing the last word in radio receivers to-day, may look a trifle obsolete and antiquated, just as does the picture of the striking Rolls Royce limousine in the previous edition of the *Encyclopædia* to-day, with its handsome body somewhat along the lines of an ice wagon. Like the motor design of the 1910 Rolls Royce, it is not improbable that the radio frequency end of the radio receiver of ten years hence will be only a refinement of its present-day predecessor, significantly changed outwardly, but still following the general circuit principles now becoming so well established.

EDGAR H. FELIX

Correction

THE location of the holes for mounting the sub-panel brackets to the main panel of the R. B. Impedance-Coupled Browning Drake Receiver were incorrectly shown in the article in the September RADIO BROADCAST. The upper hole should be located $1\frac{1}{4}$ inches above the lower hole and *not* $1\frac{1}{2}$ inches.





Coronation Music in Reims Cathedral was Never More Majestic

than the Radio Melody that floods your home till the very walls seem to sway to its rhythm, and each note hushes to enchantment all present as it wells forth full and true. Then the sense of listening ceases and you are in the great artist's presence. This is radio reception from sets made of Samson parts.

Like most fine things this is not an accident but the result of years of painstaking research and manufacturing effort by Samson scientists and engineers.

For supreme quality of reproduction and the elimination of howling, "motor boating" and other disturbing noises, radio and audio frequency currents must be kept where they belong. For this purpose Samson Chokes cannot be approached because their patented helical winding prevents the choke acting as a by-pass condenser at certain frequencies and reduces distributed capacitance effect to a negligible minimum. These chokes have no pronounced self resonant points. Special bulletins on the uses of these chokes are available.

No. 85 Samson R. F. Choke (85 millihenries).......... $1.50
No. 125 Samson R. F. Choke (250 millihenries).......... $2.00
No. 3 Samson A. F. Choke (3½ henrys).................. $3.00

Our book—"Audio Amplification"—already accepted as a manual of audio design by many radio engineers—contains much original information of greatest practical value to those interested in bettering the quality of their reproduction. Sent upon receipt of 25c.

MEMBER R.M.A.

SAMSON ELECTRIC COMPANY

Main Office, Canton, Mass. Factories at Canton and Watertown, Mass.

Manufacturers Since 1882

★ Examined and approved by RADIO BROADCAST ★

Press, Weather, and Time Signals

Times and Wavelengths of Stations in All Parts of the World Transmitting the Above Signals

IN THE accompanying table of transmissions of time, weather, and press intelligence, which we print, with corrections, through the courtesy of our contemporary *The Lightning Jerker*, a Chicago publication, the scheduled times of transmission are given in Greenwich Mean Time, Eastern Standard Time, and Pacific Standard Time. This list, we feel sure, is as accurate as it is humanly possible to make it, but minor changes are often made at the stations concerned with little or no notice. PX in the last column stands for "Press"; WX for "Weather"; TFC for "Traffic transmissions." The other abbreviations are obvious.

TIME G. M. T.	TIME E. S. T.	TIME P. S. T.	CALL	LOCATION	WAVE IN METERS	FREQUENCY KCS.	REMARKS
01:00	8 P. M.	5 P. M.	WHB	New York	2100	142.8	Spark; Press.*
01:30	8:30 P. M.	5:30 P. M.	MPD	Poldhu	2700	111.0	Spark; Press.
02:00	9 P. M.	6 P. M.	NAH	Brooklyn	1500	199.9	Spark; WX, PX.*
02:15	9:15 P. M.	6:15 P. M.	VCE	Cape Race	600	499.7	Spark; Ice Reports, etc.
02:55	9:55 P. M.	6:55 P. M.	NAA	Arlington	2655	112.9	I.C.W.; WX, Time.
02:55	9:55 P. M.	6:55 P. M.	NAR	Key West	1463	205.0	I.C.W.; WX, Time.*
02:55	9:55 P. M.	6:55 P. M.	NSS	Annapolis	16900	17.74	Arc, WX, Time.
03:00	10:00 P. M.	7 P. M.	NPM	Pearl Harbor	1500	199.9	Spark; Press.
03:05	10:05 P. M.	7:05 P. M.	VBT	Cape Race	2700	111.0	C.W.; Press.
03:30	10:30 P. M.	7:30 P. M.	UA	Nantes, Fr.	2400	124.9	Spark; Press.*
03:45	10:45 P. M.	7:45 P. M.	FL	Eiffel Tower	2500	119.9	Spark; Time.*
03:50	10:50 P. M.	7:50 P. M.	WSH	New York	2478	120.9	Arc; Press.
04:30	11:30 P. M.	8:30 P. M.	WNU	New Orleans	3331	90.04	C.W.; WX, TFC, and PX.
05:15	12:15 A. M.	9:15 P. M.	WRQ	New Brunswick	1250	239.9	C.W.; Press.
05:40	12:40 A. M.	9:40 P. M.	NPL	San Diego	13300	22.54	Arc; Press.
06:00	1:00 A. M.	10:00 P. M.	BZL	Demerra	1300	230.6	Spark; Press†.
07:00	2:00 A. M.	11:00 P. M.	GPH	Guayaquil	750	399.8	Spark; Press.†
07:30	2:30 A. M.	11:30 P. M.	BZM	St. Johns, Nfd.	1500	199.9	Spark; Press.
08:00	3:00 A. M.	12 Mid.	YN	Lyons, Fr.	5000	59.96	Arc; Press.
08:00	3:00 A. M.	12 Mid.	VCU	Barrington	1500	199.9	Spark; Press.
08:00	3:00 A. M.	12 Mid.	NPL	San Diego	13300	22.54	Arc. Press.
08:00	3:00 A. M.	12 Mid.	NAH	Brooklyn	1500	199.9	Spark; Press.*
08:00	3:00 A. M.	12 Mid.	BYC	Norsea	4300	69.73	Arc; Press.
08:00	3:00 A. M.	12 Mid.	NBD	Bar Harbor	1900	157.8	Spark; Press.
08:00	3:00 A. M.	Mid.	KPH	San Francisco	2300	130.4	C.W.; Press.
09:30	4:30 A. M.	1:30 A. M.	MPD	Poldhu	2700	111.0	Spark; WX.
09:45	4:45 A. M.	1:45 A. M.	FL	Eiffel Tower	2500	119.9	Spark ‡
09:55	4:55 A. M.	1:55 A. M.	NAX	Colon	1800	166.6	I.C.W.; Time.*
09:55	4:55 A. M.	1:55 A. M.	NBA	Balboa	7000	42.83	Arc; Time, PX.†
10:30	5:30 A. M.	2:30 A. M.	NBA	Balboa	7000	42.83	Arc.; Press.†
10:44	5:44 A. M.	2:44 A. M.	FL	Eiffel Tower	2500	119.9	Spark; Time.
11:00	6:00 A. M.	3:00 A. M.	GPH	Guayaquil	750	399.8	Spark; Press.
11:30	6:30 A. M.	3:30 A. M.	VMG	Apia, Samoa	2000	149.9	Spark; Press.
12 Nn.	7:00 A. M.	4:00 A. M.	BYC	Horsea	4300	69.73	Arc; Press.
12 Nn.	7:00 A. M.	4:00 A. M.	POZ	Nauen	12000	24.99	Arc; Time.
14:15	9:15 A. M.	6:15 A. M.	VCE	Cape Race	600	499.7	Spark; Ice Reports, etc.
15:00	10:00 A. M.	7:00 A. M.	FL	Eiffel Tower	2000	149.9	Spark; Press.
15:15	10:15 A. M.	7:15 A. M.	BZI	Durban, S. A.	2000	149.9	Spark, Press.
15:30	10:30 A. M.	7:30 A. M.	VIS	Sydney, Aus.	2000	149.9	Spark; Press.
16:00	11:00 A. M.	8:00 A. M.	BYC	Horsea	4300	69.73	Arc; Press.
16:00	11:00 A. M.	8:00 A. M.	FL	Eiffel Tower	2500	119.9	Spark; WX.
16:30	11:30 A. M.	8:30 A. M.	VIP	Perth, Aus.	1500	199.9	Spark; Press.
16:30	11:30 A. M.	8:30 A. M.	WNU	New Orleans	3331	90.04	C.W.; WX, TFC, and PX.
16:55	11:55 A. M.	8:55 A. M.	NAA	Arlington	2400	124.9	C.W.; Time, etc.
16:55	11:55 A. M.	8:55 A. M.	NAR	Key West	1463	205.0	I.C.W.; Time.
16:55	11:55 A. M.	8:55 A. M.	NSS	Annapolis	16900	17.74	Arc; Time.
16:55	11:55 A. M.	8:55 A. M.	NAT	New Orleans	2700	111.0	I.C.W.; Time.
17:00	12 Nn.	9:00 A. M.	NPL	San Diego	13300	22.54	Arc; Press.
17:30	12:30 P. M.	9:30 A. M.	MPD	Poldhu	2700	111.0	Spark; WX.
17:55	12:55 P. M.	9:55 A. M.	NAX	Colon	1800	166.6	I.C.W.; Time.*
17:55	12:55 A. M.	9:55 A. M.	NBA	Balboa	6663	45.02	Arc.; Time.
18:00	1:00 P. M.	10:00 A. M.	VAS	Glace Bay	2700	111.0	Spark; Press.
18:00	1:00 P. M.	10:00 A. M.	VJZ	Rabaul, Aus.	2900	103.4	Spark; Press.
18:30	1:30 P. M.	10:30 A. M.	VID	Darwin, Aus.	850	352.7	Spark; Press.
19:00	2:00 P. M.	11:00 A. M.	XDA	Mexico City	2700	111.0	C.W.; Time, WX.
19:55	2:55 P. M.	11:55 A. M.	NPK	Point Arguelle	1500	199.9	Spark; Time.
19:55	2:55 P. M.	11:55 A. M.	NPL	San Diego	9800	30.59	Arc.; Time.
19:55	2:55 P. M.	11:55 A. M.	NPH	San Francisco	4800	62.46	Arc.; Time.
20:00	3:00 P. M.	12 Nn.	BYZ	Rinella	4200	71.39	Arc.; Press.
20:00	3:00 P. M.	12 Nn.	NBA	Balboa	2400	124.9	Spark; Press.
20:00	3:00 P. M.	12 Nn.	BYC	Horsea	4300	69.73	Arc; Press.
20:00	3:00 P. M.	12 Nn.	KAV	Norddeich	1800	166.6	Spark; Press (German).
21:15	4:15 P. M.	1:15 P. M.	BXW	Singapore	2000	149.9	Spark; Press.
21:30	4:30 P. M.	1:30 P. M.	MPD	Poldhu	2700	111.0	Spark; WX.
21:45	4:45 P. M.	1:45 P. M.	BXY	Hong Kong	2000	149.9	Spark; Press.
22:15	5:15 P. M.	2:15 P. M.	IDO	Rome	10000	29.98	Arc; Press.
22:30	5:30 P. M.	2:30 P. M.	BZG	Mauritius	2000	149.9	Spark; Press.
23:45	6:45 P. M.	3:45 P. M.	FL	Eiffel Tower	2500	119.9	Spark; Press.
24:00	7 P. M.	4 P. M.	NPM	Pearl Harbor	11200	26.77	Arc; Time.
24:00	7 P. M.	4 P. M.	BYC	Horsea	4300	69.73	Arc; Press.
24:00	7:00 P. M.	4:00 P. M.	PRG	Prague	9300	32.24	Arc; Press§
24:30	7:30 P. M.	4:30 P. M.	YN	Lyons	15100	19.86	Arc; Press.

*Possibly changed to c.w. May have been discontinued. Uncertain with all marked thus.
†Uncertain of wavelength.
‡This weather sent in code form. Useless unless you have reference code book.
§English press sent on 4100 meters (73.13 kc.)

Practically all of the above stations, it will be seen, transmit on wavelengths too long to be covered by the ordinary broadcast receiver. Experimenters desirous of listening to the above signals might very well employ an ultra-audion circuit for this purpose. RADIO BROADCAST Laboratory Information Sheet No. 19, which was printed in the August, 1926, issue, gives a suitable circuit, together with data for the coils.

What Really Comes Through Your Transformer?

We know what you want to get out of your set. Everyone wants it. It is clear, pure-toned reception—and you don't want to miss a note from the muffled base of the kettledrum or the profound booming of the baseviol to the shrill "sky-high" tones of the fife and piccolo.

So much depends on your circuit, so much on your speaker—but even more on your transformers. To render sweet music and to get the full range of orchestral or instrumental performance, the transformer must faithfully reproduce all frequencies.

The FERRANTI TRANSFORMER

Meets Every Condition of Good Audio Reception

It takes two and a half miles of wire for the coils of the A.F. 3 and one and a half for the A. F. 4 plus the many refinements which the genius of Dr. Ferranti has made possible, to create transformers whose amplification curve is almost perfect—almost a straight line. By installing Ferrantis you can modernize your old set or perfect your new one. Ferranti will give you an uncensored message from the sending station.

If you want to make the best of the power tube feeding the loud speaker, use Ferranti.

Ask your dealer for a Ferranti. Don't be satisfied until you have installed one. If he does not carry Ferranti Transformers, write us and we shall tell you where you can get one. No better transformer is available at any price.

For the best available transformer results—Ferranti Audio Frequency Transformer A.F. 3—ratio 3½ to 1—$12.

For a transformer far superior to the average, use Ferranti A. F. 4—ratio 3½ to 1—$8.50.

HIGHSPOTS

High amplification ratio with flat curve.

Ferranti brings out the fundamental frequency of low tones—none are heard merely by inference from higher harmonics.

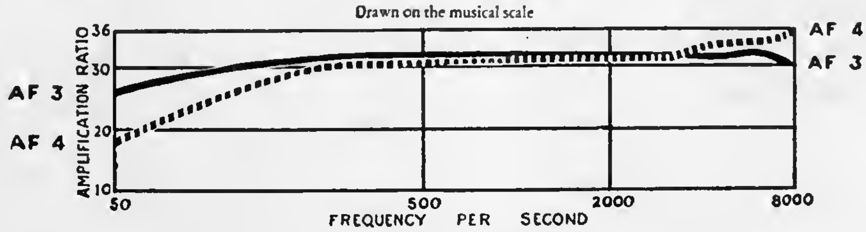
Every transformer tested ten times—all short-circuit turns eliminated.

Windings have high impedence.

Built by an established manufacturing company with forty years' experience in the winding of coils of fine wire for electrical instruments and meters.

Primary shunted with built-in condenser of correct capacity

Tested to 1000 volts between primary and secondary and between primary and secondary and ground.



This graph is drawn on a musical scale—the only accurate way of showing the full value of each tone which your set receives. Note that the evenness and fullness of amplification in both the Ferranti A. F. 3 and the A. F. 4 extends throughout the range of the organ, cello and the human voice.

No Better Transformer Is Available at Any Price

FERRANTI, INC.
130 West 42nd Street
New York, N. Y.

No Better Transformer Is Available at Any Price

THE NEARLY PERFECT TRANSFORMER

The Relation Between Wavelength and Frequency

By CHARLES F. FELSTEAD

THE relation between wavelength and frequency is of a fixed and definite value, and is such a very simple matter when it is once understood that it should offer no confusion to the beginner. A radio wave is an electric wave by means of which radio communication is carried on. Radio, light, heat waves, and X-rays, are all forms of electric waves. The only difference in these waves is their frequency; they all travel at the same speed. The to-and-fro motion of the alternating electric current set up in the antenna and counterpoise (the latter often replaces the ground in a transmitting station) by the transmitting set, produces an alternating electric pressure in the space between this antenna and counterpoise system. This causes a to-and-fro wave motion in the ether that travels out from the radio transmitting station in all directions with the speed of light, just as ripples run out in all directions when a stone is dropped in a pool of water. These electro-magnetic waves travel at the rate of 186,300 miles per second, or 300,000,000 meters per second (to be more exact, they travel at 299,820,000 meters per second). When the electro-magnetic waves sent out by a transmitter reach a receiving antenna, they produce a slight to-and-fro electric current in that antenna, which corresponds in frequency to the frequency of the transmitted electro-magnetic waves. This occurs only when the receiver is tuned to the same frequency as the transmitter. The slight current thus set up in the receiving set is rectified by the detector and changed to a pulsating direct current, which actuates the diaphragms of the head phones, or is amplified by successive audio amplifier stages until it has enough strength to operate a loud speaker.

"Wavelength," as the word itself explains, is the length of the waves sent out by the transmitting station, while "frequency" refers to the number of waves generated per second, or the number of to-and-fro electric oscillations per second. The wavelength, or length of a single wave, is the distance between two similar points on two successive electric waves, as shown in Fig. 1, and this resembles a cross-section of the ripples caused by the stone in the pool of water. One wavelength is the distance from the crest of one wave to the crest of the next adjacent wave We can speak of either the number of waves per second or the number of cycles per second sent out by a transmitting station. The wavelength can be measured in feet, meters, or any other linear unit of measure, though it has been customary to express wavelength in meters. Four hundred meters are equal to approximately 1300 feet; one meter equals about 3.25 feet. The metric system of linear measure (centimeters, meters, and kilometers) has the advantage that it is more easily adaptable to scientific measurements.

With the advent of congestion in the ether channels allotted for the use of broadcasting stations, it became necessary to decide upon a uniform figure by which stations should be separated. For various reasons a ten-kilocycle separation was chosen, and nowadays it is becoming customary to refer to a station by its frequency instead of its wavelength.

All that is necessary to convert meters to kilocycles (1000 cycles) is to divide the number of meters into 300,000. The reverse is also true; to convert kilocycles to meters, 300,000 is divided by the number of kilocycles. The result is the corresponding wavelength in meters.

The explanation of this relation between the wavelength in meters and the number of cycles per second follows. As previously mentioned, the velocity of electro-magnetic (radio) waves has been found by experiment to be the same as the velocity of light, which is approximately 300,000,000 meters per second. If a radio transmitter is adjusted—or tuned, as it is called—so that it sends out 100,000 waves per second, that is, 100,000 cycles per second, and since we know that each wave travels 300,000,000 meters in one second, then we know that in one second 100,000 waves have left the transmitting station, and that the first wave is 300,000,000 meters away from the station. Thus, the 100,000 waves are equally spaced over a distance of 300,000,000 meters. By dividing the 300,000,000 by the 100,000, we find that each wave is 3000 meters long. In other words, the frequency which corresponds to 3000 meters wavelength is

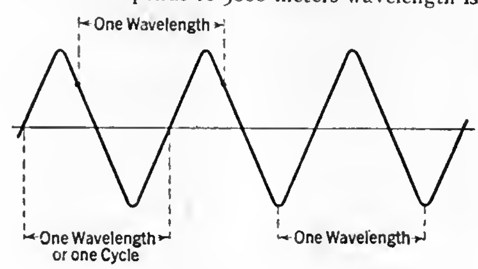


FIG. 1

100,000 cycles, or 100 kilocycles. The shorter the wavelength, the greater the number of waves that will pass a given point in one second; that is to say, the shorter the wavelength, the higher the frequency.

The above is usually put into formula by letting V represent the velocity of electric waves, or 300,000,000 meters per second; N the frequency of oscillations (cycles); and the symbol λ (the Greek letter "lambda") the wavelength in meters. The formula is now $V = N\lambda$. Substituting and dividing we get:

$$\lambda = \frac{300,000,000}{N}, \text{ or } N = \frac{300,000,000}{\lambda}$$

A table of wavelengths, with the corresponding frequency, is given below. It will be seen from an inspection of this table that as the frequency becomes greater, the wavelength becomes shorter, and vice versa.

WAVELENGTH IN METERS	FREQUENCY IN KILOCYCLES
0.5	600,000
1	300,000
4	75,000
5	60,000
10	30,000
50	6000
100	3000
150	2000
200	1500
300	1000
400	750
500	600
600	500
1000	300
2000	150
5000	60
10,000	30
20,000	15

LETTERS FROM READERS

Contributions from Readers on Various Subjects of Radio Interest—An Open Forum for All

From the Sponsor of the Dill Bill

PREPARATORY to its appearance in RADIO BROADCAST for November, galley proofs of Carl Dreher's article entitled "A New Plan to Regulate Radio Broadcasting" were sent to Senator C. C. Dill. As all radio fans are well aware, the Dill bill for regulation of radio broadcasting passed the Senate without a record vote on the eve of the adjournment of Congress. Here is the Senator's letter sent after receipt of the galley proofs:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.
SIR:

On my arrival here, I find your letter of recent date together with the galley proofs of an article for RADIO BROADCAST for November. I have read this article with much interest and have found it most interesting and instructive, but neither of the bills passed by the House and Senate provides for any such specific method of determining what broadcasting stations shall be allowed to use the air, although I think the language of the Senate Bill is wide enough to permit the Commission to lay down such a basis of deciding between numerous applicants.

I think these suggestions are most excellent to be presented to the Commission that will have charge of carrying out the bill when it is enacted into the law.

It seems to me that the multiplicity of conditions and problems affecting the decision of the question of who shall broadcast in each community, as so well presented in this article, make it all the more necessary to have a Commission that will give its entire time and attention to these problems, such as is provided by the Senate Bill, rather than an appellate body that will give only cursory attention to these questions as presented to it from time to time.

I earnestly hope that the House and Senate conferees will be able to agree on satisfactory legislation early in the coming session.

Thanking you for your letter and the information you sent, I am,

Very truly yours,
C. C. DILL.
Washington, District of Columbia.

The R. B. "Lab" Receiver

THOSE who have already constructed the R. B. "Lab" Receiver, together with the many would-be builders, will be interested in this letter telling of the experiences of one who has already experimented for several weeks with a home-constructed receiver of this type.

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.
SIR:

I have been working with your R. B. "Lab" circuit for several weeks now and, as you have asked for reports, I will try and tell you of my experiences with this receiver.

I have every issue of RADIO BROADCAST for the last year and a half, and have tried nearly every circuit described therein, from the old original Roberts to the "Aristocrat," but my success with the new R. B. "Lab" circuit exceeds that I have had with any of the others. I have had a very interesting time comparing other sets I have built with the "Lab" set.

We are about three hundred miles from Chicago and it takes a very good set to bring in any station from that city during the daytime, but I can get KYW on the loud speaker with the "Lab" circuit when the static is not too strong. I have not used the best of parts and the coils are all home made. I use a toroid of 145 turns, cutting off 48 turns for the primary, in the detector circuit. Using a solenoid low loss space-wound coil in the r. f. circuit, with a secondary of 50 turns and a primary of 12 turns, got even better results than with a toroid coil.

I did not have any trouble in getting perfect neutralization so did not resort to the use of the tuned trap you speak of. The tone is all that could be desired, and the volume equals that of any five- or six-tube set. I use a 2:1 transformer in the first stage with one of 3½:1 in the last stage. My opinion is that you have the best four-tube receiver yet presented to the public.

Very truly yours,
E. H. BREWER.
Belmond, Iowa.

From a DX Lion

MR. MOSKOVITA calls himself a DX *fan* in his letter below. With all due respects, many in the swim of radio matters would preferably dub him a *hound*, of the species DX. Yet we prefer to give him the title of DX *lion*, for it is doubtful whether many can offer proof of reception of so many distant stations as he can:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.
SIR:

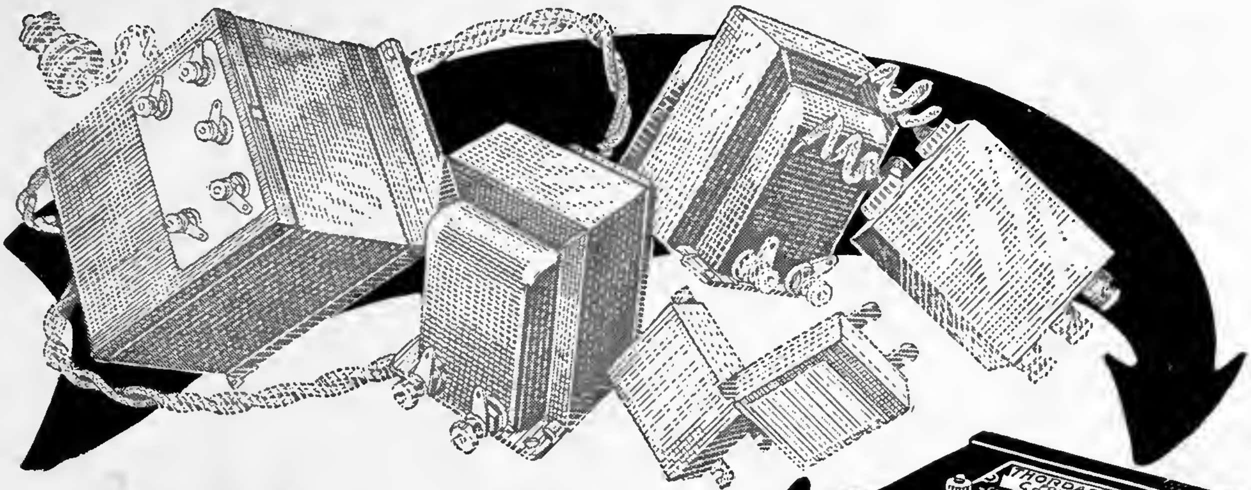
After reading a letter in the October RADIO BROADCAST about Mr. Harding Gow, of East Sound, Washington, picking up station 3 LO, Melbourne, Australia, I thought I would write to you about my DX reception. I am a veritable DX fan, having tuned-in practically every high-powered station in the United States, and many of low power. Of these latter, especially would I like to mention the reception of CFCQ, Vancouver, British Columbia, a station of only five watts or so. Last winter I used to tune-in this station about four times a week, and this I have had confirmed. In fact, all stations have been verified, both American and foreign.

I have a log book that looks like a Webster's dictionary. Whenever I tune-in a station, I jot down the items being rendered, together with the exact time, and also make note of the dial settings.

My radio is the greatest pleasure I get out of life, and the greatest satisfaction is to tune-in some distant foreign station and have it confirmed. One of the biggest secrets of successful DX reception is patience—and plenty of it too. Many times I will wrestle with an elusive carrier for two hours or more, but I never give up until I have clearly heard a song or some other selection whereby I may have my reception confirmed.

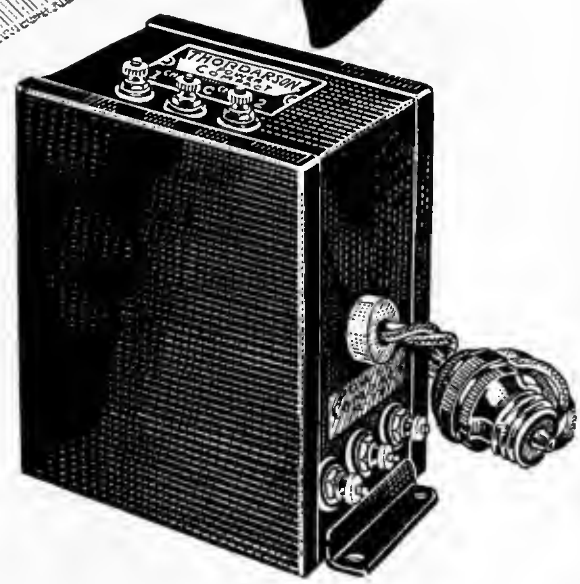
At the present time (the second week in October), the Australian stations are coming in with good loud speaker volume. I get 4 QG, Brisbane, 3 LO, Melbourne, 2 BL, Sydney, and 5 CL, Adelaide. These stations all employ 5000 watts input, I believe. They are heard best at about 3 A. M. Pacific Standard Time.

The Japanese stations are also coming in well. The Tokyo station, JOAK, is the most consistent, while JOCK, Nagoya, and JOBK, also come in with good strength. The Australian stations have excellent programs, composed mostly of classical music, and very little jazz. They are strong for community singing, and there is hardly a night (or, rather, morning) that one or other of



All in One!

THORDARSON POWER COMPACT



TYPE R-171

Contains a power supply transformer for Raytheon BH rectifier, 2 filter chokes, 2 buffer condensers, and a filament supply for UX 171 power amplifying tube.

$15.00

TYPE R-210

Contains a power supply transformer for UX 216-B rectifier, 2 filter chokes, and a filament supply of 7½ volts for UX 210 power amplifying tube.

$20.00

The Complete Foundation Unit

for power amplification and B supply

Simplified Assembly. The Power Compact contains within itself the greater part of the complete B supply unit. With the Type R-171, only 14 leads complete the Raytheon assembly. All terminals are carefully located for the greatest ease of assembly.

Compactness. The only additional apparatus required to build the B supply are the condenser block (Raytheon type), a Raytheon tube BH, and the resistance units. The complete eliminator occupies a space of but 6 in. x 9 in. without crowding.

High Efficiency. The power supply of either Power Compact furnishes the proper current for maximum efficiency of the rectifiers used; the chokes are of sufficient capacity to carry the maximum output. Conservatively rated, will not heat up in continuous service.

High Voltage Output. The R-171 Power Compact assembly will deliver a maximum plate voltage output of 300 volts at 30 milliamperes, or 275 volts at 40 milliamperes.

The R-210 type assembly will deliver 400 volts to the plate of the power tube, and in addition, will supply a constant 90 volts to the receiver at any current drain up to 40 milliamperes.

Silent in Operation. There is no traceable hum, either mechanical in the compact itself, or electrical through the loudspeaker.

Complete Supply for Power Amplification. The Power Compact not only supplies B voltage, but also provides for the filament current and grid bias of the stage of power amplification. *Makes it possible to use power amplification even on sets designed for dry battery operation.*

Electrically Centered Filament Supply. The power tube filament supply *is tapped at the exact electrical center for grid return.* The center tap is taken from the common lead of two perfectly balanced windings—completely obliterating the A. C. hum. (An exclusive Thordarson feature.)

Write for instruction booklets SD-49 and SD-50.
If your dealer cannot supply, order direct from the factory.

THORDARSON ELECTRIC MANUFACTURING CO.
Transformer Specialists Since 1895
WORLD'S OLDEST AND LARGEST EXCLUSIVE TRANSFORMER MAKERS
Huron and Kingsbury Streets — Chicago, Ill. U.S.A.

3446 ★

the Australian broadcasters is not sending out this community and choral singing. They also broadcast church services, on Sundays, followed by an hour's selection of band music after the services.

These foreign stations have one weakness in my opinion, and that is their announcing, or lack of it, rather. If you tuned-in on one of the Australian or Japanese stations, you would never complain about the American announcers. Sometimes they play six or more numbers without announcing, and then, when they do announce, it is very hard to catch what they are saying.

The Japanese stations also have very good programs. Mostly classical Japanese music, and occasionally foreign selections, will be heard from these stations. JOAK and JOBK give lessons in English every day for about forty-five minutes.

Very truly yours,
JACK MOSKOVITA.
San Pedro, California.

Critical Hours for the Broadcasting Industry

UNDER the above heading, the leading editorial in "The March of Radio" in the November RADIO BROADCAST set out to place before the reader a brief summary of the existing status of radio conditions in an unbiassed manner. The proverbial ostrich attitude adopted by so many who asseverate that there is little or no cause for alarm, was ignored, and an editorial opinion based upon actual collected data was expounded.

Editor, RADIO BROADCAST
Doubleday, Page & Company,
Garden City, New York.
SIR:

The editorial appearing in the November RADIO BROADCAST, "Critical Hours in the Broadcasting Industry," most certainly deserves commendation I am glad to see one editor displaying the temerity to face facts as they are, rather than resort to the usual ballyhoo. Things are not well with the broadcasting situation, and the more publicity given the matter, the quicker will wrongs be corrected.

I doubt if even you, in your eastern location, have any conception of the interference that has come with wave-jumping. Nineteen heterodyning points, which you mention, is not only a commonplace during the past month, but is far from being the greatest number to be found! The situation now is not one of being able to select the particular program that most pleases one, or is being received to best effect in the old sense, but boils itself down to this: "Where can I find a station that is not being smeared by a half dozen others?"

As matters now stand, our *good* nights are the *bad* ones, for, on these latter, reception from one or two stations is made possible because the bad atmospheric conditions have blanketed off the rest of them! The broadcasters are, by wave-jumping, doing more to help the phonograph companies than the latter are able to do for themselves.

I heartily commend your courage in flatly facing matters, for I believe you are the first to do so. The others tell us all is well, trying to foster an improvement by harboring a delusion.

Very truly yours,
GORDON BALCH NEVIN.
Johnstown, Pennsylvania

Mr. Henney's Tube Articles

TO TELL the good from the bad, by mere external examination, is hardly possible—this apropos tubes. "Every Tube Tested," is by no means an unfamiliar sign bedecking the windows of unprincipled as well as dependable radio dealers. Little does it mean in the formers' case, for, as often as not, the purchased tube is roughly thrust into the tester's socket, the needles on the meter dials "kick," and all is well. By the time the customer is enabled to grasp the meaning of the multifarious meters, his tubes are wrapped and he is requested to pay at the desk. Mr. Henney's tube articles have been written for the benefit of such customers who are interested, without the necessity of heavy expenditure for apparatus, in testing and measuring the characteristics of their own tubes. Read on:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.
SIR:

I have just completed my second reading of Mr. Henney's illuminating series of articles on the uses of vacuum tubes which appeared in the December, 1925, and February and April, 1926, issues of RADIO BROADCAST. They contain so many valuable ideas, clearly stated, that I feel I must tell you of my appreciation.

Nowadays radio magazines are apt to minimize technical explanations of theory to almost the vanishing point. Although the practice of popular radio journals to leave all theoretical discussions to engineering publications may be justifiable to a certain extent, there are many readers of these popular magazines who would like to know not only *how* to do it but *why* to do it. This group of "broadcast amateurs" (to distinguish them from the "hams") lies between the ordinary entertainment-loving listener and the pure scientist, and Mr. Henney's articles appear to have been written for this group. They (the articles) do not stop at telling *where* a particular tube should be used, but go on to say *why* it should be used there.

Another article of this type, that combines theory with practice, was that of Hugh S. Knowles, in the February *Popular Radio*. Let's have more!

Very truly yours
WILLIS G. HAZARD.
East Jaffrey,
New Hampshire.

Commends Our Laboratory Information Sheets

WE HAVE received many letters commenting favorably on our substitution of the Laboratory Information Sheets for the former "Grid" Department. A typical one herewith:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.
SIR:

Having been a constant reader of your magazine for over two years, I wish to congratulate you on the recent change in its quality, not in the quality of its reading matter, for this has always been far above any other periodical, but in the physical quality and the excellence of the various departments.

I am particularly glad to see the data sheets as their inclusion fills a long-felt want on my part, for what they contain is brief and to the point, exactly what the earnest radio fan, the one who is more than a broadcast listener, needs. Particularly are the circuit data and data on the new tubes to my liking.

I also wish to congratulate Mr. Keith Henney on his laboratory apparatus articles which have been of great value to me. I regret that I have been unable to become a subscriber as my work as field engineer for a well-known radio manufacturer keeps me on the road so much that I have no permanent address, but the highest praise that can be bestowed on your magazine is manifest by the speed with which it disappears from the newsstands the day after publication. My first thought around the 15th when out of town is to tell a local news dealer of the city I am in to hold a copy for me.

Very truly yours,
B. B. ALCORN.

NATIONAL B-ELIMINATOR COMPONENTS

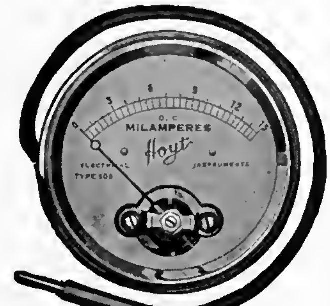
℄ NATIONAL CO., INC., announces a new line of Components for the construction of B-Eliminators, using the Raytheon BH Tube. ℄ The TRANSFORMER is made to carry the full load without heating and has both five and seven volt filament windings, center-tapped. The 0.1 Mfd, Buffer Condensers are enclosed in this case and connected. ℄ The FILTER CHOKES have heavier covers and windings than usual, and really high inductance. ℄ The CONDENSER Block employs TOBE High Voltage Condensers and matches the TRANSFORMER and CHOKE Cases. ℄ These units are built to a standard of quality—The NATIONAL Standard. Anyone who has built a set using BROWNING-DRAKE Transformers and NATIONAL Condensers knows what *that* means. ℄ Be sure you get the genuine NATIONAL products. ★

N A T I O N A L

RADIO PRODUCTS

NATIONAL CO., INC., W. A. Ready, Pres. *Engineers and Manufacturers* **Cambridge, Mass.**

Hoyt PHONE-PLUG MILLIAMMETER



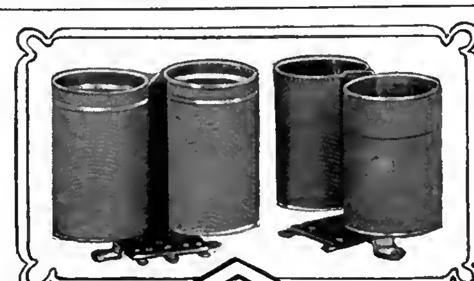
★

This precision moving-coil instrument is made to plug into the loud speaker lead on your set and enables you to adjust your C battery bias on the power tube, for perfect reproduction. Instantly attached. A necessary accessory if you desire the utmost in quality.

Price $8.50

BURTON-ROGERS CO.

Boston, Mass. ***Sales Dept. for Hoyt Electrical Instruments***



SPECIALLY DESIGNED FOR R.B.LAB RECEIVER

GEN-WIN R·B·LAB·COILS

PATENTS PENDING

There Is No Substitute ★

THE HEART of the new RB Lab Receiver—in fact the heart of any receiver—is the coils. These Genwin Coils were designed to meet the specifications of the engineers who built the RB Lab. Receiver. Patents have been applied for. This is the coil Radio Broadcast prescribes—there is no substitute. As the demand for these coils is taxing our capacity to the utmost, order yours today—don't delay. Then you can build the RB Lab. Receiver and enjoy its marvelous advantages. Like all Genwin products these coils are unconditionally guaranteed.

At Your Dealers or Postpaid **$5.50** *per pair*

GENERAL WINDING COMPANY, Inc.

214 FULTON STREET NEW YORK, N. Y.

A KEY TO RECENT RADIO ARTICLES

By E. G. SHALKHAUSER

THIS is the fourteenth installment of references to articles which have appeared recently in various radio periodicals. Each separate reference should be cut out and pasted on cards for filing, or pasted in a scrap book either alphabetically or numerically. An outline of the Dewey Decimal System (employed here) appeared last in the November, RADIO BROADCAST, *and will be reprinted in an early number.*

R800 (537.65). PIEZO-ELECTRIC PHENOMENA. QUARTZ CRYSTALS.
QST. Sept., 1926. Pp. 17–19.
"Luminous Frequency Standards," J. M. C.
A piezo-electric resonator, not oscillator, to be used as a frequency standard, has been developed by Loewe of Germany, and placed on the market. This resonator consists of a piezo-electric crystal mounted between two plates and placed in a gas-filled tube. When connected inductively to an oscillating circuit, resonance is indicated by the polarizing of the plates from the crystal, and the gas within begins to glow. An accuracy of one fiftieth of one per cent. or better, may be obtained with this device. They are available to cover wavelengths from 35 to 1200 meters (8566 to 250 kc.) at present.

R281.71. QUARTZ. QUARTZ.
QST. Sept., 1926. Pp. 23–25.
"Examining Quartz for Oscillator Use," L. H. Dawson.
Information is given on the testing and cutting of quartz crystals. The uncut crystal is first analyzed regarding its optical and electrical axes. Two types of crystals exist, namely, "right-handed" and "left-handed," but either will serve as an oscillator. Sometimes a crystal is found having the double property mentioned above, in which case it cannot be used. An instrument for detecting defects and locating the axes, is described. It can readily be made at home.

R382. INDUCTORS. INDUCTORS.
QST. Sept., 1926. Pp. 26 ff.
"Easy Tuner Design."
Charts are presented for the easy calculation and design of tuners and wavemeter circuits using the Hammarlund short-wave coil, which has 10 turns per inch on a three-inch tube. With a given inductance value, and a variable condenser of specific capacity, the shunted circuit obtained will tune over a definite range, as shown. Suggestions are offered as to the best method to employ in the choice of coils for various condensers on the market, and the range these coils will cover when placed in a circuit, is detailed.

R387.1. SHIELDS. SHIELDS.
QST. Sept., 1926. Pp. 29–32.
"Multi-Purpose Shielded Units," W. M. Henderson.
Shielded r.f. units, which may be used for a multiplicity of purposes, are discussed, the accompanying curves and photographs showing the method of construction and operation. Claims are made that greater selectivity, stability, elimination of station pickups, decrease of interstage coupling, and the use of a greater number of r. f. stages, are possible with this type of tuner. Of the metals tried (brass, copper, and aluminum), aluminum proved the best as a shield, as is evidenced by the frequency-resistance curve. The Weston method of measuring coil resistance at high frequencies is described in detail, the circuit and hook-up of the apparatus being shown and explained.

R330. ELECTRON TUBES. TUBES, *UX*-210.
QST. Sept., 1926. Pp. 33–36.
"Radiotron Model UX-210."
Detailed information is given concerning the new Radiotron tube, UX-210. Charts and curves show how the tube will function as an oscillator at the various wavelengths. A method of finding plate impedance, amplification constant, and other important characteristics, is explained.

R383. RESISTORS. RESISTORS.
QST. Sept., 1926. Pp. 37 ff.
"Metallized High Resistance Units," J. Morgan.
A new type of high resistance unit, which may be used for grid-leaks, coupling units in amplifiers, potentiometers, and in A and B battery devices, has been developed commercially. It consists of a glass filament coated with a very thin film of metal, and sealed within a glass tube. The process of development and manufacture is described, and a table is presented which shows the relation between resistance and current carrying capacity. Normally, the units are said to be accurate to within 5 per cent. when manufactured in large quantities.

R342.15. AMPLIFIER TRANSFORMER. AUDIO AMPLIFIER ACTION
Radio News. Sept., 1926. Pp. 244 ff.
"Overloading the Audio Amplifier," S. Harris.
In this fourth of a series of discussions on audio amplifiers, the author takes up the causes of overloading the amplifier; also he discusses the effect of this overloading on the quality of reproduction, and considers the nature of the load as it affects the output of the amplifier coupling device. A theoretical discussion, studying the probable effects of tube capacity, coil capacity, and resistance in the circuit as the apparatus is connected together, is presented. The curves show that several variable quantities may experience considerable variation with frequency input; for instance, the input impedance of the tube may change considerably when the frequency changes. Distortion may therefore be introduced for reasons not commonly suspected.

Increased Selectivity Greater Distance More Volume

BUT ABOVE ALL—

Quality of Tone

On any set from the modest little Crystal Hook-up to the Super Outfit—you simply install

THE CARBORUNDUM STABILIZING
Reg. U. S. Pat. Off.
DETECTOR UNIT

$3.50 (in U. S. A.) Dealer or Direct

Our Hook-up Book tells you how—send for it

THE CARBORUNDUM COMPANY, NIAGARA FALLS, N. Y.

SALES OFFICES AND WAREHOUSES IN

New York : Chicago : Boston : Philadelphia : Cleveland : Detroit : Cincinnati
Pittsburgh : Milwaukee : Grand Rapids
The Carborundum Co., Ltd., Manchester, Eng.

Carborundum is the Registered Trade Name used by The Carborundum Company for Silicon Carbide. This Trade Mark is the exclusive property of The Carborundum Company.

★

The Carborundum Company
Niagara Falls, N. Y.

Please send free Hook-Up Book D-2.

Name ____________________

Street ____________________

City ____________________ State ________

Let us greatly increase the efficiency of your receiving set

WE are the *sole* service representatives of Radio Broadcast, appointed after a thorough investigation of our facilities and experience.

This is our offer: For $2.50 we will inspect and test any ordinary radio receiver. In addition, we will furnish a written report describing the faults we find, together with an estimate of the cost of remedying them. For a Superheterodyne or other highly complicated receiver, a similar service will be rendered at a slightly higher cost.

Our business is to permanently remedy the faults in radio receivers which are not working satisfactorily. Why not get the benefit of our service? The cost is small, the results will delight you.

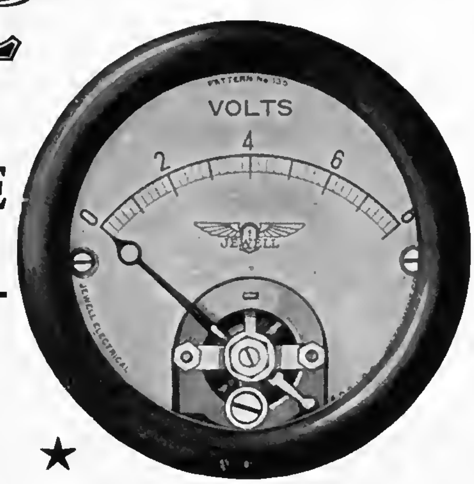
Telephone RECtor 2538

Rossiter,
Tyler & McDonell, Inc.
Consulting Radio Engineers
136 Liberty St., New York

R T M RADIO SERVICE

JEWELL

INFRADYNE BUILDERS:—



here is the quality radio instrument recommended for use with the new Infradyne receiver. It is obtainable in any of the ranges given below, of which the **0-5 volt** has been particularly specified for the Infradyne.

★

Pattern No. 135 Panel Mounting Voltmeter (actual size) Ranges—
0-5, 0-8 or 0-10 volts
0-10, 15, 25, 50 or 100 milliamperes.

Ask your dealer for one of our new radio instrument catalogues, No. 15-C, which describes our many radio instruments in detail, or write to us direct for it.

JEWELL ELECTRICAL INSTRUMENT CO.
1650 Walnut Street **Chicago**
26 Years Making Good Instruments

R325.1. DIRECTION FINDERS. DIRECTION FINDERS.
A Scientific Paper, Bureau of Standards, No. 525.
"A Uni-Control High-Frequency Radio Direction Finder," F. W. Dunmore.

The paper describes a direction finder, functioning on a 2100-kc. (143 meters) frequency, to be used on ships, especially Coast Guard patrol boats. The direction-finder coil consists of four turns of ignition cable wound on a 20-inch frame. It is installed over the pilot house and rotated from below. A tuning unit and coupling transformer have been designed so that the direction finder coil may be used on the ship's receiving set without changing its tuning adjustments, which are locked in the 2100-kc. position. A special form of automatic balancing condenser, operated by a special cam rotating with the direction-finder shaft, is incorporated in this instrument, whereby a clear minimum may be obtained at all angular positions of the coil without manual operation of the balancing condenser. The controls necessary when taking a bearing are thus reduced to one, *i. e.*, that of rotating the direction finder coil to obtain the minimum signal.

R580. TELEVISION (OTHER APPLICATIONS OF RADIO.) TELEVISION.
Radio News. Sept., 1926. Pp. 206 ff.
"Television, An Accomplished Fact," A. Dinsdale.

After a preliminary discussion covering the historical developments of television and some of its problems, the author describes the Baird System, which transmits images in one tenth of a second. The principle consists in rotating a disc carrying spirally-arranged lenses through which light passes, which, in turn, is collected by a light sensitive cell and converted into electromagnetic waves. The article is illustrated.

R344.5. ALTERNATING CURRENT SUPPLY POWERFORMER.
Radio News, Sept., 1926. Pp. 240 ff.
"Powerformer Combines B Eliminator and Power Amplifier," D. E. Harnett.

In converting a.c. to d.c. for radio receiving set purposes, two things are needed—a rectifier, and a filter system. Various types of rectifiers may be used. Regarding filters, it must be remembered that d.c. is going through the circuit and this cannot be impeded by condensers in series or high-resistance coils. The load to a line supply device varies considerably, and must be taken into account. The circuit diagram, using a combination B eliminator and power amplifier, is presented and discussed. Detailed constructional information is to follow in a subsequent article.

R090. HISTORY OF RADIO. HISTORY.
RADIO BROADCAST, Oct., 1926. Pp. 471–473.
"Is There a Monopoly in Radio?" F. Strother.

In this article the writer touches upon the various phases of the radio art as it was in the beginning, from the time that the principles of radio were discovered by Hertz and Branly. He continues with a discourse on how this art has carried on during the early period of development. Its rapid growth, and the great interest shown, has brought the inventors and their inventions in this new field into a tangle which, even to-day, is leading to numerous patent suits regarding infringements. It is stated that the conditions in which radio finds itself in Great Britain are vastly different than those here in the United States. In the former country Marconi controls practically the entire industry whereas, in America, the law provides for a patent monopoly but not a monopoly of patents. In subsequent articles the inventors, the inventions, the present patent situation, and also the business side of radio, will be discussed.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, *Equamatic.*
RADIO BROADCAST. Oct., 1926. Pp. 479–482.
"How to Build the 'Equamatic' Five-Tube Receiver," Zeh Bouck.

Complete constructional details are given relative to the "Equamatic" receiver, in this case a five-tube set. With this system, by means of which the coupling between primary and secondary of the inductances is automatically varied when the capacity is changed, it is claimed that the maximum amount of energy is transferred at all frequencies of the receiving range without tube oscillation or distortion. A panel layout, circuit diagrams, and constructional details of the coils, are shown.

R344.5. ALTERNATING CURRENT SUPPLY. ELIMINATOR, *A, B, and C*
RADIO BROADCAST. Oct., 1926. Pp. 485–489.
"An A, B, C Line Supply Device," B. F. Roland.

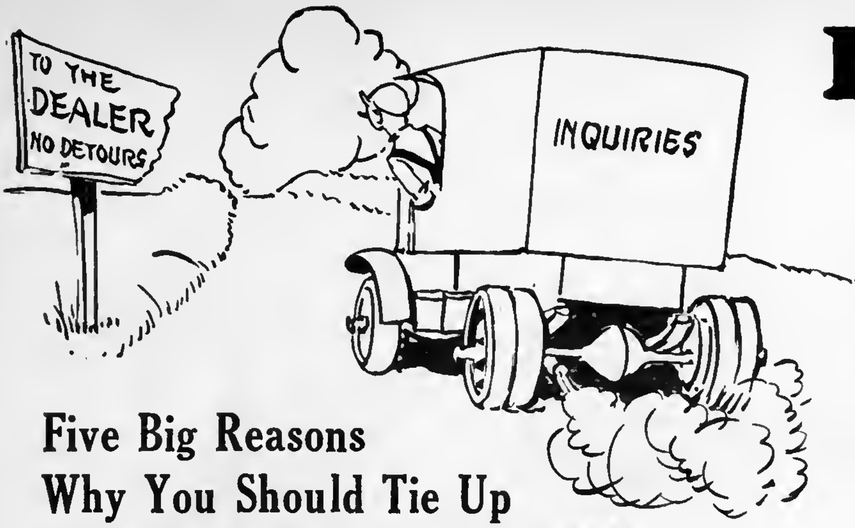
The author describes in detail the construction of an A, B, and C supply unit for connection to the a.c. circuit to be used with sets employing 199 type tubes. This is accomplished by means of the new Raytheon BH type rectifier, and auxiliary apparatus. Up to nine tubes may be supplied with energy from this layout. Voltages and currents furnished are given as follows: A Battery—60 milliamperes, 6 to 30 volts; B Battery—up to 25 milliamperes, 45, 90, and 200 volts; C Battery—from 0 to 50 volts. The parts recommended are standard and are readily obtainable.

R080. COLLECTIONS, TABLES, MISCELLANIES. STATIONS, *List of.*
Wireless World, London. Aug. 18, 1926. Pp. 221–222.
"Short-Wave Transmissions."

A list of short-wave transmitting stations of the world, both telegraph and telephone, between 23,076 and 2000 kc. (13 to 150 meters) is given. The information includes call letters and either the owner or location of each station.

R346. RADIO TELEPHONE SETS. TRANSMITTER-RECEIVER COMBINATION.
Wireless World, London. Aug. 25, 1926. Pp. 247–248.
"Low-Power Transmitter-Receiver," F. J. Haynes.

A combination transmitter and receiver in one set, is described. The same tubes are used for the two purposes, namely, receiving and transmitting. The grid and the plate connections are switched over in order to make the change. Complete constructional details and the method of operation, are given, together with a panel layout and photographs. The transmitter here described is tuned to 3333 kc. (90 meters), the range being conservatively estimated at from 10 to 20 miles.



HOMMEL never RETAIL$

Five Big Reasons Why You Should Tie Up with "THE HOUSE OF HOMMEL"

1. Unexcelled Dealer co-operation.
2. Ample Stocks at all times.
3. Wholesales Exclusively.
4. Dealers' Repair and Inspection Department.
5. Modern Display Room Facilities.

STRICT adherence to this fundamental Hommel policy over a period of many years has established the "House of Hommel" into the abiding confidence of thousands of radio dealers all over the country.

Hommel's liberal and consistent national advertising acts as a constant sales stimulant that keeps dealers' stocks constantly on the move.

All inquiries, resulting from Hommel's national advertising, are promptly turned over to Hommel dealers—exemplifying the highest type of jobber loyalty and co-operation a dealer can enjoy.

If you like a fair and square jobber connection—tie up with Hommel—the wholesaler who never retails.

Write to-day for the Hommel Catalogue—27-B.

WHOLESALE EXCLUSIVELY

LUDWIG HOMMEL & CO

929 PENN AVENUE PITTSBURGH, PA.

Improve the Tone of Your Set with a

KELFORD

3 Stage Resistance-Coupled AMPLIFIER

Improves Tone
Increases Volume
Perfects Clarity

$8.00

Bakelite form with all connections and wiring concealed. Completely equipped with resistances and condensers; all metal parts highly nickel plated. Equipped with the famous Kelford "Cushion" Sockets. Can be used with all circuits to increase volume and clarity.

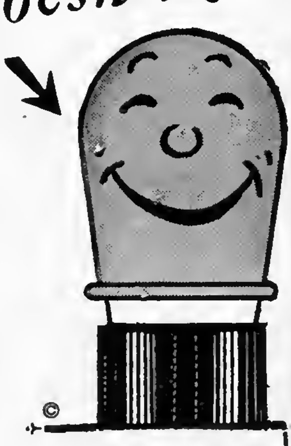
At Your Dealers

If he cannot supply you, send purchase price and we will forward one postpaid. Money back if not satisfied.

THE AMERICAN SPECIALTY CO.
Bridgeport Connecticut

IT HOWLS

Now it doesn't!



McDONALD HOWL ARRESTER

"It Stops that Howl!"

Slip one of these live rubber jackets over each trouble-making tube . . . . and the Howl *stops*.

Remember the name! You can get it for every size tube. It sells for 75c each. Just ask your dealer, or write.

Sole Selling Agents for the U. S. A.

SPARTAN ELECTRIC CORPORATION
350 West 34th Street, New York City

Manufactured in the U. S. A., by the
SCIENTIFIC PRODUCTS CANADA, LTD.

"It Stops that Howl!" ★

R131. CHARACTERISTIC CURVES; GENERAL PROPERTIES. VACUUM TUBE CHARACTERISTICS.
RADIO BROADCAST Oct., 1926. Pp. 499–503
"How to Measure Your Own Tubes," K. Henney.
Information is given on how to find the important constants of various tubes used in receiving sets. A voltmeter and a milliammeter are the only two instruments considered necessary in order to record the data presented in the accompanying charts and the tables.

R148. MODULATION. MODULATION.
RADIO BROADCAST. Oct., 1926. Pp. 507–508.
"Modulator Plate Current Variation," C. Dreher.
In the twelfth article of a series dealing with the operation of broadcasting stations, the question of d.c. plate current variation, when an audio frequency amplifier is used for modulating, is discussed. The author arrives at the conclusion that, if absolute distortionless amplification is to be obtained, it is essential that no variation occur in the d.c. current of the plate circuit of the modulator tube.

R000. HISTORY. HISTORY OF ARMSTRONG.
RADIO BROADCAST. Oct., 1926. Pp. 510–513.
"He Gave a Lusty Voice to Radio," M. May.
The history of the regenerative, the super-heterodyne, and the super-regenerative circuits, and of the man who claims to be their discoverer, is interestingly recounted.

R376.3. LOUD SPEAKING REPRODUCERS. LOUD SPEAKERS
RADIO BROADCAST. Oct., 1926. Pp. 514–516.
"Cone Loud Speakers," C. L. Farrand.
This article, presented before the Radio Club of America, tells of the development of the cone type loud speaker. It is stated that three conditions must be met in order to have true conversion of sound energy to electrical energy, or vice versa; namely, provision of a surface in the front of the sound wave which will move in accordance with the sound wave; adaptation of this surface to control an electric or magnetic field; arrangement of the field so it can be utilized for the production of the necessary voice currents.
The requirements of a good horn are also mentioned.

R113.5. METEOROLOGICAL. METEOROLOGY.
Popular Radio. Sept., 1926. Pp. 415ff.
"Foretelling Radio Reception from the Weather Map," B. Dashiell.
The problem of trying to predict conditions of radio reception from weather maps and other information, has been one of a guessing nature rather than one of accuracy. However, as explained by the author, some things are known about this important problem and, to some extent, predictions can be made which are fairly reliable. Static, due to atmospheric disturbances in the troposphere, or lower atmosphere, is considered one of the worst disturbers of radio programs. Barometric pressure changes may account for considerable fading of signals. More data concerning "highs" and "lows," together with changes in humidity and location of isobars in connection with variations of radio signals, will undoubtedly aid materially in obtaining definite knowledge concerning many of our present radio troubles.

R342.4. IMPEDANCE COUPLING. AMPLIFIERS, *Impedance.*
Popular Radio. Sept., 1926. Pp. 418ff.
"How to Build an Impedance-Coupled Amplifier," L. M. Cockaday.
Minute constructional details are presented for a receiver of the impedance-coupled type, using three stages of amplification and a filter choke in the output of the last stage.

R800. (537.65). PIEZO-ELECTRIC PHENOMENA. QUARTZ CRYSTALS.
Popular Radio. Sept., 1926. Pp. 421 ff.
"A Radiant Crystal Pilot."
A new method of using quartz crystals to accurately determine frequencies is found in the glowing crystal tube. The tubes contain a vapor surrounding a quartz crystal and mounting which causes the tube to glow with an orange-red color when exact resonance is established in a circuit which is coupled to it inductively. Several tubes are mounted in a row, each one tuned to a period just a little different from the next.

R383. RESISTORS. FILAMENT RESISTORS, *Automatic.*
Popular Radio. Sept., 1926. Pp. 424 ff.
"How to Simplify Your Set with Automatic Filament Controls," K. Humphrey.
A method of measuring the relative characteristics of automatic filament current-control devices, and the results obtained, are outlined. These devices usually consist of some metal which has a positive resistance coefficient to temperature changes, so that when more current than necessary passes through the circuit, the higher temperature of the metal causes the resistance to increase, and this, in turn, decreases the current automatically.

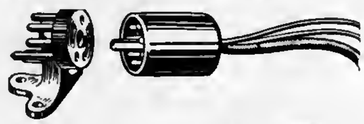
R134.75. SUPER-HETERODYNE ACTION. OSCILLATORS IN SUPER-HETERODYNES.
Radio. Sept., 1926. Pp. 33–34.
"Super-Heterodyne Oscillators," G. M. Best.
This discussion pertains to the oscillator tube and circuit used in the super-heterodyne receiver. The requirements to be met in a receiver of this type are that the circuit be able to tune over a frequency band from 545 to 1500 kilocycles, be free from harmonics, and have an oscillator condenser which can be controlled without trouble from body capacity effects.
Diagrams of the four most popular oscillator circuits are discussed separately. These circuits may be used for other purposes, as stated.

R140. RADIO CIRCUITS. OSCILLATIONS IN TUNED CIRCUITS.
Radio. Sept., 1926. Pp. 31 ff.
"Tuned Radio Frequency," L. W. Hatry.
Several methods employed to control oscillations in a radio-frequency amplifier are analyzed. The losser methods include the use of the potentiometer in the grid circuit; also the connection of the grid return to the negative filament. The neutrodyne control overcomes oscillations by neutralizing parasitic capacities. Of these, Hazeltine contributed the method shown in Fig. 3A, where voltages are balanced against each other with coupling to the plate coil. The Rice method does the same thing only couples to the grid coil. The Browning-Drake circuit attempts the problem by reducing the effective coupling between the primary and secondary of the transformer.

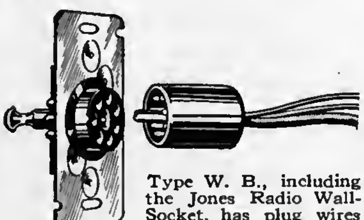
There is One Best Way

Jones MULTI-PLUG, the Standard Set Connector, is illustrated below in its various models. To-day the discriminating buyer chooses a set MULTI-PLUG equipped or immediately equips his own set with the MULTI-PLUG because it affords greater simplicity, safety and more convenience than any other method used to connect the radio receiver with the current supply.

Type P. M. is mounted right in the panel. Plug leads go to batteries, ground and aerial. New low price; 4 ft. cable, $3.00.



Type B. M. is mounted on the base and wires are soldered to back of socket posts; no binding posts are necessary. 4 ft. cable, $3.50.



Type W. B., including the Jones Radio Wall-Socket, has plug wires leading direct from binding posts; plug goes into wall socket. Wall socket is connected with hidden batteries, ground and aerial. Adapted to any set. 4 ft. cable, $3.50.

Type B. P. is adapted to any set. The wires from the socket lead to the binding post, while the wires from the plug lead to the batteries, ground and aerial. 4 ft. cable, $4.00.

★

Double Plug Cable is used when both set and current supply are equipped with Jones Sockets. 6½ ft. cable, $5.00.

Consider the MULTI-PLUG in your Karas Equamatic Set, as specified by the designers

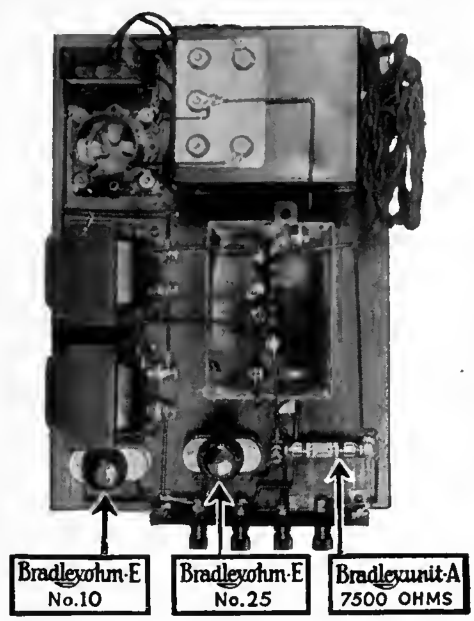
HOWARD B. JONES
618 S. Canal St. Chicago, Ill.

BROADCASTING FROM THE INSIDE

EVERY month in RADIO BROADCAST appears the department, "As the Broadcaster Sees It," written by Carl Dreher, one of the best known broadcast engineers in the country. Alive with humor, news, apt and searching comment, Mr. Dreher's writings have become one of the most popular features of radio writing anywhere. Are you reading it? Subscribe by the year and make sure of not missing a single issue. Mail your check for $4.00 to Subscription Department, Doubleday, Page & Co., Garden City, N. Y.

American Radio Now—
50% DISCOUNT ON RADIO!
BIG NEW 1927 CATALOG-FREE

Dealers, Agents, Set Builders—get our big 1927 Catalog—225 nationally advertised lines. Lowest prices in America! Largest, most complete stock. Radio's latest developments. It's FREE—send for your copy now.
AMERICAN AUTO & RADIO MFG. CO., Inc.
1435 McGee Street, Kansas City, Mo.



What a whale of a difference a few Bradleyohms make —in a B-Eliminator!

MAGAZINES and newspapers have been publishing circuits and instructions for assembling B-eliminators. Many types of kits have been used, but the outstanding feature has been the almost unanimous recommendation to use Bradleyohm-E for plate voltage control and Bradleyunit-A for the fixed resistor.

The leading manufacturers of B-eliminators have long since adopted Allen-Bradley variable and fixed resistors as standard equipment for their B-eliminators. In fact, the Bradleyohm-E has become almost as universally used in Raytheon tube B-eliminators as the Raytheon tube itself. The scientifically-treated graphite discs in these remarkable units have never been equaled for silent, stepless plate voltage control so essential for the satisfactory operation of a radio set with a B-eliminator.

When you build your B-eliminator, always insist that Bradleyohm-E and Bradleyunit-A are included with kit. You then will be assured of perfect voltage control. Send for folder "How to Build a B-eliminator" describing seven popular hookups.

Bradleyohm-E

For B-eliminator service requiring wide voltage control, Bradleyohm-E is essential. It is an oversize Bradleyohm with sufficient capacity to handle all normal B-eliminator requirements. Be sure to ask for Bradleyohm-E in the checkered carton. Your dealer can get them for you.

Bradleyunit-A

This solid, molded, fixed resistor has no glass or hermetic sealing in its construction. It is a solid unit with silver-plated end caps that are not affected by temperature, moisture and age. By all means, use Bradleyunit-A when you need a fixed resistor.

ALLEN-BRADLEY CO.
278 Greenfield Ave. :: Milwaukee, Wis.

★ **Use Allen-Bradley Perfect Radio Devices**

R343.5. ELECTRON-TUBE RECEIVING SETS. RECEIVER, *Infradyne*.
RADIO. Sept., 1926. Pp. 18 ff.
"More About the Infradyne," E. M. Sargent.

As a supplementary discussion on the Infradyne circuit (Aug., 1926. Pp. 11 ff.), reasons are given for selecting the wavelength of 86 meters (a frequency of 3486 kc.) for the amplifier circuit instead of using some lower value. Suggestions are also presented concerning the arrangement of the parts of the set, the circuit of Fig. 1 being given for a more detailed discussion concerning this point. The size of the antenna is supposed to determine selectivity and sensitivity to a great extent.

R321.5. DIRECTION-FINDERS. DIRECTION FINDERS.
Radio. Sept., 1926. Pp. 19 ff.
"An Accurate Direction Finder," W. H. Stirling.

A direction finder which eliminates doubtful minimum bearing, 180-degree ambiguity, and lack of definite indication of bearing, has been developed by the Federal Telegraph Company, for the Chief Radio Supervisor. It covers a range from 90 to 750 meters (3330 to 400 kc.) The circuit arrangement shows the method of hook-up. A discussion on the construction of a similar direction finder, and details for using it, are given.

R132.3. RESISTANCE COUPLING. DISTORTION IN RESISTANCE COUPLING.
Radio. Sept., 1926. Pp. 25–26.
"Distortion in Resistance-Coupled Amplifiers," J. Anderson.

Contrary to much published information on resistance coupling, this method of amplification will introduce distortion if proper selection of parts, such as condensers and resistances, is not made. This happens in the circuit because it is not entirely resistive, but has reactance, due to the coupling condensers. The equivalent circuits and the curves show the distortion effect, a mathematical discussion of the principle involved also being presented.

R380. PARTS OF CIRCUITS: INSTRUMENTS. TESTING INSTRUMENT.
Radio. Sept., 1926. Pp. 27–28.
"A Portable All-Purpose Testing Instrument," E. E. Griffin.

The construction and the use of a special type of test instrument for use with radio receivers in general, is described. It consists of a Weston 0-5 milliammeter, and a Weston bi-polar switch, together with a tube socket, plugs, and resistances, all assembled in a portable case. Instructions for operating the outfit are given, as also is the circuit di. gram.

R440. REMOTE CONTROL (BY WIRE.) REMOTE CONTROL AND BREAK-IN SYSTEM.
QST. Sept., 1926. Pp. 9–13.
"Break-In and Remote Control," J. M. Clayton.

For fast and realiable handling of messages, the writer recommends adapting the break-in system, here described, to all amateur c.w. and i.c.w. stations. It is stated that the break-in system can be used on all waves. A separate antenna for transmitter and receiver, the latter not tuned to the transmitter, will guard against burn-outs in the grid leak or the tube. A relay key is described. It is recommended that, in order to avoid key thumps, the circuit be broken both in the grid and in the primary of the plate transformer. This will prevent all oscillations in the transmitter.

Having the transmitter remotely controlled also is of advantage in locating it properly with respect to the aerial, and the receiver can be used continuously. Several methods of remote control, five-wire, three-wire, and two-wire, are outlined.

R351. SIMPLE OSCILLATORS. OSCILLATORS.
QST. Aug., 1926, pp. 36–37.
"A Grid-Meter Driver," W. A. Hoffman.

An oscillator capable of setting up persistant oscillations at all possible adjustments of the constants making up the radio frequency circuit, is shown. The range covered with the five coils described falls between 25,000 and 375 kc. (12 meters to 800 meters). Several applications of this particular driver are appended.

R113.4. IONIZATION; HEAVISIDE LAYER. HEAVISIDE LAYER.
Proc. I. R. E. Aug., 1926, pp. 521–540.
"Relation Between the Height of the Kennelly-Heaviside Layer and High Frequency Radio Transmission Phenomena," A. Hoyt Taylor.

The author presents data, accumulated during a long period of observations, relative to skip distances and height of the Kennelly-Heaviside layer when transmitting on very short wavelengths. From the data and the graphs, it would seem that experimental facts coincide with the theoretical calculations published in a previous paper. (*Physical Review*, January, 1926).

R070. EDUCATION: TRAINING. EDUCATION.
Proc. I. R. E. Aug., 1926, pp. 431–439
"Collegiate Training for the Radio Engineering Field," C. M. Jansky, Jr.

Scientific development is classified as: First, that which increases our knowledge of fundamental physical phenomena second, that which applies these phenomena to practical apparatus and equipment. The former falls into the field of physics and the latter into the field of electrical engineering. Again, electrical engineering is divided into: First, power engineering and, second, into communication engineering.

Physics and mathematics are considered fundamental requirements for courses in engineering. This more or less abstract training should be supplemented by drawing practical illustrations and problems from all the various fields of engineering, not primarily from the power field. Thus for a radio engineer, practical problems should be taken from the radio engineering field, he likewise being brought into contact with the problems actually involved. In this way he will become more or less acquainted with the field he desires to specialize in.

Another Tube Article

Keith Henny is preparing another of his tube articles for publication in an early issue of RADIO BROADCAST. It will be all about special-purpose tubes, such as those now available for r. f., detector, high-Mu, and output stages.

Quali-Tone

TROUBADOUR

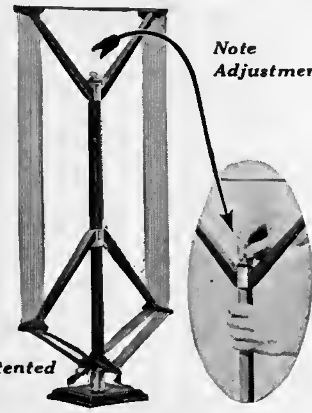
Drum Type $30.00

Just as the amorous noblea of old Spain, France and Italy enraptured a continent with their hauntingly beautiful music and poetry . . . so has the marvelous reproduction of THE TROUBADOUR impressed itself upon the Radio World of to-day.

It is Music and Song and Poetry unaltered, undistorted . . . true. Distinctively artistic in design, body finished in rich walnut brown, base and faces in dull black Morocco leather finish. Troubadour's weight of 11 pounds is absolute assurance against vibration, while Quali-Tone construction along advanced lines results in a new quality of reproduction that amazes listenera by its depth, resonance and purity.

Height 16¼". Diameter 13½". Depth 5½".

Send for literature on Quali-Tone's complete line, which includes Junior Speaker $7.50, Quali-Tone No. 2 Speaker $10, Quali-Tone No. 3 Speaker $15, Quali-Tone No. 4 Speaker $25, Quali-Tone Radio Units $6 and $7.50.



Note Adjustment!

★

Patented

8000 MILE RECORD

The Quali-Tone Loop pictured above holds two World's Records for distant reception, having brought in stations 8000 miles away. Write for verification of these records. Exclusive Thumbscrew Adjustment keeps wirea taut always. Guaranteed to improve the performance of any receiver. Price $10

DEALERS—Write for discounts—JOBBERS

Send for circulars

DURO METAL PRODUCTS CO.
2657 N. Kildare Ave. Chicago

Next Month

A Two-Tube R. B. "Lab" Circuit wi-h Power Amplifier and "B" Supply.

A New All-Shielded Model of Striking Design and Performance in the January RADIO BROADCAST.

AUDIO AMPLIFICATION FREE

The four types thoroughly explained in a fully illustrated booklet 9 x 12".

This booklet will be sent to you absolutely FREE if you will send me six cents in stamps to cover cost of handling and postage.

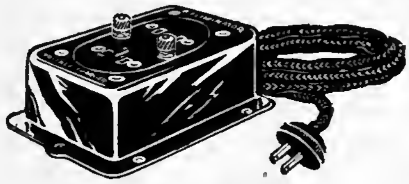
W. McMANN

64 Church St. Dept. R.B. New York City

These Automatic Switches at $2.00 to $3.75

WITH the completion of the "Convenience Model" of the Reliable Automatic Control Switch, set owners may now have their choice of two types of automatic switches at prices ranging from $2.00 to $3.75. It is no longer necessary to pay more for this new radio necessity.

Either type switch will make the A Battery switch on your receiving set, automatically turn on and off, either or both the Trickle Charger and B Eliminator as required.



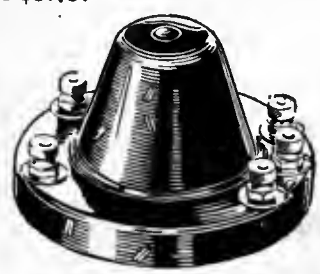
$3.50

Convenience Types

Model 23—Complete with cord and plug and receptacles for connection with Trickle Charger and B Eliminator. This model is for receiving sets using 3 to 8 type 201-A tubes or their equivalent in amperage drain. Retails at $3.50.

Model 24—Same construction as Model 23 but is intended for use with sets using from 5 to 10 type 199 tubes or their equivalent in amperage drain. Retails at $3.75.

Utility Types



$2.00 ★

Model 13—This model is identical electrically with Model 23 except that it is without cord and plug. Connections are easily made to binding posts. Retails at $2.00.

Model 14—This model is identical electrically with Model 24 except that it is without cord and plug. Connections easily made to binding posts. Intended for use with sets using from 5 to 10 type 199 tubes or their equivalent. Retails at $2.50.

Ask the nearest radio dealer to show you these newest necessities of radio, or if he cannot take care of you, order direct, giving dealer's name on the coupon below.

THE RELIABLE PARTS MANUFACTURING CO.
2831 Prospect Avenue ∴ ∴ ∴ Cleveland, Ohio

Reliable Automatic Power Control Switch

Reliable Parts Mfg. Co.
Cleveland, Ohio

I would like to have one of your Reliable Automatic Switches.

$2.00	$2.50	$3.50	$3.75
☐	☐	☐	☐
No. 13	No. 14	No. 23	No. 24

My Dealer is ______________________________

My Name ________________ *My Address* ________________

Fully guaranteed. Money returned if unsatisfactory for any reason. Sent C. O. D. if desired.

THE "RADIO BROADCAST" INFORMATION SERVICE

How to Write for Technical Information—The Scope of This Service

AS WAS announced in the June RADIO BROADCAST, all questions which were formerly sent to "The Grid" will now be handled by the Technical Information Service, RADIO BROADCAST Laboratory. That service is maintained under the following rules:

1. All questions from subscribers to RADIO BROADCAST will be answered free of charge.
2. Non-subscribers to RADIO BROADCAST will be charged a fee of One Dollar for the Laboratory Technical Service.
3. All questions will be answered by mail and none will be published in RADIO BROADCAST.

The Technical Information Service of the Laboratory feels that it is important to define the scope of its service to readers. Although the Service is of very general help to our readers, there are certain demands which can not be met.

The Technical Information Service:

1. Cannot make comparisons between various kinds of receivers or manufactured apparatus.
2. Wiring diagrams of manufactured receivers cannot be supplied. This information can be secured from the various manufacturers.
3. Complete information cannot be given about sets described in other publications, but in all cases (wherever possible), inquirers will be referred to a source of information where the data can be obtained. In this connection, the monthly department in RADIO BROADCAST "The Best in Current Radio Publications" should be of great help, and should be consulted. That department records the most important constructional, technical, and general radio articles which appear.
4. Special receivers or circuits cannot be designed by the Technical Service.
5. Those who ask questions which cannot be answered in the scope of a letter will be referred, if possible, to sources where the information can be obtained.

Readers who help by complying with the simple rules of the Information Service will greatly aid us in sending them a complete, accurate and speedy reply to their questions.

TECHNICAL INFORMATION INQUIRY BLANK

Technical Service,
RADIO BROADCAST Laboratory,
Garden City, New York

GENTLEMEN:

Please give me fullest information on the attached questions. I enclose a stamped addressed envelope.

☐ I am a subscriber to RADIO BROADCAST, and therefore will receive this information free of charge.

☐ I am not a subscriber and enclose $1 to cover cost of the answer.

Name....................................

Address....................................

R. B. D.

The Shielded Dual-Control Receiver

THROUGH an unfortunate error, improper C bias was specified in the article on "A Shielded Dual-Control Receiver" which appeared in the October RADIO BROADCAST. On page 498 it is stated that a small 22½-volt B battery should be used as C bias when the plate voltage is supplied from *four* 45-volt batteries. This should read *three* 45-volt B batteries, and, if four are used, the proper bias will be 40.5 volts.

Sheet Copper for Shielding

Shielding

Prevents aerial radiation and feedback.

Insulates against interference from adjoining circuits.

Improves efficiency, selectivity and tone quality.

USE SHEET COPPER because it combines low resistance with easy working qualities.

COPPER & BRASS
RESEARCH ASSOCIATION
25 Broadway — New York

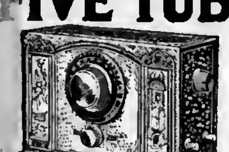
★

In January—

Working On Ultra-Short Waves. Details of Fascinating High-Frequency Transmission by Voice—with circuit details.

Radio Broadcast for January, on sale Dec. 15

FIVE TUBE RADIO

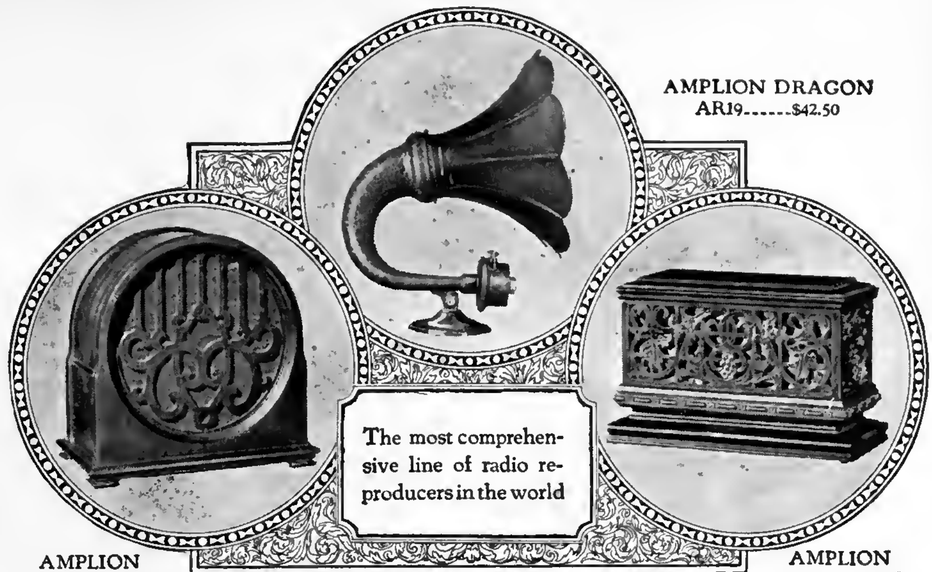


$25.00

AGENTS WANTED BIG COMMISSION

Demonstrating agent wanted; every county. Exclusive to right man. Sell what public wants—five tube, long distance, loud speaker radio with single dial control. Price within reach of all, $25,00 retail; liberal discount to agents. Sell in spare time—evenings. No selling or radio experience necessary. Territory going fast. 100 page Radio Book FREE. Write today—don't delay.

C. P. FISCHER, 122 W. Austin Ave., Chicago



Amplion reproduces the entire musical scale with absolute fidelity

—no matter what set you have, you need an Amplion to bring out its best

THE Amplion Patrician assembles a 48" air-column with the matchless Amplion reproducing unit in a richly carved mahogany cabinet, 18" x 12" x 9". The Patrician is non-directional and is notable for the pleasant, soft mellowness of its tone.

The Amplion Cone is totally different in principle from any cone type of reproducer. Its especial superiority lies in its clear, clean-cut reproduction of speech.

The Amplion Dragon is used as a standard of comparison in radio experimental laboratories all over the world.

To any radio enthusiast no gift could be more acceptable than an Amplion. Prices range from $12 to $45.

Ask your dealer for a demonstration or write to us for interesting Amplion Booklet. ★

THE AMPLION CORPORATION OF AMERICA
Suite L, 280 Madison Avenue, New York City

From 1887 . . . . . . A path of brilliant achievement . . . . . . to 1927

AMPLION

AROUND THE DIAL
with the Mu-Rad Super-Six Receiver

Shining Eyes, Happy Hearts, a Resonant Xmas with the New Mu-Rad Receiver

WHEN the gifts are untied, the candles extinguished and the kiddies gather 'round at the close of a happy Christmas Day, the soft sweet tones of MU-RAD will waft their way into your heart. Faithful reproduction, exquisite tonal qualities, simplicity of operation—all this is yours with the new MU-RAD receiver. Ask your nearest dealer for a demonstration. You may exchange your old MU-RAD set for new yearly models.

MU-RAD
Radio Corporation
Dept. B Asbury Park
New Jersey ★

ACROSS THE CONTINENT

Mayolian
"B" SUPPLY

Type 612—$42.50
The "B" Without a Buzz

Also—Complete set of parts for home-builders at reasonable prices. Write us.

MAYOLIAN
RADIO CORPORATION
1668 Webster Ave., New York, N.Y.
Pioneers in Battery Elimination

★ MEMBER R.M.A.

The Power of Niagara—
The Quiet of an Arctic Night

Bradleyometer
THE PERFECT POTENTIOMETER

Uses graphite disc resistors which are noiseless and not affected by atmospheric conditions. Metal parts are nickel plated. One hole mounting. Finish and knob match Bradleystat. Made in 200 and 400 ohm ratings.

Allen-Bradley Co. ★
Electric Controlling Apparatus
278 Greenfield Avenue Milwaukee, Wis.

HOW TO ORDER BLUEPRINTS FOR THE

R. B. Impedance-Coupled Browning-Drake. Radio Broadcast "Aristocrat." Four-Tube Roberts Receiver. Send one dollar for each set desired to Booklet Department, Radio Broadcast, Garden City, New York. Each set of blue prints accompanied by full instructions.

I. C. A.
★ **PANELS**
For "RADIO BROADCAST" and All Popular Circuits

"The PANEL OF NO REGRETS"

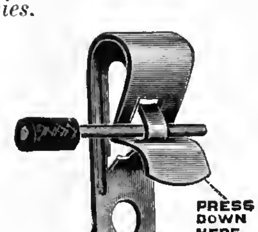
Build your set around an I. C. A. Panel of Insuline or Bakelite and make it a *Complete success*. These standard insulating materials guard you against leakage losses, and also give your set a thoroughly professional appearance. Furnished in Black and Wood finishes, for all popular circuits. Drilled ready to set up. Name, dial markings, etc. by exclusive Etch-O-Gravure process. Write for Free Booklet B-12 describing I. C. A. Panels, Sub-Panels, Mounting Brackets, etc. for "Radio Broadcast" and all popular circuits.

If your dealer can supply you write us direct. Don't take a substitute.

INSULATING CO. of AMERICA, Inc.
59 Warren St., New York City

Fahnestock Clips
RADIO'S GREATEST CONVENIENCE

Used by Manufacturers of Standard Sets and Parts—and by Manufacturers of High Grade Wet and Dry Batteries.



★

ALL GENUINE FAHNESTOCK CLIPS

bear our imprint on the thumb piece of the clip.

WORLD'S LARGEST MAKER OF CLIP TERMINALS

48 different sizes and styles to meet all requirements.

Send for Catalog and Samples

FAHNESTOCK ELECT. CO.
L. I. City New York

Build the Browning-Drake Receiver described in the September RADIO BROADCAST with the aid of full-sized Blue-prints. Complete constructional and wiring information together with instruction booklet may be obtained for one dollar. Send remittances to RADIO BROADCAST Magazine, Book Dept., Garden City, N. Y.

Kit Panels With Gold Decoration

FORMICA is this year providing amateurs through the leading jobbers and dealers with handsomely decorated gloss black panels with gold decoration for the leading kits: Infradyne, Aerodyne, Bremer Tully Counterphase and Power Six; Browning Drake National; Victoreen Superheterodyne; Victoreen Universal; Madison Moore Superheterodyne; Camfield Duoformer; St. James 8 tube; Karas Equamatic front and sub panels and H. F. L. Nine-in-line Superheterodyne.

Manufacturers are using handsomely decorated Formica panels in dull finish some of them in two colors.

The FORMICA INSULATION COMPANY
4628 SPRING GROVE AVENUE CINCINNATI, OHIO

Hear the FORMICA Orchestra Tuesday 9 to 10 over WLW

★

FORMICA
Made from Anhydrous Bakelite Resins
SHEETS TUBES RODS

Formica has a Complete Service on Insulating Material for Radio Manufacturers

---

In a Jiffy-anywhere
PUT UP-CHANGE-OR TAKE DOWN
Reel Aerial
SATISFACTION GUARANTEED

TAKE your set anywhere—to demonstrate it, entertain friends or experiment—and in a few moments have a 100% efficient OUTSIDE aerial on the job. Simply lead in the Reel Aerial Antenna under or over window or door, which may be closed tight without harm to wire.

Makes a "Reel" Christmas Gift!

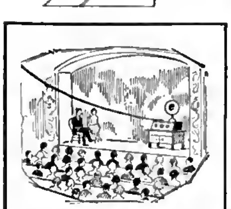
Something different and new for your radio friends. An aerial they can use at home, change about for testing and take with them on visits or trips! Note other uses illustrated. Mail coupon if dealer cannot supply you.

HERE'S 100 feet of ¼ in. wide FLAT bare copper wire, with insulator on outer end, reeled up in a handsomely nickeled metal case, 4¼ in. diameter. Weighs only 21 ounces. Fits pocket. Unreel as long an aerial as desired, place case on or near set, insert plug on cable in center hole—attach other end of cable to set—and tune 'em in. Unused portion in case does not cause dead end losses. When through reel in like a tape measure, No tangling. Provides 100% efficient aerial in a few moments—any time, any place—indoors, outdoors.

Unsurpassed Permanent Aerial! Reel Aerial antenna has same inductance value as stranded copper wire. Being flat, smooth, and easy to take down, it is easily cleaned.

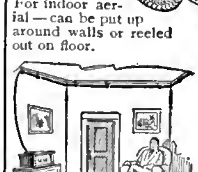
Pat. Applied for

½ Size Illustration.
Actual size of Case 4¼ in. diameter
INSULATOR →



For use in halls, theatres, laboratories, schools, clubs, on trains, at fairs, etc.

For indoor aerial—can be put up around walls or reeled out on floor.



Experimenters, Engineers! Attach Reel Aerial insulator to a pole and push pole into ground. Bring antenna into house. By changing distance and locations of pole, and reeling antenna in or out, you can vary antenna.

DEALERS! JOBBERS!
Write for attractive proposition. Use Reel Aerials in making trial demonstrations. Sell Reel Aerials for indoor aerials, portable sets to travelers and tourists, to experimenters and to people desiring highly efficient permanent aerials.

★

SEND NO MONEY—JUST MAIL COUPON

HAWKEYE RADIO CO., Dept. 1712. Cedar Rapids, Iowa.
Ship me—on your MONEY BACK GUARANTEE—one Reel Aerial C. O. D. I will pay postman $5 plus few cents postage (postage prepaid when money accompanies order).

Name..

Address..

Choose Your Cone Materials Carefully

In Building Your Own

3 Foot Cone

MADE especially for cone type speakers, ALHAMBRA FON-O-TEX is used by practically all leading cone type speakers manufacturers. This remarkable material has no grain, hence no resonance point of its own; but resonates uniformly at all frequencies.

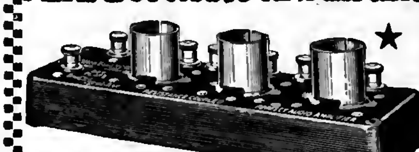
Price 75c for a sheet 38 x 38 inches, large enough for a 3 foot cone. Ask your dealer. If he hasn't Alhambra FON-O-TEX we will supply you. To the cost of the number of sheets you need, add $1 for packing and delivery charges.

★ The SEYMOUR Co., Desk B
325 West 16th St. New York City

ALHAMBRA
FONOTEX
PRODUCT AND PROCESS PATENTED
FOR CONE TYPE LOUD SPEAKERS

Bradley-Amplifier
Resistance-Coupled
PERFECT AUDIO AMPLIFIER

★



Provides audio amplification with minimum distortion. Bradleyunit molded resistors used in the Bradley-Amplifier do not vary with age and are not affected by atmospheric conditions. Can be used to replace transformer amplifiers in standard radio sets with decided increase in tone quality.

Allen-Bradley Co.
Electric Controlling Apparatus
278 Greenfield Avenue Milwaukee, Wis.

Build Your Own

Big 3 Foot Cone Speaker

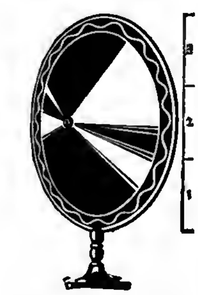
Radio Show Sensation

Unit developed and speaker designed by Clyde J. Fitch, noted radio engineer. Results guaranteed equal to the finest factory-built speaker or your money back if you wish it. Easily assembled; operates from any receiver that will work a speaker; wonderful tone quality at any volume even with power tubes.

FREE Blue Print

Famous Tun-Bar Unit sent prepaid on receipt of $7.50, or C. O. D. charges collect, if you prefer. Free blue print with each order for unit; blue print alone, $1.

Tunbar
Cone Speaker
UNIT



$7.50 Direct from Maker

TUNBAR RADIO CO.
26 Cortlandt St. Desk "I" New York City

The New 6-Tube ELKAY ★

With Donle Truphonic Audio Amplification

which delivers pure tone in any volume over the entire tonal scale, and the patented Elkay Synauto R. F., which smoothes out the tuning over the whole dial from 200 to 580 meters—is a rec iver that will be modern for years to come.

Completely shielded. Neat Uni-Control—the flexibility of 3 dials at your finger tips. In brown antique, Duco-finished mahogany, $125. (Exclusive franchise to the Trade).

The Langbein-Kaufman Radio Co.
Dept. R
62 Franklin Street, New Haven, Conn.

RADIO AGENTS WANTED

Famous Air King line of 5-Tube T. R. F. receivers. 3 models, retail for only $49.50 to $59.50. Solid walnut cabinets. Wonderful tone and power. Liberal discounts to user agents. Write to-day. **20TH CENTURY RADIO CO., 1042 Coca Cola Bldg., Kansas City, Missouri.**

Build a Giant 3 Foot Cone Speaker

SAVE

Four-fifths of retail cost. Equals finest speaker made.

You can build this SENSATION of the Radio Shows at home yourself and make it equal to a factory built one; and save four-fifths of the cost.

Only with a 3 ft. speaker can you get real tone quality—every note of the brass horns in an orchestra, the beats of the bass drum, the low notes of a pipe organ and ALL the in-between tones to the highest note of the violin and the shrill treble of the piccolo.

But you must choose your unit with care. It is most important. Insist on a

Penn Cone Speaker UNIT ★

Designed especially to operate a 3 ft. cone and to work perfectly even with power tube. Adjustable to the audio output of any set and will carry any load a set can give it. Recommended by leading radio engineers. Finest seasoned steel magnet; double pole vibration; shortest, most substantial driving rod on any cone speaker unit. A marvel of design and construction.

Your dealer has or can get the PENN Unit for you. Insist on examining it before you accept any other. Price, $9.50. If he hasn't the PENN or will not get it for you, we will ship you direct, prepaid, on receipt of price. Parts complete, $14.15.

"How to Build a 3 Ft. Cone Speaker for only $14.15" sent for 10c. Complete set Blue Prints, $1.00

Penn Radio Sales Co.
104 Fifth Ave. Suite 2009 New York City
Exclusive Distributors for G. R. Penn Mfg. Co., New York City

Leadership

with Benjamin Radio Products in Securing the Best Radio Results

All Benjamin Radio Products are of the same high standard as the far-famed Cle-Ra-Tone Sockets

You will find that almost every good radio set in the neighborhood has some or all Benjamin Radio Products in it. Radio experts and set makers have proved through long experience that only radio parts conscientiously and painfully made to improve delicate tonal quality, selectivity and volume can bring a leadership in securing the best radio results.

If you would have your set just as good or better than your neighbor's make sure that every component part is reliable and bears the trade mark of a manufacturer in whom you can place your full confidence. The world-wide recommendation of Benjamin Radio Products by radio authorities is the best testimonial for their scientific accuracy and uniformity in securing the best radio results.

Rewards for Radio Reasoners

Awards for novel and original hook-ups, modifications of existing circuits; trade names; slogans; write our nearest office for full details.

If your dealer cannot furnish you with Benjamin Radio Products send amount direct to our nearest sales office with his name and we will see that you are promptly supplied.

Benjamin Electric Mfg. Co. ★
120-128 S. Sangamon St.
Chicago

New York: 247 W. 17th St.
San Francisco: 448 Bryant St.

Manufactured in Canada by the Benjamin Electric Mfg. Co. of Canada, Ltd., Toronto, Ontario

Improved Tuned Radio Frequency Transformers

Space wound; basket weave; cylindrical; highest practical air dielectric. Proved to give the best results in sharpness of tuning, increase in volume and improvement in quality. Authoritative laboratory tests and practical experience of manufacturers and amateurs shows that this type of coil excels in every important characteristic.

2¼-inch Diameter Transformer

Compact. Especially desirable for crowded assembly. Eliminates interfering "pick-ups."

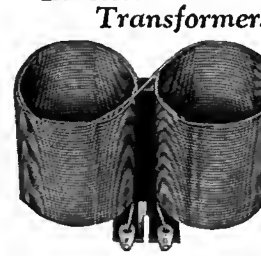
Set of Three, $5.75
Single Transformer, $2.10

3-inch Diameter Transformer

Capacity coupling reduced to lowest degree. For use with .00035 Mfd. Condensers.

Set of Three, $6.00
Single Transformer, $2.25

"Lekeless" Transformers



Uniform high inductance, low distributed capacity and low resistance. The external field is so slight that it permits placing coils close together without appreciable interaction.

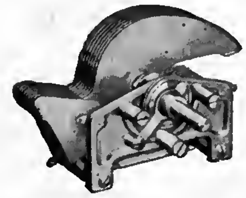
Single Transformer, $2.50

Cle-Ra-Tone Spring Supported—Shock-Absorbing Sockets

Spring Supported, Shock-Absorbing. Stop Tube Noises. The greatest aid to non-noisy operation. Contacts always clean.

75 cents each

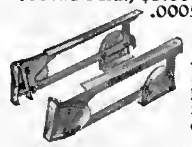
Straight Line Frequency Condensers



Eliminates bunching of stations. Spreads the log evenly over the dial. Makes tuning easy. Adjustable turning tension. Compact. A beautiful instrument that not only improves reception, but adds to the good appearance of the set.

.00025 Mfd., $5.00 .00035 Mfd., $5.25 .0005 Mfd., $5.50

Brackets



An aid to simplification in set construction. Supports the sub-panel, with room underneath for accessories and wiring.

Plain—70c pair. Adjustable—$1.25 pair

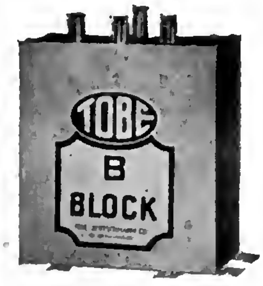
Battery Switch

Quick, positive, clean-cut make and break. When it's "in" it's "off", eliminating danger of wasteful use of battery.

30 cents each

TOBE

TRADE MARK



TOBE B BLOCKS

The quality of the TOBE B BLOCKS is immediately apparent on sight. The perfection and beauty of their finish is simply a reflection of what is packed inside. The first B BLOCK for B-Eliminator filters—and still in the lead.

★

TOBE BH BLOCK

contains one 6 and two 4 mfd. TOBE Filter Condensers. Especially designed for use with the new Raytheon BH Tube.

Price, $11.00

TOBE B BLOCK
Type 761

This contains one 8 and two 2 mfd. TOBE Filter Condensers, and is designed for use with electrolytic and D. C. eliminator filters and where separately cased condensers are used on the voltage taps.

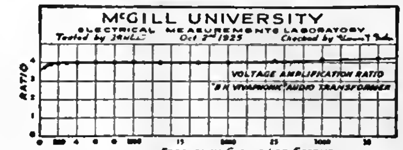
Price, $9.50

TOBE DEUTSCHMANN CO.

Cambridge Massachusetts

FAMOUS **BH** TRANSFORMERS

★



A PERFECT

AUDIO AMPLIFYING TRANSFORMER

The BH Vivaphonic is the only transformer having a low loss shield structure (patented.) It is ideal for the Browning-Drake, Universal, Roberts, etc.

BENJAMIN HUGHES ELECTRIC CO.
298 Lagauchetiere West Montreal, Can.
Transformer Builders Since 1910

Yale GROUND HOG
The Perfect Ground **DOUBLES** POWER AND DISTANCE

Marvelous newly-invented ground gives incredibly improved reception. Doubles power and distance users say. Reduces leakage. Stops jangling even in mid-summer. Results never before equalled. Satisfaction guaranteed or money back at once. Approved by Highest Radio authorities after exhaustive tests. Proven absolutely essential to clear, powerful distance reception. Draws and holds moisture indefinitely. Highly sensitive to radio energy. **SEND NO MONEY**—To introduce, we offer to those who act at once, regular $5.00 size for only $2.00. Send name today and pay $2.00 plus 17c postage on delivery. Or send only $2.00 with order and save postage.

FREE—Full description of Ground Hog and details of amazing special offer on request—write today. ★

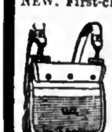
Yale Specialty Supply Co.
133 W. 5th St. Kansas City

CAL. 30-40

KRAG CARBINE STYLE

22-inch Barrel, 5 shot Box Magazine. The choice of hundreds of Big Game Hunters. Barrel slightly used and refinished, other parts NEW. First-class serviceable condition. Shipping Weight 13 lbs. PRICE F.O.B. **$15**

HAND GRENADE BAG



45c POSTAGE EXTRA Made of fine quality canvas. Size 10x10 inches inside. Suitable for School Bag and hundreds of other purposes.

Terms strictly Cash. No C. O. D. Shipments

Catalog Free on request

W. STOKES KIRK
1627-H.M. North 10th St. Phila, Pa.

B-Power Supply and Amplifier

Radio Broadcast for January will contain complete constructional information on a new and important power amplifier and B supply, especially interesting to those who have built the R. B. "Lab." circuit. Look for the January issue, on sale December 15th.

32 Page CATALOG Brings DEALERS BIGGER PROFITS

Matchless bargains in radios and accessories. Full line of Bremer Tully, Balkite, All American G. E. Tungar, Thorola, Majestic, Utah, R. C. A. Tubes, nationally advertised parts, batteries, chargers, etc. Big opportunity for live dealer to double sales quick. Tell us about your business as we sell wholesale only. Postcard or letter brings catalog and dealer's proposition. Exclusive territories open. Act—NOW!

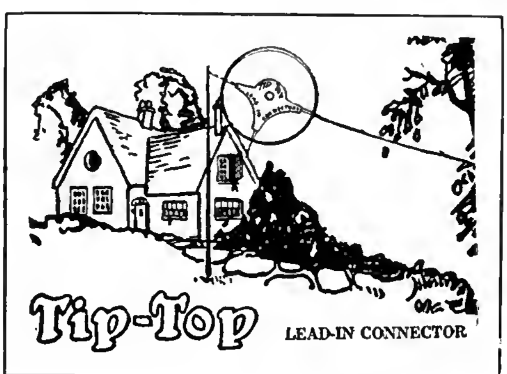
NEW ENGLAND MILLS COMPANY
Distributors of Nationally Advertised Radio Lines
Dept. 91A 851-55 Washington Blvd. Chicago, Ill.

The Best in Radio Programs

The first to review programs, Radio Broadcast, has maintained its interesting department of news and comment about broadcasters and their programs in "The Listeners' Point of View." A regular and lively department, conducted by John Wallace from his "listening-post" in Illinois.

BLUEPRINTS FOR THE BROWNING-DRAKE

Complete constructional data and large, clear blueprints can be ordered from the booklet department, *Radio Broadcast*, Garden City, N. Y. at $1.00 the set. The efficient Browning-Drake tuner unit with impedance—coupled amplification in a neat and easy-to-build layout.



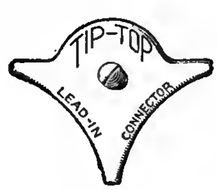
A FEW spare moments, a screw driver and you have a sure, perfect connection between your aerial and lead-in wire. No noise, no soldering, no loss of "distance" due to swinging aerial or corrosion. Tip-Top cannot work loose.

★ *Jobbers and Dealers Write Us!*

JAMES F. DOOLAN MFG. CORP.

36-42 West 47th St. New York, N. Y.

Don't Neglect this Vital Point of Contact!



25c

Eliminates Antenna Noise

Radio Code!

DO you know you can get code on your radio and read it too? You can get more out of your radio with the Bunnell Buzzoplex. It's easy to learn wireless and radio signals with the buzzer, or shift to the lamp for practice in flash or heliographic work.

Used by military schools, boy scout camps and others, wherever code is taught. Instruction book and code chart furnished with each set. Headquarters for transmitting apparatus.

J. H. BUNNELL & COMPANY, Inc.
Manufacturers and Distributors
32 Park Place, New York
***Phone:* Whitehall 5970**

Complete with full instructions

$7.50

★

ACCURATUNE
Recording Dial

Its simplicity and efficiency has overwhelmed the real radio fans.

Its positive friction grip insures absolute smooth action.

Graduated from 0 to 100 or reverse.

Sold in three ways.

Recording Dial (Ratio 10 to 1)	$2.00
With Micrometer control (Coarse ratio and 200 to 1)	2.75
Illuminated extra	.50

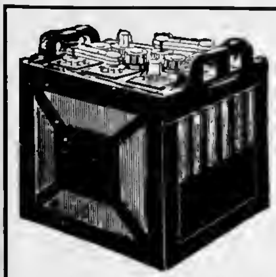
Sent direct if your Dealer cannot supply you

MYDAR RADIO COMPANY

3 Campbell St. Newark, N. J.

"Pioneer Mfrs. of Micrometer Dials"

Why not subscribe to *Radio Broadcast?* By the year only $4.00; or two years, $6.00, saving $2.40. Send direct to Doubleday, Page & Company, Garden City, New York.



CHICAGO RADIO BATTERIES

Solid One Piece Rubber Containers

GUARANTEED FOR 2 YEARS

FAMOUS for unexcelled quality, guaranteed long-lived service and unvarying dependability Chicago Batteries offer the Radio fan an "A" Power that is backed by years of experience and master workmanship with the finest materials available. Endorsed and approved by leading Radio and Automotive authorities. Chicago Batteries in their new non-leak, solid rubber cases represent an amazing value at lowest cost.

PRICES RADIO BATTERIES
Solid Rubber Cases

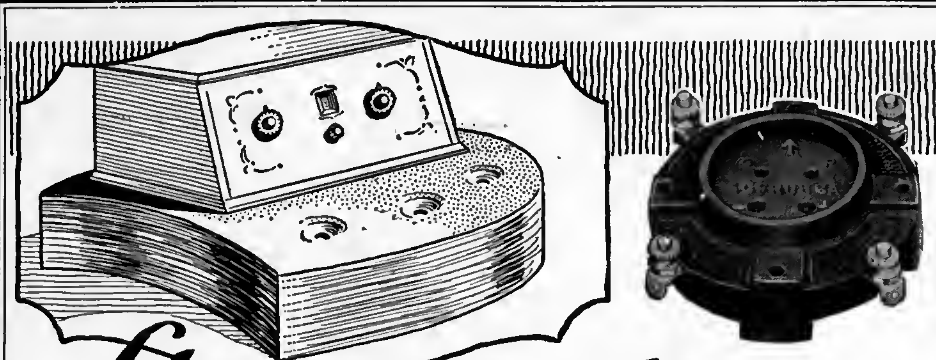
6 volts, 100 amps.	**$ 8.79**
6 volts, 120 amps.	**10.79**
6 volts, 140 amps.	**13.50**

SEND NO MONEY

Buy Chicago Batteries direct from the manufacturer. Batteries shipped same day order is received. Express C O D or 5% discount cash with order.

MOGUL ELECTRIC LABS.

1206 So. Peoria St. Chicago, Ill.



Like a rubber heel for your radio!

ELIMINATES ALL SHOCKS AND MICROPHONIC NOISES

You can remember the first time you tried rubber heels on your shoes. You were surprised in the ease, soft and nerve-soothing difference in your step.

You will be even more surprised when you try a SOFRUBBA socket in your radio set.

You can be assured that every set equipped with SOFRUBBA sockets will be free from shocks and jars that produce microphonic noises.

Whether you use last years' tube or a brand new one with this socket, you can be assured of the most satisfying results.

Price sixty cents

Inquire at any reputable dealer, or direct

MOULDED PRODUCTS CORPORATION

549-551 West 52nd Street, New York City

Attention Department C

SOFRUBBA
BALLOON SOCKET

MPC TRADE MARK

Full-Sized Blue-Prints

of the Browning Drake Receiver described in the September issue of RADIO BROADCAST makes its construction extremely simple. The receiver combines a stage of tuned, neutralized radio frequency amplification enploying a type 199 tube, a regenerative detector and three stages of impedance-coupled audio frequency amplification. High-mu and power tubes are used. This is one of the best receivers of the year. Obtain your copy of the full-sized blue-prints complete with instruction book by mailing remittance of one dollar to

RADIO BROADCAST Magazine

Book Dept. Garden City, N. Y.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., required by the Act of Congress of August 24, 1912, of RADIO BROADCAST, published monthly at Garden City, New York for October 1, 1926. State of New York, County of Nassau.

Before me, a Notary Public in and for the State and County aforesaid, personally appeared S. A. Everitt, who, having been duly sworn according to law, deposes and says that he is the treasurer of Doubleday, Page & Company, owners of Radio Broadcast and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: *Publisher*, Doubleday, Page & Co., Garden City, N. Y.; *Editor*, Willis Wing, Garden City, N. Y.; *Business Managers*, Doubleday, Page & Co., Garden City, N. Y.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent. or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.) F. N. Doubleday, Garden City, N. Y.; Arthur W. Page, Garden City, N. Y.; S. A. Everitt, Garden City, N. Y.; Russell Doubleday, Garden City, N. Y.; Nelson Doubleday, Garden City, N. Y.; John J. Hessian, Garden City, N. Y.; Dorothy D. Babcock, Oyster Bay, N. Y.; Alice De Graff, Oyster Bay, N. Y.; Florence Van Wyck Doubleday, Oyster Bay, N. Y.; F. N. Doubleday, or Russell Doubleday, Trustee for Florence Van Wyck Doubleday, Garden City, N. Y.; Janet Doubleday, Glen Cove, N. Y.; W. Herbert Eaton, Garden City, N. Y.; S. A. Everitt or John J. Hessian, Trustee for Josephine Everitt, Garden City, N. Y.; W. F. Etherington, 50 E. 42nd Street, N. Y. C.; Henry L. Jones, 285 Madison Avenue, N. Y. C.; William J. Neal, Garden City, N. Y.; Daniel W. Nye, Garden City, N. Y.; Mollie H. Page, Syosset, N. Y.; E. French Strother, Garden City, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) 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 the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, 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 a 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.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is...... (This information is required from daily publications only.)

(*Signed*) DOUBLEDAY, PAGE & COMPANY
S. A. Everitt, *Treasurer*.

Sworn to and subscribed before me this 16th day of September, 1926.

[SEAL] (*signed*) Frank O'Sullivan
My commission expires March 30, 1928.)

Helpful Technical Information

A regular feature of RADIO BROADCAST is the series of Laboratory Information Sheets, which cover a wide range of information of immediate value to every radio worker, presented in a form making it easy to preserve them. To insure your having every issue, send your check for $4.00 to

Subscription Department, Doubleday, Page & Co., Garden City, N. Y.

THE 1926 X-MAS Gift for Every Radio Fan---

A book 8½" x 11 in., containing large photographs of all the chief announcers of the leading broadcasting stations in the United States, Canada and Cuba and bubbling over with interesting items regarding their lives, personality and style of announcing. Has six time-divisioned maps and everything to make it the finest radio log ever published. The book is beautifully bound in red flexible art binding and is put up in loose leaf form, allowing for future additional photographs and sketches.

Order quickly to insure Christmas delivery.

SEND CHECK OR MONEY ORDER TO

THE AMERICAN ANNOUNCER

41 FRANKLIN STREET - - BUFFALO, N. Y.

Price per copy $2.50

DEALERS WANTED EVERYWHERE

Bradleyleak

THE PERFECT GRID LEAK

Provides a noiseless range of grid leak resistance from ¼ to 10 megohms. Assures most effective grid leak resistance value for *all* tubes. Small grid condenser (0.00025) is separate. Metal parts nickel plated. One hole mounting.

★ **Allen-Bradley Co.**

Electric Controlling Apparatus

278 Greenfield Avenue Milwaukee, Wis.

See that Screw

A screw-driver adjusts an X-L in crowded places

★ **X-L VARIO DENSER**

RESULTS in easier tuning, more distance, volume and clarity—greater stability. Indorsed by leading authorities.

Model "N" A slight turn obtains correct tube oscillation on all tuned radio frequency circuits. Neutrodyne, Roberts two tube Browning-Drake, McMurdo Silver's Knockout, etc. capacity range 1.8 to 20 micro-micro farads. **Price $1.00**

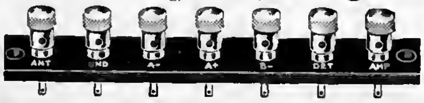
Model "G" With grid clips obtains the proper grid capacity on Cockaday circuits, filter and intermediate frequency tuning in heterodyne and positive grid bias in all sets. Capacity range.

Model G-1—.00002 to .0001 MFD
Model G-5—.0001 to .0005 MFD
Model G-10—.0003 to .001 MFD

Price $1.50

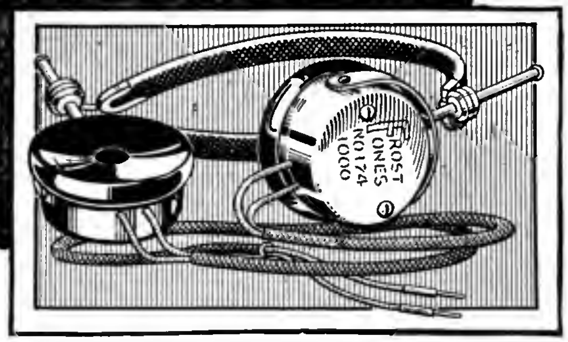
X-L Push Post. Push it down with your thumb, insert wire, remove pressure and wire is firmly held. Releases instantly. **Price 15c.**

Push Post Panel permanently marked in white on black rubber. In box including soldering lugs, raising bushings and screws for mounting, etc. **Price $1.50**



X-L Radio Laboratories 2424 Lincoln Ave. CHICAGO, ILL.

FROST FONES



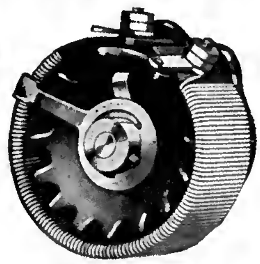
Nothing can quite take the place of **FROST-FONES** when you want sensitiveness, pure tone quality and clearness on distant stations. The pole pieces in these fones are ground to exacting limits to insure absolute uniformity. Compare them with other makes at your dealer's.

Prices $3.00 to $6.00

The New

FROST-RADIO RHEOSTATS

Type 800, Bakelite Frame



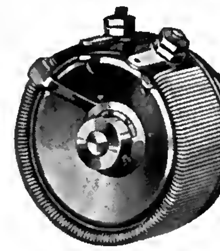
List price, 75c

FROST-RADIO Type 800 Rheostats have a frame cast from genuine Bakelite and designed to allow a free circulation of air around the windings for quick radiation of heat. They operate with a smooth and noiseless action—cannot overheat or vary in resistance. Arranged for single hole mounting; equipped with Bakelite pointer knob. Supplied in twelve resistances, from 2½ to 75 ohms.

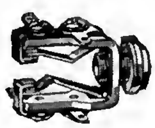
FROST-RADIO Type 700 Rheostat is simple and rugged in design, being built on a one-piece metal frame that cannot warp or bend. This method of construction makes possible a high grade unit at a very low price. Arranged for single hole mounting; equipped with pointer knob.

Supplied in 12 resistances—from 2½ to 75 ohms. See both types at your dealer's.

Type 700, Metal Frame



List price, 50c



Gem-Jac

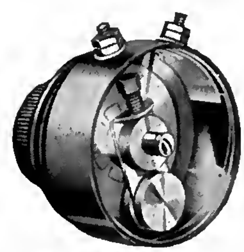
A small, sturdy jack projecting only 1 inch behind panel. Its strong, self-cleaning springs are permanently adjusted and have Sterling silver contacts.

Prices 40c to 50c

Pan-Tab

Built to the finest precision standards, the Pan-Tab appeals to the set builder who includes nothing but the best parts. Nickel plated and hand-buffed to a high finish.

Prices 65c to 90c



FROST-RADIO Super-Variable Resistances

These new **FROST-RADIO** units find a ready use in most of the new circuits. They are non-inductive, smooth and noiseless in operation. As the knob is turned the resistance is graduated continuously without steps or jumps. Type 880 has 2 terminals and Type 890, 3 terminals. Both types - - **$1.25 each**

No. 530 **FROST-RADIO** Socket

List price, 40c

FROST-RADIO Automatic Plug No. 141

List price, 75c

HERBERT H. FROST, Inc.

160 N. La Salle Street

New York CHICAGO Los Angeles

MEMBER R.M.A. ★

LOOK FOR THE JANUARY RADIO BROADCAST

Five important constructional articles of unusual interest. Details of new receiver circuits—Broadcasting from banquets—The New Hammarlund-Roberts—A New Super-Heterodyne—Many other articles of wide interest—On sale Dec. 15.

STORAD RADIO POWER SUPPLY

TYPE 101X—"B POWER"

Raytheon Tube Type Unit with Storad REMOTE CONTROL feature. Place Unit batteries, etc., where you wish. You control them entirely with the Storad REMOTE CONTROL at the set.

100% over capacity work on all sets regardless of size, without hum. Will operate sets using power tube on last stage audio.

Operates on house lighting circuit. Three variable controls from 180 volts down.

Ask your dealer or write for information

THE STORAD MANUFACTURING CO. ★

2415 Detroit Ave. Cleveland, Ohio

SM

630 SILVER SHIELDED SIX

The Radio Broadcast star of approval is on the Shielded Six! In the October issue this remarkable receiver was described at length—approved by the Radio Broadcast laboratory!

The Shielded Six is one of the highest types of broadcast receivers. It embodies complete shielding of all radio frequency and detector circuits. The quality of reproduction is *real*—true to the ear.

Behind the Shielded Six is competent engineering. It is sensitive. Day in and day out it will get distance—on the speaker. It is selective. Local stations in the most crowded area separate completely—yet there are but two dials to tune. These features—its all metal chassis and panel, its ease of assembly and many others, put it in the small class of ultra-fine factory-built sets, priced at several times the Six's cost.

The S-M 630 Shielded Six Kit—including matched and measured parts to build this remarkable receiver—price $95.00.

The 633 Shielded Six Essential Kit contains four condensers, four radio frequency transformers, four coil sockets, four stage shields and the link motion—all factory matched—price $45.00.

Clear and complete instructions, prepared by S.M. engineers, go with each kit—or will be mailed separately for 50c.

220 & 221 AUDIO TRANSFORMERS

The S-M 220 is the outstanding Audio Transformer that is in demand everywhere and whose popularity has taxed in the severest way the manufacturing facilities of Silver-Marshall, Incorporated. It is the audio amplifying device that has created a new standard by which the merits of audio transformers are measured. It is the first transformer with the rising low note characteristic that means real quality—not theoretically—but to the human ear. It is a power job—yet this finest of audio amplifying devices is sold with a guarantee for but $6.00.

The S-M 221 is an Output Transformer that improves low note reproduction in any set. It is for use between the last audio tube and the loud speaker. It eliminates blasting and will increase speaker capacity for handling strong signals without distortion—price $6.00.

Prices 10% higher West of the Rockies

SILVER-MARSHALL, Inc. ★

838 W. JACKSON BLVD. CHICAGO, U. S. A.

Your program starts with a snap–

It does if your "snap" judgment is good! Because good reception demands lively batteries. And that's what you get when you snap on your Rectigon to do your charging. The time to start bringing in tomorrow's snappy program is tonight—after the last station signs off. You just plug into the light socket and attach the terminals. That keeps your batteries at their peppy best. That saves service station bother. And you'll never be caught with batteries run down, or absent for charging when the week's best program is on the air.

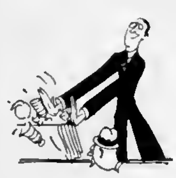
when you charge 'em at home with

The Westinghouse Rectigon Battery Charger

©, 1927, W. E. & M. Co.

No noise as it charges—not a bit of fuss. Not even a murmur that would disturb the mildest slumber.

No acids, no chemicals—no moving parts—nothing to spill or burn. No muss, no worry. You'll have no spoiled rugs, no ruined clothing.



Saves its cost in short order—Count the dollars spent in a few trips to the service station and you'll hotfoot it for a Rectigon, for the good it does your pocketbook as well as your batteries.

Charges both "A" and "B" batteries—Keeps both packed with power. Bulb is used for "B" battery charging and is enclosed, like all other parts, in metal, safe from accident. (Rectigon charges automobile batteries, too.)

Perfect safety for your set—If you tune in while you're charging there'll be no harm either to set or batteries. Nor will batteries be discharged if anything happens to the current while your Rectigon's attached.

★

THE RECTIGON is a superb Westinghouse product. Things you *can't* see, like extra heavy insulation, things you *can* see, like the durably enameled case—all are of highest quality. Westinghouse also manufactures a complete line of radio instruments, and Micarta panels and tubes.

No Storage Battery Radio is Complete Without a Rectigon

WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

Tune in on KDKA - KYW - WBZ - KFKX

RADIO BROADCAST

JANUARY, 1927

WILLIS K. WING, Editor

KEITH HENNEY, Director of the Laboratory
JOHN B. BRENNAN, Technical Editor

EDGAR H. FELIX, Contributing Editor

Vol. X, No. 3

CONTENTS

BEHIND EDITORIAL SCENES

ALTHOUGH this January, 1927, RADIO BROADCAST is not decked out with red holly and demure Santa Clauses in appropriate poses, it is nevertheless a Christmas issue, and contains a greater quantity than usual of interesting material. In this issue, we have a description of a very interesting super-heterodyne which a large number of readers have been pleading for, ever since Kendall Clough's article on super-heterodyne operation appeared in our September number. We present Thornton Dow's first article on the crystal and its use in radio, the first of a series of articles by David Grimes, describing his remarkable new inverse duplex circuit, a description of the new Hammarlund-Roberts "Hi-Q" receiver, and last, the two-tube R. B. "Lab." circuit receiver with the National Amplifier and B Supply. That is an array of technical and constructional material of which we are quite proud. For our Christmas presentation to our readers, we have omitted the seasonal decorations and have supplied as many fine technical articles as we could. Even so, the article by Howard Rhodes, of the RADIO BROADCAST Laboratory, telling of J. H. Hallberg's work on very short waves had to be held over for our February number.

FOR those who have been wondering about the details of the cathode ray tube developed by Doctor Coolidge of the General Electric Company, James Stokley's leading article supplies the information and, what is more, not a little of the impression created by actually seeing the tube in operation. The tube is now more than a laboratory fact and the medical application lies with that profession. That step, we understand, has already been taken. . . . There is a paragraph on page 258 in the "March of Radio" directly under the heading "The Month in Radio," which is more than usually prophetic, as announcements about the time this magazine appears will well show.

WE, like the aural Mr. Wallace, who each month interprets "The Listeners' Point of View," have a strong aversion to the average questionnaire. But so much nonsense has been uttered, and worse, written, about what the radio listener likes, that we have decided to give those listeners who read this magazine an opportunity to tell something of their habits and preferences. We hope that every reader will tear out page 270 and fill out the answers.

THE tabulation of advertising volume in general and class magazines in *Printers' Ink* shows that for November magazines, RADIO BROADCAST had a total of 29,504 lines, being exceeded by *Radio News* with 35,506, and followed by *Popular Radio* with 29,315, *Radio* with 19,706, and *Radio Age* with 8834.

RADIO BROADCAST for February will contain another article on the R. B. "Lab." Circuit, this time with especial reference to the four-tube model. We are beginning to hear from the provinces on this set and as Mr. Harvey Merwin of Florida phrased it, "the circuit is so much better than you said it was that I cannot understand why you did not shout louder, but perhaps it is wiser to let the user discover that for himself." The first of two articles by B. F. Miessner on electrically operated receivers will appear in February. Keith Henney is working on another of his popular tube articles which will soon appear. —WILLIS K. WING.

Doubleday, Page & Co.
MAGAZINES
COUNTRY LIFE
WORLD'S WORK
GARDEN & HOME BUILDER
RADIO BROADCAST
SHORT STORIES
EDUCATIONAL REVIEW
LE PETIT JOURNAL
EL ECO
FRONTIER STORIES
WEST

Doubleday, Page & Co.
BOOK SHOPS
(Books of all Publishers)
NEW YORK: LORD & TAYLOR; PENNSYLVANIA TERMINAL (2 Shops); GRAND CENTRAL TERMINAL; 38 WALL ST. and 526 LEXINGTON AVE.; 848 MADISON AVE. and 166 WEST 32ND ST.
ST. LOUIS: 223 N. 8TH ST. and 4914 MARYLAND AVE.
KANSAS CITY: 920 GRAND AVE. and 206 W. 47TH ST.
CLEVELAND: HIGBEE CO.
SPRINGFIELD, MASS.: MEEKINS, PACKARD & WHEAT

Doubleday, Page & Co
OFFICES
GARDEN CITY, N. Y.
NEW YORK: 285 MADISON AVE.
BOSTON: PARK SQUARE BUILDING
CHICAGO: PEOPLES GAS BUILDING
SANTA BARBARA, CAL.
LONDON: WM. HEINEMANN LTD.
TORONTO: OXFORD UNIVERSITY PRESS

Doubleday, Page & Co.
OFFICERS
F. N. DOUBLEDAY, *President*
A. W. PAGE, *Vice-President*
NELSON DOUBLEDAY, *Vice-President*
RUSSELL DOUBLEDAY, *Secretary*
S. A. EVERITT, *Treasurer*
JOHN J. HESSIAN, *Asst. Treasurer*

DOUBLEDAY, PAGE & COMPANY, Garden City, New York

TERMS: $4.00 a year; single copies 35 cents.

look inside that Christmas Radio Set

THE *equipment* is as important as the set. The distance reach of a set depends a great deal on the tube in the detector socket. The over-all performance of a set depends very much on the tubes in every socket. The volume and tone quality you will get are dependent upon the tube in the last audio stage. In every point, the tubes are as important as the set. And everyone who realizes this insists on genuine RCA Radiotrons.

The research laboratories of RCA, General Electric and Westinghouse have developed Radiotrons to new accomplishment, year by year. And the manufacturing skill of these same companies keeps RCA Radiotrons far in the lead in accurate making.

• • •

Be sure, when you buy a Christmas radio set, that you are getting genuine RCA Radiotrons with it. You can tell by the RCA mark inside the glass at the top. Or take out the tube, and look at its base.

Extra! Extra! Gift Ideas for Radio fans

A "spare" Radiotron—genuine RCA Radiotron, of course—of the type he uses.

A *power* Radiotron UX-112, UX-171 or UX-210 for bigger volume and finer tone.

A special *detector* Radiotron UX-200-A for storage battery sets—for longer distance reach.

Ask any dealer all about these Radiotrons—he'll tell you which to get. But be sure it's a genuine RCA Radiotron, if it's to be worthy of gift giving.

RADIO CORPORATION OF AMERICA
New York Chicago
San Francisco

★

RCA-Radiotron

MADE BY THE MAKERS OF THE RADIOLA

THREE GREAT RESEARCH ENGINEERS

Dr. Irving Langmuir, Dr. Willis R. Whitney, and Dr. W. D. Coolidge. Doctor Langmuir has contributed much to the development of the vacuum tube. Doctor Whitney is chief of the research laboratories of the General Electric Company, and Doctor Coolidge is the assistant director of the Laboratory. The remarkable new cathode ray tube is due to the experiments of Doctor Coolidge

RADIO BROADCAST

VOLUME X | NUMBER 3

JANUARY, 1927

The Hundred-Billion-Dollar Vacuum Tube

New Cathode Ray Tube Has Greater Electronic Emission Than all Available Radium in the World—How the Rays Are Caused to Pass Through a Nickel "Window"—Their Effect Is to Cause Calcite Crystals to Glow, Glass to Change Color, Wax to Become Electrified, Acetylene Gas to Solidify

By JAMES STOKLEY

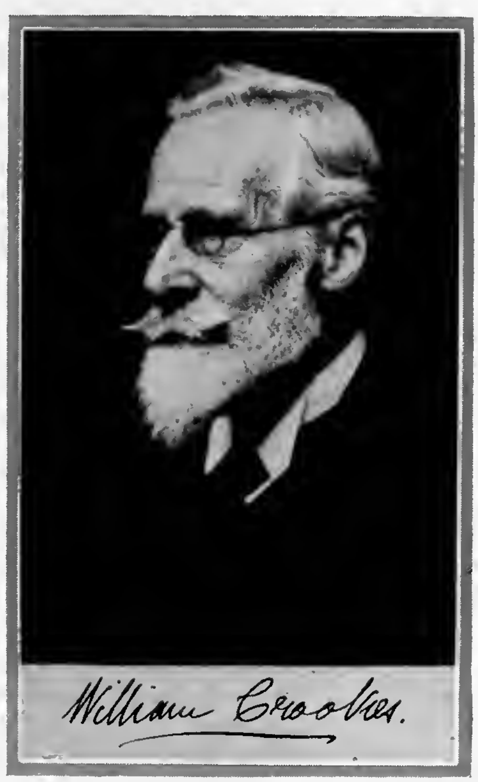
Science Service

IT HAS been estimated that the number of electrons given out by the new Coolidge cathode ray tube would be equal to that given out in the same time by a ton of radium, were it possible to obtain so much of this precious material. A hundred billion dollars would be the cost of so much radium, but the fact is that there is less than a pound of radium available in the whole world!

The cathode ray tube is essentially a vacuum tube put to a new use. It differs somewhat in form from the conventional tube, and the voltages applied to it border upon the 350,000-volt figure instead of the requisite 90 or 180 volts which we use on the plates of our vacuum tubes in a radio receiver. The source of electrons in the Coolidge cathode ray tube is the same as in the ordinary radio tube—a heated filament in a vacuum. In the radio tube, the electrons are emitted from the filament and are utilized for carrying electricity from the filament to the plate, under control of the grid. In the cathode ray tube, the electrons are emitted in a similar manner but are attracted to the plate by means of a very high voltage, and are caused to pass outside the tube through a thin nickel window, where their behavior upon various materials may be studied.

As early as November 30, 1878, a paper was presented to the Royal Society in London by Professor (later Sir) William Crookes, which gave some particulars of the phenomena which takes place when an electrical discharge is sent through a highly evacuated tube. Since then many men have taken up the study.

On October 20, 1926, Dr. William D. Coolidge, assistant director of the General Electric Company's Research Laboratory at Schenectady, New York, gave a public demonstration of the latest type of Crookes' tube which is capable of producing *large* quantities of electrons or cathode rays outside of the tube itself.



SIR WILLIAM CROOKES

Famous English physicist, whose early experiments with electrical discharges within evacuated glass bulbs led to the discovery of X-rays, and, later, to the invention of the cathode ray tube by Dr. W. D. Coolidge

In the ordinary cathode ray tube, the electrodes are of aluminum, consisting, like all forms of matter, of atoms, which, in turn, consist of electrons. When the electrodes are connected with an induction coil, or some other apparatus to produce a high voltage, the small amount of gas left within (for the vacuum, though high, is not perfect) is ionized. That is, the atoms of which the gas consists are broken up into smaller units called ions, which are of two kinds, one bearing a positive charge and the other a negative.

When these positive ions hit the cathode, they knock out electrons from the aluminum atoms, and it is these electrons, moving with a speed comparable with that of light itself, that form the cathode rays.

In the Coolidge tube, however, the electrons are emitted from a heated filament in the same manner as they are in the ordinary vacuum tube. This filament may be heated by means of an ordinary storage battery and gives off quantities of electrons. Then, when a high positive potential is applied to the cylindrical anode, the electrons are drawn with great velocity from the cathode toward and through the anode to the window, even though the vacuum is so great that, when the filament is cold, the highest voltage will not cause a discharge in the tube.

For many years it was known that there were electrons inside the tube but that they were not coming outside. Crookes referred to them as the "Fourth State of Matter," for they were obviously not solid, liquid, or gas, the three states of matter then known. Neither were they wave motions, like light, or radio waves. At that time the opinion was justified that the cathode rays, or electrons, could never be obtained outside of the tube.

Later, however, a German physicist, P. E. A. Lenard, made a tube which allowed a few scattering electrons to come outside the tube through a small aluminum window.

In the Coolidge X-ray tube (not to be confused with the cathode ray tube) the electrons from the hot filament are driven against a heavy tungsten target thus causing a secondary radiation from the target called X-rays. In the cathode ray tube the electrons, or cathode rays, are driven against a thin nickel window which they penetrate to get outside the tube.

It is this nickel window which replaces the aluminum window of Lenard. Though it might seem strange that these tiny particles could pass through an apparently solid piece of metal, it is not so strange if we realize that the most solid substance consists of atoms, according to the modern ideas of the constitution of matter. The atom, which not many years ago was supposed to be a solid and indivisible unit, is now believed to be built something like the solar system, with a charge of positive electricity in the center, called the proton, and a varying number of particles of negative electricity, or electrons, revolving around it. It is the number of the orbital electrons, and the extent of the electrical charge on the proton, that determines what element the atom makes.

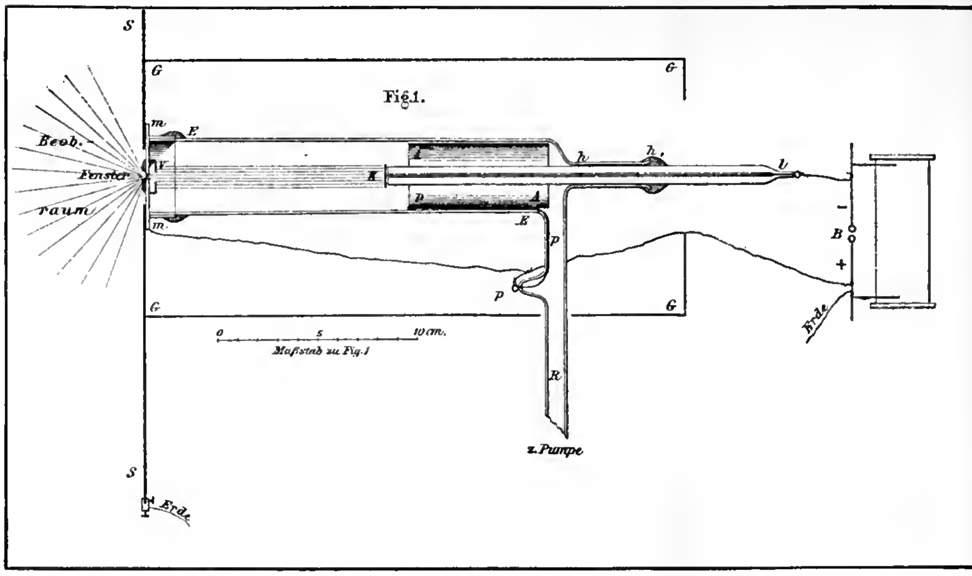
Thus, in the cathode ray tube, the cathode rays, which may travel as fast as 150,000 miles in a second, or about eight tenths the velocity of light, pass between the parts of the nickel atoms of the window, and out into the open air. But the air can't get into the tube, because the oxygen and nitrogen atoms are about the same size as those of the window, and so are too big to crawl through the cracks.

Theoretically, says Doctor Coolidge, the element with the lowest atomic number, which is its number in a list of all the elements in order of atomic weights, would be best for the window, because such an atom would have the smallest number of parts to obstruct the rays. Beryllium is No. 4, but practically, nickel, which is No. 28, works best. It is strong, and does not have to be cemented to the tube, and a cemented joint is the most vulnerable spot for leakage of air.

To fasten a piece of nickel, three inches in diameter, and five ten-thousandths of an inch thick to a glass tube so that no air will leak around it, seems, and is, a rather difficult procedure, but Doctor Coolidge has succeeded. The seal is even more airtight than it was in Lenard's $\frac{1}{8}$-inch window, for he had to keep his tube connected to a vacuum pump in order to keep the vacuum sufficiently high, but Doctor Coolidge is now able to seal his tube off from the pump after it has been exhausted. This has the advantage that the tube can be easily transported and used in any position.

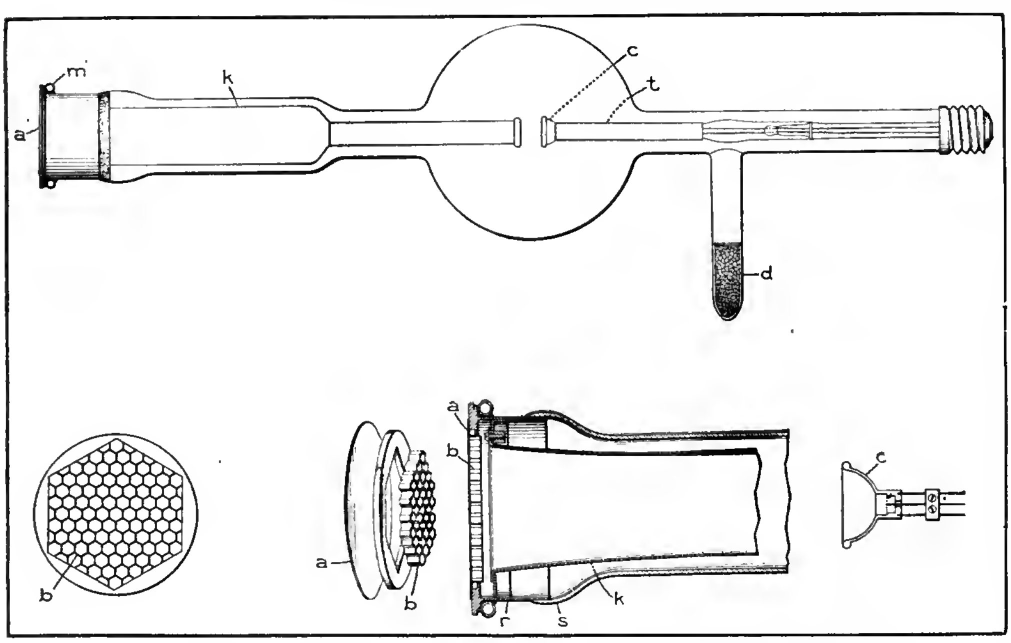
The method of sealing the window makes use of invar, an alloy of nickel and steel, which has the peculiar property that it expands and contracts with changes in temperature by nearly the same amount as does the glass which is sealed to it. The nickel window is soldered on to a ring of invar, and the invar is sealed to the glass. Metals in general could not be sealed to the glass, because, when the glass and metal cooled, after the seal was made, the metal would contract at a different rate from the glass. In addition, in order that the thin nickel may not be broken by the air pressure over its surface, amounting to more than a hundred pounds, a honeycomb-shaped grid of molybdenum, a very strong metal, with a very low coefficient of expansion, is placed behind the window.

Connected with the window, and, with it, forming the anode, is a copper tube, shown in the diagram. This extends to within an inch of the cathode, and serves to protect the glass walls from the bombardment of the electrons. Otherwise, at the high voltages used, the glass would soon be punctured.



LENARD'S CATHODE RAY TUBE

The first apparatus for producing cathode rays in air. Small quantities of the rays came through a tiny aluminum window shown at the left of the diagram. As this window could never be made completely airtight, it was necessary to keep the tube constantly connected to an air pump while in operation, a difficulty which Doctor Coolidge has surmounted.



A PICTURE DIAGRAM OF THE COOLIDGE CATHODE RAY TUBE

The diagram shows the complete tube and component parts in detail. (a) Anode window, a very thin piece of nickel foil, through which the electrons pass. (b) A molybdenum hexagonal grid to reënforce the window against the pressure of the atmosphere. (c) Hemispherical cathode cup, focussing the electrons released by the tungsten filament within the cup. (d) Charcoal trap for residual gases. When immersed in liquid air, the charcoal removes all traces of gas within the tube. (k) Copper shield, preventing the electrons from striking the glass tube. (m) Water-cooling tube, to prevent the window from becoming over-heated. (r) Sleeve of invar to which the window is soldered. . (s) Glass to invar seal. (t) Cathode shield

THE TUBE IN OPERATION

BUT now let us see the tube in operation. The room is darkened, and the dim figure of the scientist is seen moving a switch. Suddenly there is visible a large ball of purple light, with its center just in front of the window. This is the luminosity of the air, excited by the cathode rays, and the scattering of the rays causes the glow to extend even behind the window.

Air is not the only thing that glows in the path of the rays. In some of the tubes with which Crookes experimented he placed various minerals, and the rays caused them to glow with vari-colored lights. The same effects are observed when such substances are placed in front of the new tube. For instance, a crystal of calcite, a very pure form of marble, is placed in front of the window, and it glows with a bright orange light. If the current is turned off, the crystal continues to glow, as if red-hot, but it can be handled without danger, for it is as cool as it was at first, though the glow continues for many hours.

But the mere glowing is not the only remarkable effect of the cathode rays on the calcite crystal, for, after it has been exposed to them, it may show bluish white scintillations for a minute or more after the current has been turned off. And even then, until as much as an hour after raying, scintillations can be made to occur by scratching the crystal with a sharp point. Another way of prolonging the state in which scintillations may occur is by the use of low temperature, for if the crystal is plunged into liquid air just after it has been rayed, and kept there for even a week, it starts to glow and scintillate again when it is restored to normal temperature.

Five other substances that have been tried show these scintillations at ordinary temperature; these are amber, rosin, and the crystals of the chlorates of barium, potassium, and calcium. A large number of other substances, celluloid among them, show the scintillations also if they are cooled to liquid air temperature while being rayed.

If the spot where these scintillations have occurred is examined with a microscope, there is found a tiny crater with canals leading into it. These canals are straight in the calcite, but curved in celluloid. Apparently, this sparkling is due to the fact that the negative electrons driven into the surface of the crystal produce a potential gradient in the crystal, or celluloid, and when this becomes great enough, the discharge takes place, with a miniature eruption, which leaves the crater.

Another effect of the electrons is to produce a permanent electrical charge in certain substances. Everyone knows how a fountain pen, or other piece of hard rubber, may be charged by rubbing on one's sleeve, for example. But the charge finally dispels itself. However, a few years ago, a Japanese physicist, Eguchi, made what he called a permanent electret, analogous to the permanent magnet. A flat pan was filled with a melted mixture of rosin and carnauba wax, and this mixture was allowed to solidify between two large electrodes connected with a source of high voltage. When it hardened and was removed, it had an electrical charge which persisted in spite of rough treatment.

THE EQUIVALENT OF A TON OF RADIUM

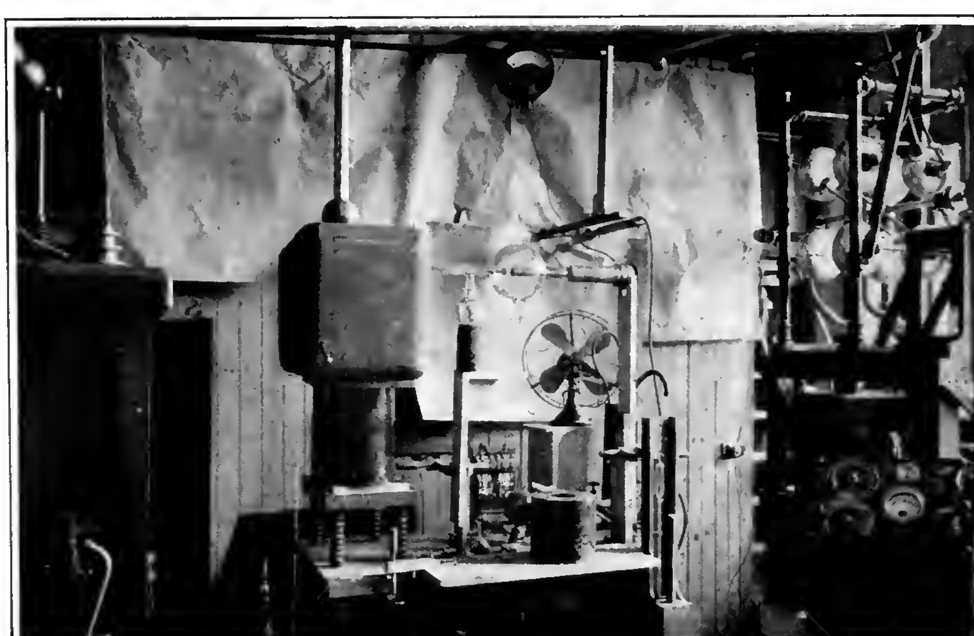
A man can hold it easily. In the center of the round glass bulb can be seen the hemispherical shield containing the filament which forms the cathode of the tube. The anode is a hollow cylinder located to the left and extending from within an inch of the cathode toward the window at the extreme left, from which the rays are projected. The thin nickel sheet is on the outside and under it may be seen the form of the molybdenum grid which prevents it from breaking under the pressure of the air

When the cathode rays are made to impinge on a similar wax disc, it has been found that they produce a negative charge extending in to a depth corresponding to their penetrating power in this material. As in Eguchi's electret, this charge appears to be very permanent.

Visible changes are produced in some chemical substances; for example, the water clear crystals of cane sugar are turned white by a short exposure to the rays, while white crystals of potassium chloride are turned purple. Glass, likewise, is turned to a lavender color with an exposure of about a second—an effect that has been observed in windows of old houses that have been exposed to sunlight for a century or more.

ACETYLENE GAS SOLIDIFIED

ANOTHER curious chemical effect is that on acetylene gas. When the rays are turned into a glass chamber of the gas, and this glass chamber is surrounded by a metal vessel connected to the nickel window, a yellowish brown powder falls to the bottom. Previously a similar appearing substance has been obtained in much smaller quantities by the action of the rays from radium-like substances, but it is unique because no chemical has yet been found which will dissolve it. A possible use for this substance would seem to be as a varnish, because it would be impervious to everything, but the difficulty is



APPARATUS FOR PRODUCING CATHODE RAYS IN AIR

The tube is seen in the center of the picture, the window from which the electrons emerge being pointed to the right. The electric fan is used in keeping the tube cool while in operation. The high voltage (350,000 volts) necessary for operation is produced by the transformer at the left

A LIVE RABBIT'S EAR

Was exposed to the cathode rays for a second with a current of a milliampere within the tube. This caused a scab to form over the rayed area

The leaf of a rubber plant was placed in front of the tube while operating, and it was found that the rayed area almost instantly became covered with a white latex, as if thousands of holes had been pricked in the surface and the sap allowed to ooze out. The effect is seen on only the side of the leaf toward the tube. The rays are not very penetrating.

Bacteria and insects are killed very quickly with the rays, while their effect on higher forms of life are very striking. For these experiments, rabbits were used, but despite the treatment, when the work with them was finished, there were more rabbits than when they first arrived!

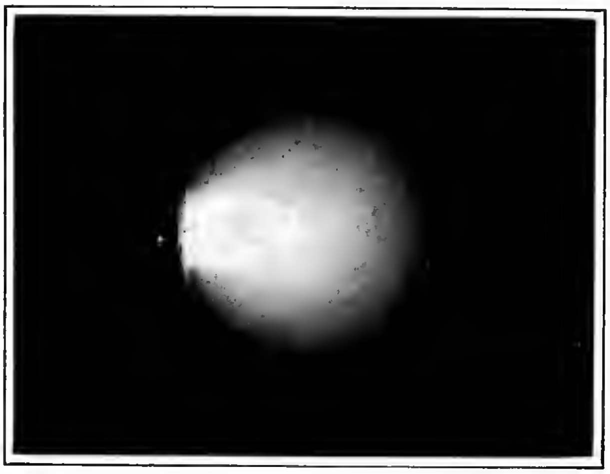
A circular area on the rabbit's ear about the size of a dime was exposed to the rays for a tenth of a second with a current in the tube a milliampere. The skin became dark, as if sunburned, and a few days later the hair fell out, not to reappear for seven weeks. Then another similar area was rayed for a second with the same current, and this caused a scab to form over the rayed area, but two weeks later a profuse growth of snow-white hair began which finally became longer than the original gray hair. Finally, a third area was rayed for fifty seconds, also with one milliampere. Scabs formed on both sides of the ear and when they dropped off, a hole was left, the edge of which was finally covered with the snow-white hair.

AGAIN THE RABBIT'S EAR

Only two weeks after the appearance of the scab on the ear caused by the one-second exposure, a profuse growth of white hair covered the bare part

in applying it. Ordinary varnish, such as shellac, requires some medium which will dissolve it, alcohol, for example, before it can be applied. However, if no metal vessel is used around the glass chamber containing the acetylene, the solid substance resulting from the cathode ray bombardment deposits as a hard yellowish lacquer on any object placed within the chamber.

It is the effects of the cathode rays on living tissue, however, that excite the most interest, for they are similar to that from a large amount of radium. One of the chief radiations from radio-active substances, the so-called "beta" rays, are nothing but rapidly moving electrons, just like the cathode rays, except that they move somewhat faster. Doctor Coolidge estimates, as stated elsewhere, that the number of electrons given out by the new tube is the same as that given out in the same time by a ton of radium. If such a vast amount of radium could be obtained, it would be worth something like a hundred billion dollars, but the fact is that there is less than a pound of radium available in the world.

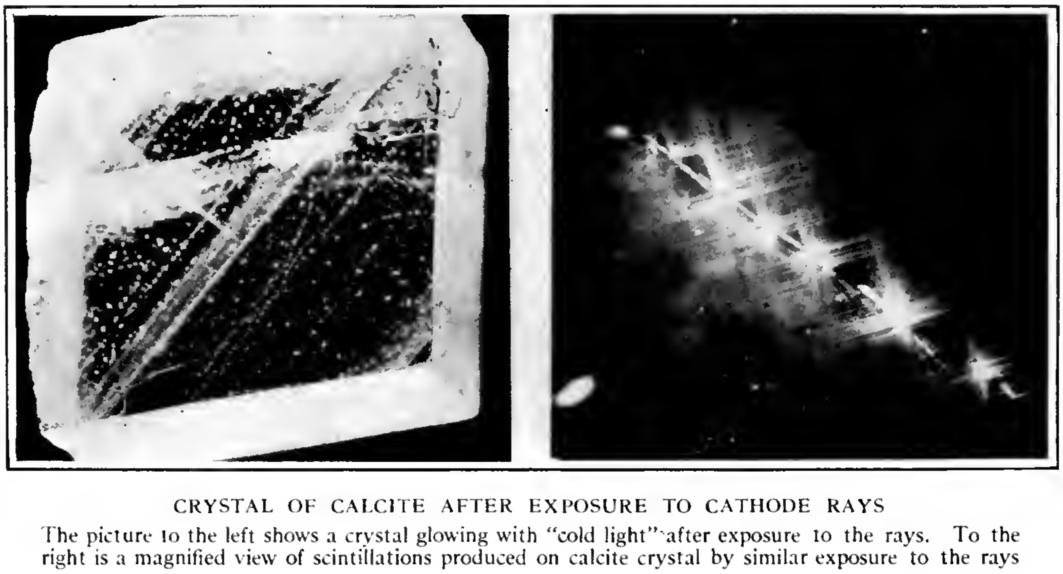


IN THE DARK ROOM

The front of a cathode ray tube is here shown projecting into a dark room during operation, the luminosity of the surrounding air being clearly indicated

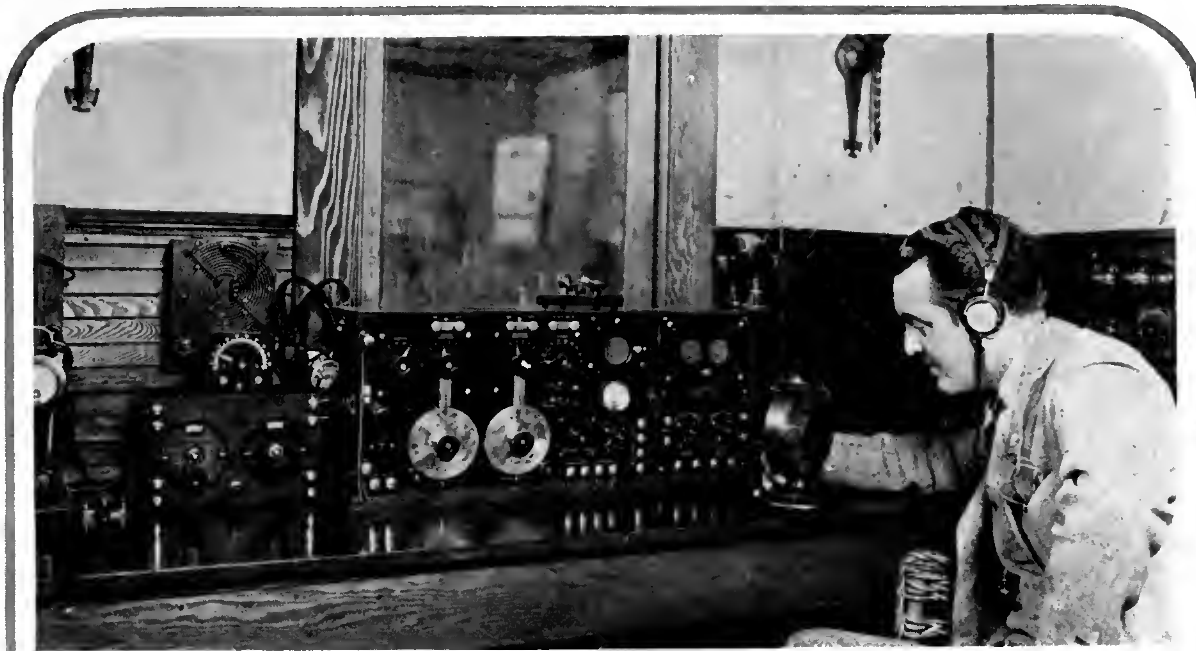
The possibilities of the tube have only begun to be investigated. However, with the 350,000 volts, the highest power that has yet been used on the tube, the range of the rays is only about two feet from the window. With still higher voltages this could be increased, but the highest possible voltage could scarcely give a range of more than a few yards, which automatically precludes its use as a weapon of offense in warfare.

But to the scientist, a new instrument for study has been provided, and the relatively few effects of the tube already observed show that it will doubtless lead to many other interesting discoveries. A new field of research is opened in the study of the effect of cathode rays on all sorts of materials, many of which could not hitherto be brought into vacuum tubes. Even Dr. Coolidge himself hesitates to make predictions.



CRYSTAL OF CALCITE AFTER EXPOSURE TO CATHODE RAYS

The picture to the left shows a crystal glowing with "cold light" after exposure to the rays. To the right is a magnified view of scintillations produced on calcite crystal by similar exposure to the rays



THE MARCH OF RADIO

News and Interpretation of Current Radio Events

Why the Department of Commerce Should Control Radio

ONE fine day in December, out of a bustling committee room in the national capital, where, for a period of weeks, Congressmen have whispered, Senators orated, and self-appointed experts expounded, perhaps will come forth the compromise radio bill. Presented on the floor of both Houses, there will be questions, speeches, and amendments and, little altered, the bill will be sent to the President for signature.

More than likely, the bill will provide for a radio commission which will cost taxpayers probably a quarter of a million a year in salaries and expenses. Being far better than no regulation at all, the creation of the commission will not be a calamity. It is simply a wasteful and inefficient means of accomplishing the regulation of radio. Perhaps some candidates, defeated for reëlection on November 2, will find a berth on the commission a great help in tiding over what might be a period of unemployment.

Broadcasting managements will have to be more polite to politicians than in the past. Occasionally program managers will sidetrack meritorious program features in favor of a speech by a friend of a member of the commission. Pussyfooting in Washington for wavelengths will become the established profession of a new breed of lobbyists—men who can "handle" the radio commission.

The radio industry, through its coördinating committee, representing various trade organizations, including the National Association of Broadcasters and the Radio Manufacturers' Association, is maintaining headquarters in Washington in order to assist the conference of Representatives and Senators with expert advice. Just what kind of advice they will give is not certain. A statement from one of the organizations represented in the coördinating committee is to the effect that they believe the White and Dill Bills can be satisfactorily combined. Apparently they will not raise their voices too loudly against the formation of the commission.

The National Association of Broadcasters says: "We are not spending our time worrying about chaos any more, for that is a matter of history." Similar reassuring statements come from various sources, leading one to believe that the doctrines of Coué are evidently the guiding spirit of the radio industry. Possibly, when the doors of the committee room are closed and plain-clothes men stationed in the hall outside, representatives of the industry may be willing to whisper to the conference committee that the present wavelength tangle is intolerable. But they will be careful not to raise their voices when they say it, lest some broadcast listener overhear. Then the secret would be out! Those who dare to cry out against the ridiculous wavelength congestion are accused of being calamity howlers and spreading false information. But we admit publicly that there are too many broadcasting stations. And we are not calamity howlers.

The prosperity and popularity of radio has not been affected by the chaotic situation (yes, we said chaotic) because DX listening is a minor and unimportant phase of radio entertainment. The æsthetic enjoyment of radio is a matter of listening to high-grade local stations. The fact that, for example, WODA, WLWL, and WRNY have, by their choice of wavelength, at various times excluded WGY from New York listeners is a minor loss as long as WHN, WEAF, and WJZ are undisturbed. The little fellows have stepped on each other's feet with utter abandon so that listening to them is as pleasant as a cat fight at midnight. But who cares? There are good, high-power local stations to listen to, offering a tremendously improved brand of broadcast entertainment.

We make our last plea for the formation

The photograph forming the heading shows the excellently arranged amateur 'phone transmitting station of George C. Tichenor at Los Angeles, operating on 2499, and 1666 kc. (84.5, 120, and 180 meters) using the calls 6 AQA and 6 XK of a Bureau of Radio Communication in the Department of Commerce on the grounds of economy and efficiency. We hope for a law which provides unequivocally that there shall not be more than two stations of 500 watts power operating on the same channel, separated by at least 2000 miles; that stations of more than 500 watts be assigned exclusive channels; that not more than two thirds of the available frequencies be assigned to this high-grade service; that smaller stations, not covering large areas, be limited to 250 watts power; that they be given a free and clear channel by a separation of at least 500 miles from the nearest partner in their channel. This plan provides for 256 small stations and 75 large stations.

If service to the listener is the object of legislators, they will give him a clear, uncongested ether. If political expediency rules, they will provide soft berths for "lame ducks" by creating a cumbersome radio control commission and they will lack the courage necessary to reduce the number of broadcasting stations by some 40 per cent., an essential process to securing enjoyable and clear broadcasting.

At one fourth the cost of the proposed commission, a Bureau of Radio Communication can be maintained with a chief at $12,500 a year, an assistant chief at $6000 a year, nine deputy supervisors, one for each of the nine radio districts at $4000 a year, the latter to work with the local radio inspectors in handling broadcasting problems in each district. Eligibility to serve in the Bureau should be subject to passing a civil-service examination. The membership of the bureau should be entirely independent of the fortunes of politics and politicians.

©Bachrach

GEORGE S. DAVIS

Mr. Davis died on October 8, 1926, and was vice-president and general manager of the Tropical Radio Company, president of the Wireless Specialty Apparatus Company, and a director of the Radio Corporation. Mr. Davis, regarded as one of the most able men in commercial radio, worked up to his important position from a start as a ship wireless operator. The Tropical Radio Company is the company which manages the radio activities of the United Fruit Company, and the Wireless Specialty Apparatus Company is one of the chief manufacturing organizations for the Radio Corporation

If broadcasting must be saddled with the radio commission, we may hope that it be quickly appointed and that it proceeds with courage to its job of decimating the ranks of broadcasters.

President Coolidge has frequently expressed his opposition to the formation of unnecessary boards and commissions. A Radio Commission is unnecessary. The presidential veto power may be exercised to defeat the Commission. It is regrettable that no body representing the radio industry has given forth a single, united expression of what is good for radio.

Another Triumph for Short Waves—The Beam System

THE extraordinary results achieved by the new short-wave beam transmitter, used for communication between Montreal and London, has encouraged Guglielmo Marconi to predict that "some day electric waves may be used for the transmission of power over moderate distances, if we succeed in perfecting devices for projecting the waves in parallel beams in such a manner as to minimize dispersion and diffusion of energy into space."

Transmission of power need not be efficient to be highly useful. For example, if we could transmit electric power to aircraft, even at a loss of 75 per cent. of the energy transmitted, the commercial value of aircraft would be tremendously enhanced, relieved of carrying fuel supply as a part of the load.

Marconi's short-wave beam transmission link between London and Montreal has a capacity of 200 words per minute, rivalling the maximum capacity of the best submarine cables. Radiating its energy in one direction, it is highly economical of power.

The Marvels of the Coolidge Cathode Ray Tube

DR. W. D. COOLIDGE'S new cathode tube, which projects a stream of electrons in the open air, makes available to science a tool of research destined to become fully as important as the X-ray. Already the electron bombardment has been used to change acetylene gas into a solid—a mysterious yellow powder which it has not been possible to dissolve or analyze; it has changed castor oil to a solid; transparent rock crystal salt into a black substance; killed fruit flies exposed to it for the fraction of a second; profoundly altered the characteristics of living cells, and has caused many minerals, after brief exposure, to become luminescent. When the technique of using the electron shower is fully understood, it will be capable of producing entirely new substances with uses and properties never before conceived. In the hands of the medical profession, it is likely to rout many heretofore incurable diseases. Within a generation, man will be able to construct any substance he pleases synthetically.

© Bachrach © Harris & Ewing

TWENTY-FIVE YEARS OF WORK BY THE BUREAU OF STANDARDS

On December 4th, the Bureau of Standards celebrated its twenty-fifth anniversary. Its remarkable achievements in scientific research applied closely to the problems of industry have made the Bureau known and respected the world over. In no field have its activities been more helpful than in radio. The illustrations show Dr. J. H. Dellinger, past president of the Institute of Radio Engineers and director of the radio laboratory, and Dr. George K. Burgess, director of the Bureau

Additional "Talking Movies"

THE Radio Corporation of America reports substantial improvement in its earnings for the quarter ending September 30, as compared with the same period last year. Increased summer sales is said to account for the gain in part. Instead of a deficit of $358,275 for the quarter, as in 1925, there is a surplus of $2,116,090. It is also reported that, in collaboration with the Fox Film Corporation, the Radio Corporation will market a talking movie device, suitable not only for use in theatres but also in small auditoriums of schools, colleges, and churches. The device will be a combination of the Pallophotophone and the conventional motion picture projector.

Ways of Reducing Interference in the Ether

SINGLE side-band transmission on a frequency of 214.2 kilocycles (1400 meters) is being used by station 2 XAH of the General Electric Company for relaying its programs to WCAD, Canton, New York, for rebroadcasting. The reception of programs from single side-band transmitters requires special and delicate receiving apparatus but has the advantage of greater stability and economy of power. It utilizes less than half the frequency space required by the two side-band method ordinarily used.

Who Can Tell What is the "Best Radio Set"?

A LETTER, signed "Up in the Air," which we ought to disregard because of its anonymity, complains that the average radio fan is much confused by reading radio publications. They do not tell him plainly and definitely which radio receiver is the best. The radio fan, he says, is a thousand times more puzzled than the prospective purchaser of an automobile or a watch or gun. Automobile manufacturers, he continues, have races and tests which demonstrate the quality of their products. Why not contests for radio sets for ferreting out the best receiver in each class?

Although we have studied the automobile technically for more than ten years, we do not know which is the "best" in each price class. Winning automobile races is as much a matter of good luck and driving skill as it is the result of quality inherent in the car. Exceptional performance of a radio set is as much the outcome of good location and skillful operation as it is inherent quality. There is no "best radio set" any more than there is a "best" anything else.

Radio Leads to Another Technical Advance

IN A report to the American Mining Congress, William A. Sharp of Denver, Colorado, describes his radio cameraphone which detects the presence of solid rock, liquids, gases, and minerals in the ground. A giant meteor which buried itself years ago in Arizona but has never been unearthed, despite countless drillings and borings, was discovered by the device to be buried to a depth of 1410 feet. At another point, eighteen new veins of a mine were located and three ancient mining tunnels abandoned and sealed up years ago.

A crude predecessor of this device was used in France, after the War, to locate buried shells.

The Course of Patents in Dispute

THE Crosley Radio Corporation is defending a suit filed in Ohio by the Westinghouse Electric & Manufacturing Company under Armstrong Patent 1,113,149; A. I. Gancher, for the Gancher Service Company, accepted a consent decree obtained by the Lectophone Corporation under several Hopkins patents; the Morrison Electric Supply Company, Inc., submitted to a consent decree in favor of the Westinghouse Electric & Manufacturing Company, under Fessenden and Armstrong patents; the Westinghouse Company also brought suit against the Stewart Warner Speedometer Company under Armstrong's patent 1,113,149; the Pacent Electric Company and the Carter Radio Company are at odds over the matter of connecting plugs, while an appeal is being brought which will bring the DeForest Company and the Radio Corporation of America into another battle over Patent 879,532; an injunction was granted the Westinghouse Electric Company in its suit against C. A. Branston, Inc., under Armstrong and Fessenden patents. The

BEFORE THE DAYS OF THE RADIO COMPASS

SKIPPER OF TRAMP SHIP (endeavoring to locate his position on an old and dirty chart): "If that's a fly-mark, Bill, we're orl right, but if it's Sable Island 'eaven 'elp us!"

(Reproduced from *Radio: Beam and Broadcast*, by A. H. Morse)

AN HEROIC RADIO OPERATOR

H. T. Bruck, radio operator attached to the S.S. *New Britain*, who stuck to his post until he summoned aid for this vessel, which had caught fire when well out to sea. The ship was taken to a pier in Charleston and the fire put out

Shepherd Stores, however, advertised in the Boston *Globe*, with impunity and without patent difficulties, a sale of "437 women's summer dresses at $3.75 each, all of standard manufacture, panels, dials, switches, sockets, rheostats, coils, condensers, transformers, panel shields, resistances, micadons, etc. The reductions are enormous."

We hope for the sake of modesty that the transformers were of the closed core type and the coils did not have spaced windings.

Who Will Endow Broadcasting?

FREEMAN HOPWOOD, in a letter to the New York *Times*, decries the increasing proportion of commercial programs on the air. He would enjoy an evening with his radio if it would bring to him "the thoughts of Voltaire, the rare philosophy of Schopenhauer, the jests of Mark Twain, a discourse on psychoanalysis, selections from John Stuart Mills, the wisdom of Confucius, a verse of two from Shelley or Keats" and a few other similar appeals to highbrow tastes.

Fortunately, or unfortunately, these preferences are those of a very limited proportion of the radio audience and all of them are of a type which is ill suited to the microphone. The thoughts of Voltaire are best appreciated by reading. The ear of the individual with average education does not perceive and assimilate nearly as readily as the eye. Broadcasting is primarily a disseminator of music. The greatest stimulus to improved standards has been the very commercial programs which he decries, such as the Atwater Kent hour, the recent Balkite Hour (to mention only a few) as well as such familiar standbys as the Philharmonic concerts.

Mr. Hopwood does not suggest meeting his share of the cost of broadcasting as a means of eliminating the commercial pro-

CHARLES W. BURTON

Boston

Superintendent of Broadcasting, WEEI, Boston, Massachusetts. Especially written for RADIO BROADCAST:

"When WEEI broadcast the famous Boston Symphony Orchestra for the first time, the novelty of the thing attracted to our wavelength an audience that most nearly reached our maximum coverage. We know, from a check-up of tube and battery sales in our territory, that WEEI can be heard by 1,500,000 persons. We believe our potential audience was with us that night. Here is another way we arrive at that conclusion: We are convinced that only one person in every 500 tuned-in on a program will write a letter to the station about it. Three thousand letters followed the initial symphony broadcast.

"Most stations and program sponsors exaggerate the importance of fan mail. It cannot reflect the attitude of the audience in general; it rarely offers any intelligent criticism, and its requests, if complied with, add to the deadly similitude of programs. Many program sponsors, in order to stimulate letter writing, are offering samples, radio logs, and other articles as an inducement. Of what value to radio, or their campaign, is this? It merely indicates that people like to get something for nothing. It doesn't show whether the program has a popular appeal. Indeed, I have seen letters something like this: 'Your tenor ought to have his throat cut, and obviously your orchestra was organized 15 minutes before the program opened. Please send me one of your handy bottle openers.'

"A great many kind listeners do write fine letters to WEEI, and we love them for it. We hope their numbers will increase. But we do not hold with the old tradition that fan mail is the very life blood of the broadcasting industry."

gram, but instead hopes for an emulator of Andrew Carnegie to do it for him. To endow radio upon a satisfactory standard, such as is being rapidly attained through improvement in commercial broadcasting, would cost, through only fifty stations, not less than twenty million dollars a year. Commercial broadcasting can accomplish equally good results at half the cost because the difficult problem of collecting from the radio audience does not have to be met. There being no established source of revenue, broadcasting is able to present numerous high-grade features which would otherwise demand high payment.

Commercial broadcasters have learned that annoying the audience with persistent reference to themselves destroys the goodwill which they may gain. As a consequence, good features through high-grade stations are not rendered obnoxious because they are sponsored by commercial organizations. Even though the Royal Typewriter Company spent, it is rumored, $35,000 to make the Dempsey-Tunney fight available to the audience, the references to the company during the broadcast were laudably restrained.

The Month In Radio

CAPT. R. H. RANGER of the Radio Corporation of America announces a marked improvement in the transmission of radio photographs by utilizing a minute stream of hot air which largely eliminates the dots and "freckles" characteristic of the pictures so far transmitted.

With the possibility of working with the transmission of photographs and the well-developed and fascinating field of short-wave experiment at their disposal, thousands of set constructors are directing their energies to new channels. The development of photographic transmission is approaching the point that the broadcasting of pictures is bound to be undertaken soon. It will have the same significance as the opening of WWJ and KDKA as public broadcasting stations. A few devoted experimenters will obtain the complex apparatus necessary to decipher radio pictures; gradually they will win public attention and eventually picture reception will spread, as did broadcasting, to all parts of the world. Whether this will take place in one year or five years is as difficult to predict as was the radio enthusiasm in 1920.

EXPERIMENTS conducted at the Indiana Harbor Belt Railroad classification yards at Gibson, Indiana, have demonstrated the superiority of radio over the usual system of signals by means of lights and whistles. Obscuring of signals by mist and strong sunlight is eliminated. Since only low power is required, this communication does not add seriously to ether congestion. It eliminates much tooting and whistling which would otherwise annoy those in the vicinity of the freight yards.

THE Radio Manufacturers' Association is contributing a valuable service to the industry by gathering statistics which are being issued by J. B. Hawley, Chairman of its Statistical Committee. It is interesting to note the progress of the art by the increasing volume of sales and the varying ratio of purchases in sets, parts and accessories. The figures are millions of dollars:

Year	*Sets*	*Parts*	*Accessories*	*Total*
1922	5	40	1.5	46.5
1923	15	75	30	120
1924	100	100	150	350
1925	175	74	200	449
1926	225	75	230	520

THE Tri-State Telephone & Telegraph Company is trying out a plan in St. Paul, Minnesota, to furnish telephone subscribers with radio broadcast programs picked up by a central receiving station. The company installs loud speakers in the residences of 'phone subscribers, using a special pair of cables independent of the regular telephone circuit. The listener is freed of all maintenance and tuning difficulties but must content himself with the program selected by the company. In addition, he, of course, pays a monthly fee for the service.

THE Bureau of Standards celebrates its twenty-fifth anniversary on Saturday, December 4. The efficient coöperation of the Bureau with industry marks it as one of the Government's most successful and constructive scientific agencies.

THE production of multi-tube radio sets for 1925 was 2,180,622, an increase of 1045 per cent. over 1923 when 190,374 were produced. In that same period, tube production increased from 4,687,400 to 23,934,658, an increase of 410 per cent. and loud speakers from 623,146 to 2,606,866, an increase of 318 per cent. The value of radio products in 1925 increased 215 per cent. over 1923. The largest manufacturer to give out his production figures is A. Atwater Kent, who is, at this time, turning out 5200 sets a day.

THE Radio Manufacturers' Association reports an increase of membership from 63 in August, 1925, to 184 in the middle of September, 1926.

THE Radio Trade Association of Michigan conducts a school for radio service men. Students are put out on practical jobs in repair and construction work during their training. The radio industry suffers from lack of competent service men and the establishment of radio trade schools is a step in the right direction.

FRANCIS R. HOYT has obtained allowances on a patent application covering magnetic switches for the control of A battery charger, A battery and B battery substitute, through the receiving set switch.

QST Français Radio Électricité blossoms forth in a new and larger form with a recent issue, in which *QST Français*, combines with *Radio Électricité*. We wish our authoritative contemporary every success.

BOLSHEVIST propaganda, intended for the British miners, has been picked up by radio listeners in England. The use of an international medium such as radio for propaganda, regardless of whether destructive or not, is a practice indulged in only by shortsighted governments which do not mind making themselves unpopular in the eyes of the world. It is a veiled way of making war. Imagine our feelings if a station in Canada engaged in fomenting labor troubles in the United States!

THE Olympia Exhibition, which corresponds in England to our Radio World's Fair, in the first showing of new lines, is featuring sets with simplified control and more convenient accessories. Some receivers are equipped with only an on-and-off switch, with means of permanently adjusting the circuits to the favorite local, high-power station. Others give a choice of two stations through a two-point switch.

A DISPATCH to the New York *Times* from Strassbourg announces that agents for a German radio firm are selling radio sets in Alsace-Lorraine at the extraordinarily low price of forty francs. These sets are built so that only the wavelength of Freiburg, a German broadcasting station sending out special programs for Alsace-Lorraine, may be heard. Something will have to be done to curb the international abuse of radio.

CORRESPONDENCE in British radio magazines indicates that WGY, WJZ, and WPG are the three American stations most frequently heard on the other side. The reports indicate that receiving conditions are much better this year than last year for hearing American stations in Europe.

CANADA has been most capable in regulating radio by assigning broadcasting licenses on a sound and simple basis. Each district of the country is given one channel exclusively, there being duplication only between Montreal and Vancouver, separated by 2000 miles and four hours of time difference. Stations operating in the same locality divide the time. In Toronto, for example, there are ten stations sharing one wavelength. Until American broadcasters began abusing the gentlemen's agreement to keep off the fourteen Canadian channels, Canada's 67 stations operated entirely without interference. Of course, it could not be expected that the ruthless American ether vandals would regard international agreements worthy of consideration. When an American broadcaster interferes with a Canadian frequency, he injures radio for an entire district.

WHEN Danish musicians broadcast as members of bands and orchestras, they are to receive an extra 50 per cent. over their regular pay. Not that broadcasting involves the slightest extra work on the part of such musicians. When the usefulness of a service performed is increased, certainly its remuneration should be increased, but the increase should bear some relation to the increased value of the service and to the additional skill and effort required. A 50 per cent. increase for broadcasting seems like extortion.

A SUBSCRIPTION is being collected for Charles Clavier, victim of the wreck of the New York-Paris plane at Mineola. Clavier began his career as a radio operator in 1907 and served with distinction during the War aboard the French destroyer *Coutelas*. He took part in the Gallipoli campaign. He leaves a family of three. Subscriptions to the fund are being received by *La T. S. F. Moderne*, 9 Rue Castex (4me), Paris, France.

BEGINNING with a talk by former Lieut. Governor George G. Lunn, through WGY, in April, 1922, educational work in behalf of forestation has been extended until the U. S. Department of Agriculture is now sending information to farmers on the subject of forestation through 100 broadcasting stations. There are more than 550,000 radio sets on farms and, in some states, one farmer out of four has a radio receiver.

A DECREE of the French Government requires that all commercial airplanes, carrying at least ten passengers and traveling more than 160 kilometers, and those flying over the sea for a distance of more than 12½ kilometers from the coast shall be equipped with radio telegraph apparatus.

When the London-Paris airplane, carrying ten passengers, six of them Americans, on October 21 fell to the sea, there was time to send an SOS. It resulted in the rescue of all concerned. A fishing smack drew alongside, but not until after most of the plane was already under water and the passengers and crew were clinging precariously to the tail, waist deep in water. An eloquent proof of the wisdom of the French decree.

THE dove of peace hovers in the copyright controversy, according to a statement from E. C. Mills, Chairman of the Administrative Committee of the American Society of Authors, Composers, and Publishers. Soon we may expect photographs in the rotogravure sections of Mr. Mills embracing Mr. Klugh, the spokesman of the National Association of Broadcasters. The placid horizon is the result of a more reasonable view on the part of both parties. The musicians have realized that broadcasting is not making them penniless by destroying all their accustomed sources of revenue and the broadcasters have realized that some compensation is due to the composer for his share in making radio enjoyable. All that remains to be settled is the establishment of a definite, uniform, and reasonable scale of charges on the part of the society and the universal acceptance of that scale by the broadcasters. Both of these objectives are yet to be attained.

THE National Better Business Bureau has issued a booklet on radio advertising which should form the bible of every one concerned in the advertising of radio products, including publications in the field. It defines a code of ethics in connection with distance, selectivity, tone quality, and volume claims and defines the permissible practice in the use of such terms as "static eliminators," "list price," and "complete equipment." It is a valuable contribution to radio advertising literature.

Interesting Things Said Interestingly

GUNTER DOBERZINSKY (a director of the Central German broadcasting station at Leipsic, during a visit to study radio conditions in the United States):

"American radio sets first of all are attractive to the eye and are finished with a care quite unequaled abroad. The beauty and variety of the designs render them attractive in any home. In Germany we still build sets with four or five dials, which require considerable technical skill to manipulate. The American sets, I find, tend toward greater simplicity and are controlled by a single dial, which renders them largely fool proof. Your sets are controlled by a turn of a finger, while German sets require both hands.

"There is but a single broadcasting station to each of the large cities of Germany, but these are well supplied with money. In many cases they support fine orchestras and even opera companies. They also broadcast operas from Berlin and concerts by famous orchestras."

ARTHUR G. BURROWS (Director General of the Union Internationale de Radiophone in an interview with Eric Palmer):

"The first fruits of the many conferences toward coöperation that have been held will be noticed the middle of October when the voluntarily prepared repartition program of European wavelengths with the object of elimination of interference will be applied.

"This new plan should increase the chances of European stations being heard in America. Many existing stations are increasing their power and also, new higher power long-wave stations are under construction, notably, a Swedish station which is to use 40,000 watts on 1350 meters and a station in Holland which is to use 20,000 watts antenna power. There is a marked growth in experimental short-wave stations."

WILLIAM S. HEDGES

Chicago

Radio Editor, the Chicago *Daily News*. Especially written for RADIO BROADCAST:

"There are two classes of broadcasters. First, the class which maintains the viewpoint of service to the public and second, that class which is attempting to use the new medium of communication as a means of drawing attention to its firm or its products. The first class includes newspapers and radio manufacturers. The radio manufacturers as a whole recognize that they have a duty to perform, that the sale of a receiving set is not complete until there is entertainment to be picked up by the set. In the second class there are many firms to which the radio public is indebted for exceptionally high-grade programs but that group unfortunately also includes many organizations which have neither the conception of, concern for, nor the funds to adequately furnish programs, nor the ability to produce suitable programs. In the clearing of the ether, this second group will bear the closest scrutiny.

"A tabulation made by the American Newspaper Publishers Association last fall showed 67 stations owned in whole or in part by newspapers, in addition to which there were 18 newspapers which maintained studios and 37 which sponsored programs from stations in which they had no financial interest. It is logical that such a large number of newspapers deem it a function of public service to engage actively in broadcasting. The newspaper is a quasi-public institution. Its business relations are with so great a number of people in the community that the newspaper must always be mindful of public interest in its broadcasts, as well as other public appearances. Furthermore, its contacts put the newspaper in a preëminent position to serve the public as a broadcaster."

A Six-Tube Super-Heterodyne

A FRONT VIEW
Of the completed super-heterodyne. The jack at the right is used to read the plate current of the oscillator

Constructional Data on an Economical Super-Heterodyne with Its Oscillator and First Detector Circuits Shielded—One Stage of Audio Is Sufficient for Locals—Smooth Regeneration Control and Oscillator Harmonic Control Are Features

By KENDALL CLOUGH

INASMUCH as the writer's September Radio Broadcast article on super-heterodynes received such a large number of requests for tangible constructional information, a receiver has been prepared for description in this article. It is hoped that the design presented will not be accepted as a hard-and-fast application of the principles laid down in the September article, but rather, that the individual constructor will recognize the possibilities of a certain amount of flexibility in the construction of the receiver without radical departure from the design principles previously presented.

The September Radio Broadcast article went into considerable detail regarding the question of what intermediate frequency should be used, and the conclusion was reached that the best operating frequencies are those of 45, 55, and 65 kilocycles.

Preference is given to these frequencies so as to mitigate the possibility of a resultant beat note of two heterodyning stations being of such frequency as to enable its easy passage through the intermediate amplifier. Granting that all broadcasting stations are separated from each other by ten kilocycles, it will readily be seen that a resultant beat note caused by two stations heterodyning must be of a number of kilocycles divisible by ten. Thus, such a note would always be at least five kilocycles "out of phase" with that of the intermediate amplifier providing this latter figure is divisible by five but not by ten, as would be the case if any of the above-suggested intermediate frequencies were used.

The fallacy in this idea lies in the fact that many broadcasters no longer recognize the ten-kilocycle separation law, and it is now possible for two heterodyning stations to produce a beat note that is the equivalent of either 45, 55, or 65 kc. (the frequency of the intermediate amplifier) and thus the selectivity of the super-heterodyne is somewhat impaired. No super-heterodyne can successfully cope with conditions as they are today, but, as an early reversion to law and order, when the necessary ten-kilocycle separation will be universally adopted, is likely soon to come, there is no hesitation on the writer's part in recommending the super-heterodyne as representing the utmost in selectivity and all-round efficiency.

In order to simplify the construction as much as possible, and also in order to keep the receiver in a compact form, the second stage of audio amplification has been omitted, it being anticipated that the more ardent fans already have or are intending to build power amplifiers for operation with various receivers of their construction.

The receiver as described, with a single stage of audio amplification, will be found to give signals of satisfactory volume at the loud speaker for local station reception. However, the use of a second audio stage—preferably in the form of a separate unit power amplifier—is to be recommended where really loud signals are required.

The completed receiver, as seen from the front, is shown in the photograph at the top of the page. The front panel is of $\frac{3}{16}''$ bakelite, $7'' \times 18''$. From left to right may be seen the intermediate amplifier potentiometer, with the filament on and off switch just below, the antenna condenser dial, the oscillator control dial, and the filament rheostat, with a jack below. This jack is for use in adjustment of the oscillator harmonics control, and will be described more fully later. Phones, or a loud speaker, are inserted by means of pin jacks on the sub-panel. Between the two tuning controls, and at the lower edge of the panel, is the knob for the midget condenser controlling the regeneration of the first detector.

Fig. 1 shows the wiring diagram of the complete receiver, and is simply a correlation of the individual circuit diagrams shown in the September article. A slight change has been made in the first detector in the connection of the short-wave choke to the plate circuit. A connection in this manner causes the midget condenser, C2, to take the character of a throttle device for control of oscillation in the first detector and, with the particular apparatus described, seems to operate as an approximate constant regenerator, very little adjustment being required in order to keep the tube in a high state of regeneration over the entire wave band. The apparatus constituting the first detector is better shown in the right-hand stage shield in the photograph taken from above and reproduced on page 261. The variable condenser, C1, next to the panel, is of 0.00035-mfd. capacity in this case, although it is perfectly feasible to use a condenser of 0.0005-mfd. capacity if available. Immediately behind the condenser is the coil socket and antenna coupler coil of a standard make. In case the constructor desires to build his own coils, they may be made in accordance with the drawing of Fig. 2, on which winding specifications are given for both sizes of condensers mentioned. The number of turns on the plate coil of Fig. 2 may have to be altered to meet individual conditions, and this may be done as outlined later on. The antenna coupling, as provided in this sketch, is made by means of a coil wound on a short length of tubing which can be slid along the principal coil form.

At the rear of the first detector shield is the tube socket with its separate grid leak and condenser mounted on either side, and a short-wave choke, L7, to aid in obtaining oscillation of the first detector. Several chokes of this character are available on the market, but instructions for making this item are shown in Fig. 3. A pair of leads from the grid circuit of the first detector run down through the sub-panel to the oscillator pick-up coil, L4, in the stage shield at the left of the first detector.

THE OSCILLATOR CIRCUIT SHIELD

THIS shield contains a condenser, C3, of the same size and make as the first detector, and an identical coil. This coil also may be purchased or constructed along the lines of the one shown in Fig. 2. Behind the coil is the oscillator tube socket and two 1-mfd.

The Facts About This Receiver

Name of Receiver	Kendall Clough Super-Heterodyne
Type of Circuit	Super-Heterodyne
Number of Tubes	Six 201-A tubes

This receiver was designed for Radio Broadcast by Mr. Kendall Clough in response to many requests which were received for constructional data on a super-heterodyne incorporating the design features outlined by him in the September, 1926, issue. The first detector and oscillator are both shielded so as to give very stable operation. Two stages of intermediate-frequency amplification are used instead of three, as is customary. The set is designed for operation on a short indoor antenna. The plate-current drain is about 30 milliamperes.

bypass condensers, one of which completes the plate circuit of the oscillator and the other bypasses the grid bias applied for the elimination of harmonics. A small r. f. choke, L8, of similar construction to the one used in the first detector, is soldered to one of the lugs of the B-battery bypass condenser. Through this choke the connection is made from the oscillator to the B battery, thus isolating the oscillator—from a radio-frequency standpoint. The use of the two bypass condensers and the choke makes certain that all radio-frequency currents generated by the oscillator are contained within the shield except what energy is fed out through the pick-up coil to the first detector. In view of this fact, it is perfectly feasible to put a jack in the B line to the oscillator without danger of "hand capacity effect" to the jack. This jack permits the use of a milliammeter provided with a cord and plug for checking the space current of the oscillator at any time. It is very important that it be possible to read the oscillator plate current in order to properly adjust the C battery for elimination of harmonics. Just behind the oscillator shield is mounted a 200-ohm potentiometer, P1, connected across the A-battery terminals. In series with this device and the grid circuit of the oscillator are a pair of binding posts marked "plus C" and "minus C" for the insertion of a positive bias on the oscillator.

A WELL-DESIGNED SUPER-HETERODYNE

The intermediate-frequency amplifier is located at the right in this picture and the single audio stage is at the extreme left. The first detector is in the right-hand stage shield and the oscillator is in the left-hand shield

At the extreme right of the sub-panel are the two stages of intermediate amplification terminating in the second detector, which is the cushioned socket at the rear. The transformers, T1, T2, T3, used in the receiver described, peak at 54 kilocycles, and have proven very satisfactory for use in the congested districts of Chicago. These transformers have been very carefully peaked, and it should be noted that liberal space has been allowed between them in order to keep stray coupling at a minimum. The three bypass condensers shown in the wiring diagram are placed directly to the right of the long-wave transformers and, while they are sufficiently close to permit one-inch leads to their respective connecting points, they are at the same time spaced sufficiently so that the transformer fields cannot set up eddy currents in the shells of the condensers. At the left of the second detector tube socket is a 0.002-mfd. condenser across the detector output, and one of the screws which holds this condenser also holds a long-wave choke, L9, on the panel below. This choke may be better seen in the photographic under-side view of the sub-panel. It may be purchased, or wound as described in Fig. 3 on the same type of spool as the short-wave chokes previously mentioned, but with a greater number of turns. From this choke a lead goes over to the audio transformer at the left (looking from behind the panel) of the set, and the remainder of the construction is simply a one-stage amplifier terminating in two tip jacks as shown at the left-hand rear portion of the sub-panel.

In the particular receiver described, the sub-panel measures 10" x 17", and is ¼" thick in view of the considerable weight of the parts it must support. Throughout the wiring on the sub-panel, a scheme has been kept in mind which may prove valuable to the home constructor. Insofar as possible all leads carrying radio-frequency currents are kept above the sub-panel. This applies to all leads inside of the shields, of course, and to the plate and grid leads of the long-wave transformers, and also the low-potential leads from the long-wave transformers to the bypass condensers. Wherever feasible, low-potential and battery leads are brought from the upper to the lower side of the sub-panel by means of the screws that are used in holding down the various pieces of equipment.

THE HARMONIC CONTROL

THE adjustment of the harmonic control on the oscillator should be made after the receiver has been completed and operated, in order to assure one that the whole assembly is operating satisfactorily. After this, the top of the oscillator stage shield may be removed and the condenser rotated to or near maximum capacity. At this point, a trial bias of 8 to 10

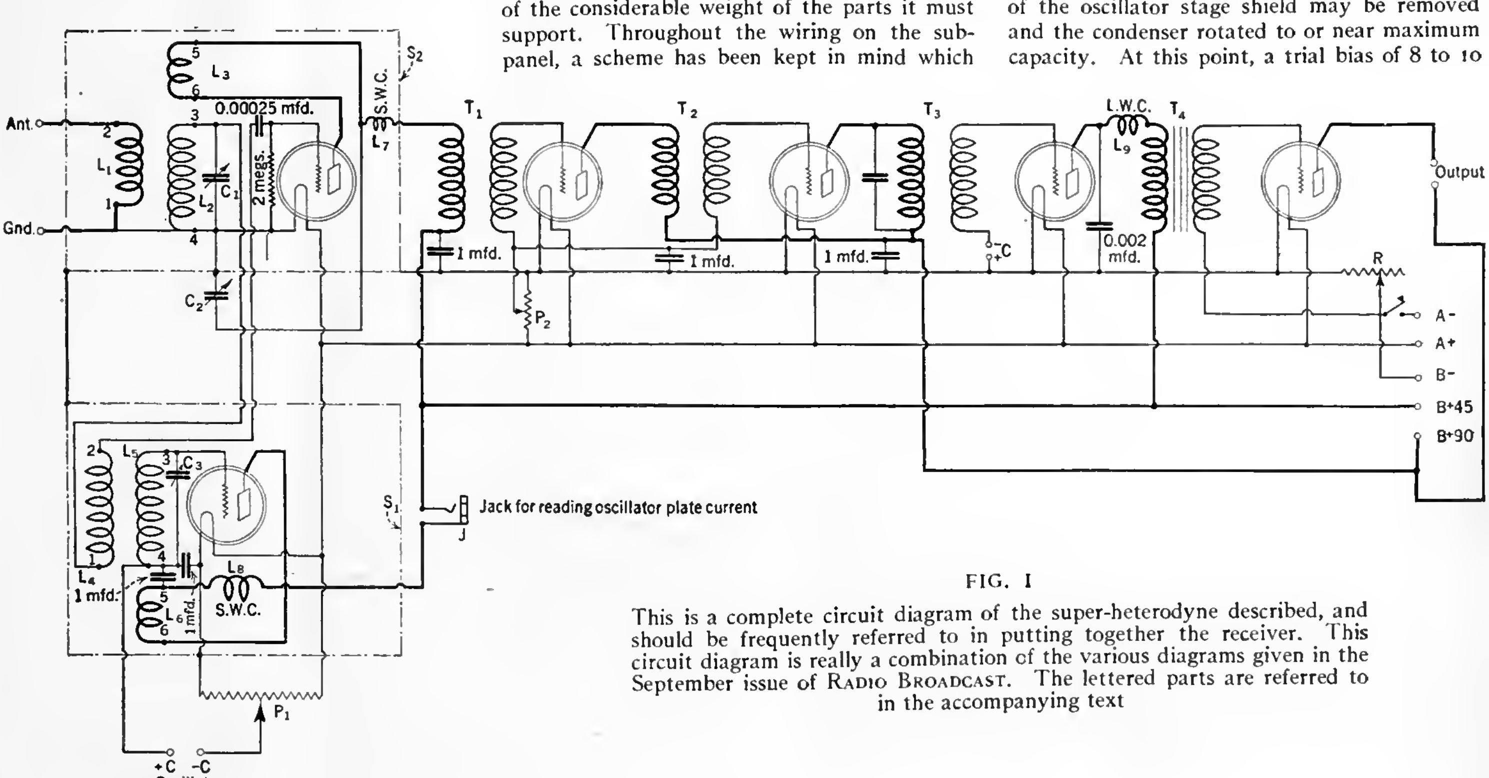


FIG. I

This is a complete circuit diagram of the super-heterodyne described, and should be frequently referred to in putting together the receiver. This circuit diagram is really a combination of the various diagrams given in the September issue of RADIO BROADCAST. The lettered parts are referred to in the accompanying text

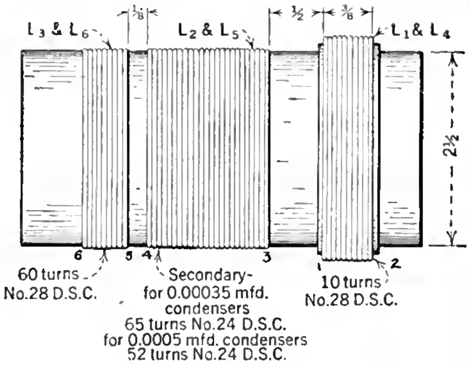
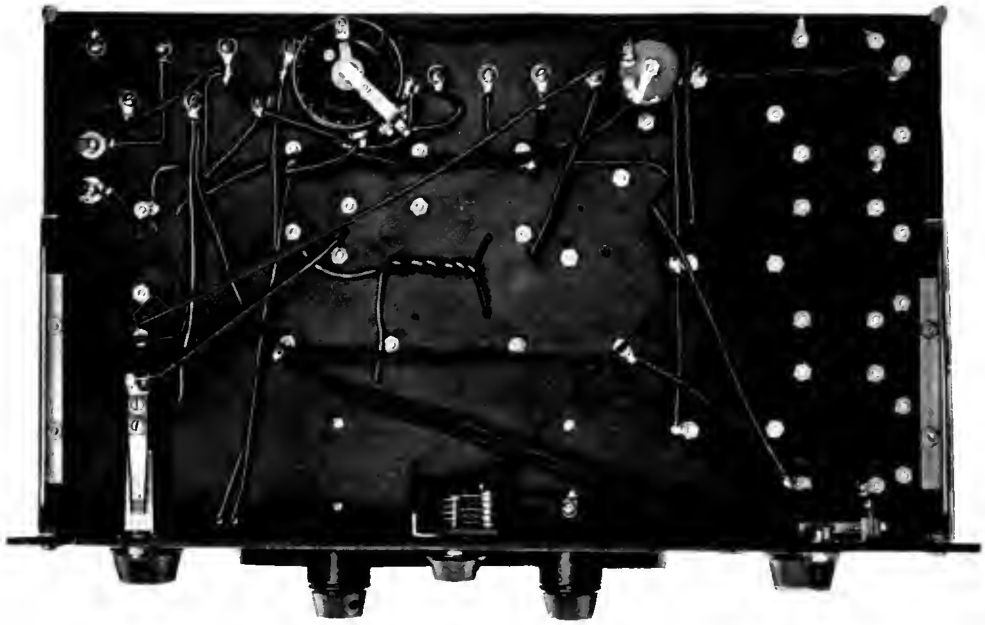


FIG. 2

Both the oscillator and antenna coupler are made exactly the same. L_1 in the drawing is wound on a cylindrical form slightly larger than $2\frac{1}{2}''$ in diameter so that it can slide over the main coil form, and the coupling be varied in this way. In the oscillator circuit L_1 becomes L_4 (see Fig. 1) and acts as a pickup coil

volts is connected to the C posts marked "Osc." in the photograph, and a 0-25 milliammeter with cord and plug is inserted in the jack on the face of the panel. The plate current is noted and the oscillator coil, L_3, is now short circuited. If the plate current now reads lower than it did previously, the potentiometer should be rotated toward the positive end until the plate current is approximately equal to the value previously obtained. If this cannot be done, then more C battery should be inserted. The conductor used for the short circuit is now removed from the coil and the plate current again noted. In case the tube has stopped oscillating with this bias it is good evidence that more plate turns are required on the oscillator coupler. If the tube is still oscillating, or has been made to oscillate, the adjustment proceeds as above, always noting the current with the tube oscillating, and then placing the short circuit on the coil and adjusting the bias to obtain the same current. This will require a number of trials but should be continued until short circuiting the coil causes no change in the oscillator plate current. The plate current consumption of the entire receiver is approximately thirty milliamperes so that good batteries must be used to operate it. The receiver's operation in one of the most congested districts of Chicago has been exceedingly gratifying—eight distant stations being received in a short evening's work through a barrage of local interference which is almost impenetrable with other receivers tried in the same location.



HOW THE RECEIVER IS WIRED

Flexible wire is used and most of the wiring is done under the sub-base. The various pieces of apparatus under the sub-base are the potentiometer for controlling the bias on the oscillator, the regeneration condenser, the jack in the oscillator plate circuit, the filament switch, and the long-wave choke coil

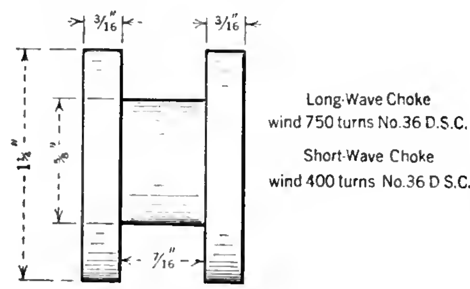
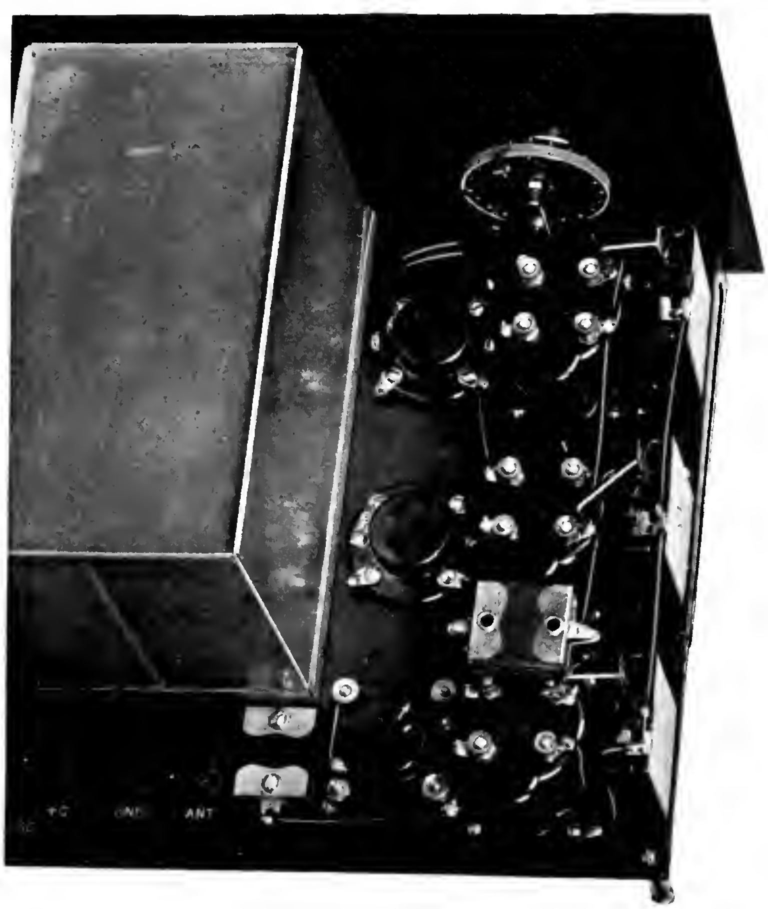


FIG. 3

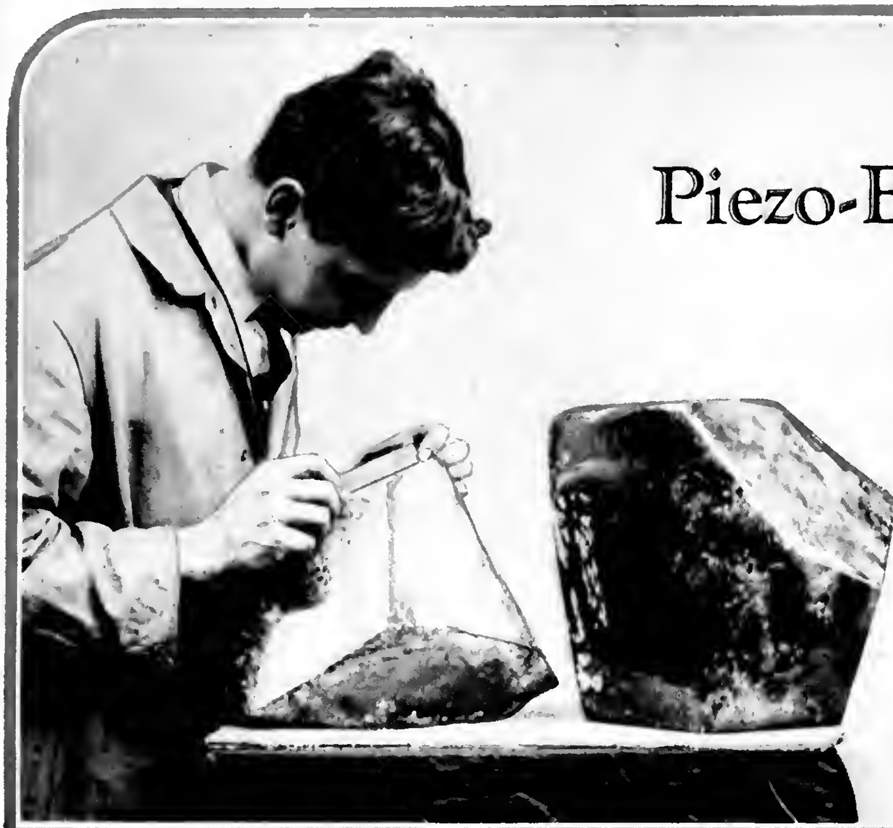
Winding data for the various choke coils used in the super-heterodyne are given in this diagram. Two short-wave chokes should be made up, one for the first detector and the other for the oscillator. Only one long-wave choke is needed, this for the plate circuit of the second detector tube



(Left) this is a view of the intermediate amplifier. The transformer nearest the potentiometer is the first of the intermediate-frequency amplifiers

THE PARTS FOR THIS RECEIVER

L1, L2, L3—Silver-Marshall Antenna Coil	2.50
L4, L5, L6—Silver-Marshall Oscillator Coil	2.50
C1, C3—Two Silver-Marshall 0.00035-Mfd. Variable Condensers	9.00
C2—Silver-Marshall Midget Condenser	1.50
T1, T2, T3—Silver-Marshall Long-Wave Matched Transformers with Filter	18.00
T4—Silver-Marshall Type 220 Transformer	6.00
P1, P2—Two Yaxley 200-Ohm Potentiometers	3.50
R—Yaxley 2-Ohm Rheostat	1.35
Y—Yaxley Closing Circuit Jack, Type No. 2.	.60
S1, S2—Two Silver-Marshall Stage Shields	4.00
5 1-Mfd. Dubilier Bypass Condensers	6.25
1 0.002-Mfd. Polymet Fixed Condenser.	.35
1 0.001-Mfd. Fixed Polymet Condenser	.35
1 0.00025-Mfd. Polymet Fixed Condenser	.30
1 2-Meg. grid leak	.30
1 Yaxley Battery Switch, No. 10 Midget	.50
2 Carter Pin Jacks	.60
6 Silver-Marshall Sockets	3.00
1 Coil Burton-Rodgers Flexible Wire	1.00
TOTAL	$61.60



Piezo-Electric Crystals

How Quartz Crystals Are Used to Maintain Constant Frequencies Accurate to Within One Fiftieth of One Per Cent.

By

M. THORNTON DOW

ABOUT sixty years ago, when P. and J. Curie, two scientists in France, discovered that certain natural crystals have piezo-electric properties, they could scarcely have foreseen in those days before radio the many useful applications to which their scientifically gathered facts were so soon to be put. Yet they must have recognized that possibilities lay ahead, for they found a very practical use for their discovery in a type of voltmeter which they developed.

Many crysta.s are piezo-electric; that is to say, they have the interesting property of giving rise to an electric voltage when they are mechanically squeezed. This characteristic action also works in the reverse sense: When a voltage is properly applied, a piezo-electric crystal elongates or contracts in certain directions.

These curious and fascinating properties, first discovered by the scientists already mentioned, have ever since that time challenged the desire for knowledge of many more investigators. Everyone should know the names of some of them—such men as, Langevin, Cady, Pierce, Morecroft, Nicolson, Pupin, and Wills. These men, and also scientists in the United States Navy and at the Bureau of Standards in Washington, have all applied their ingenuity to problems the solutions of which have opened up wide fields of usefulness for crystals of this kind.

Of the many crystals which are piezo-electric, quartz crystals are most commonly in use because of their rugged mechanical, and stable chemical, properties. Some natural crystals of quartz are shown in Fig. 2, and in the photograph at the top of this page. Such crystals are found as natural deposits, and they may range in weight from a small fraction of an ounce to several hundred pounds. They are six-sided and have ends shaped like a six-sided pyramid except that alternate edges near the base of the pyramid have been flattened off by nature. With these ends cut off, the remaining part would look somewhat like the hexagonal box schematically shown in Fig. 3. If light passes through the crystal lengthwise, in the direction shown by the arrow O, it is acted upon in an extraordinary and very interesting way. But of more interest just here is the fact that along this axis the crystal is quite unresponsive to electric voltage while in the direction of the arrow E, the quartz is electrically readily excitable. A voltage applied between two pieces of tin foil pasted at opposite corners of such a crystal causes the distance between these two corners to decrease (by a small amount, depending upon the magnitude of the voltage), while the distance between two faces marked by the arrow B, perpendicular to them, may at the same time increase. Reversing the polarity of the voltage reverses these effects. On the other hand, if by any mechanical or electrical means the crystal is compressed or elongated, it spontaneously sets up a voltage in the direction of the axis E.

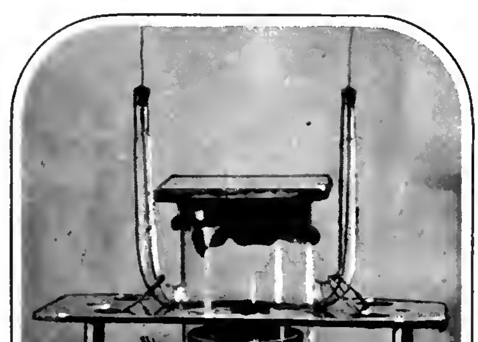


FIG. 1

The crystal on the glass-enclosed mounting will oscillate at nearly six million cycles per second. In order to keep the temperature constant, the container, from which air has been pumped may be submerged in a water bath

The fact that stressing a piezo-electric crystal causes it to develop voltage has been useful in the development of an electrical reproducer for the phonograph. By use of a needle, or by other means, the impressions on a phonographic record produce variations in pressure on a crystal. A voltage of correspondingly varying intensity is set up by the crystal and electrically operates a device such as a loud speaker or telephone receiver.

A slab of crystal, such as is shown and illustrated in Figs. 5 and 6, may be cut to take advantage of these peculiar pressure-electric properties for giving rise to electrical and mechanical oscillations. If the polarity of a rather high voltage, applied to a smaller but similar crystal, is reversed with sufficient rapidity, the crystal, due to mechanical vibration, may actually creep out from between two brass plates (See Fig. 4). To keep an oscillating crystal in its place, its mounting usually takes the form of a box arranged to carry an upper and a lower brass plate to serve as electrodes. The crystal may rest upon the lower electrode but it does not necessarily need to come in contact with either electrode. Various kinds of mountings used with piezo-electric crystals are shown in Figs. 1 and 7. Some of these, in their experimental form, have adjustable electrodes, but in practical use this feature is not necessary.

In common with so many of the developments in radio, the recent rapid rise to popularity of the piezo-electric crystal waited upon the evolution of the vacuum tube. These two children of the laboratory, the crystal and the tube, grew up independently, only to be lately introduced to

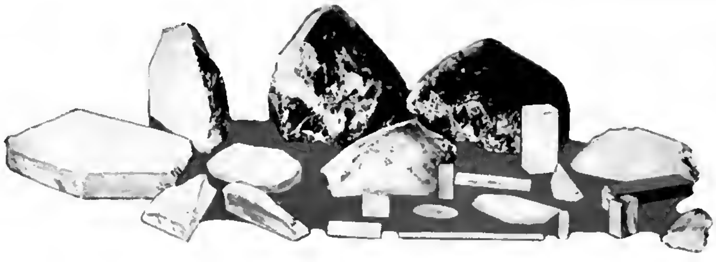


FIG. 2
Several quartz crystals and pieces sawed from larger crystals. The pyramid ends of the large crystal in the picture forming the heading to this article are shown among them

each other by scientists. The useful pair now coöperate in many ways to promote improvements in radio communication and explorations into various dark corners of the world of science. For instance, the fact that an oscillating crystal gives rise to a system of sound waves in the surrounding air has made it possible to measure with great precision the velocity of sound at frequencies far beyond the range audible to the human ear. With suitable apparatus, moreover, such an inaudible sound can be transmitted through water, between, for example, two submerged submarines, and can be made intelligible by electrical devices at chosen receiving posts.

APPLICATIONS TO BROADCASTING

TODAY, crystals find their widest applicability in the radio field due to the fact that, in combination with a vacuum tube oscillator, they act as stabilizers of frequency. There are two principal ways in which radio requires the steadying influence on frequency of the piezo-electric crystal. In the first place, for satisfactory operation of a broadcasting station, the transmitted carrier frequency must be held very nearly constant. And, in order to avoid confusion, every frequency assigned and used must be accurately known in terms of a standard. In either case the requirement is met by the quartz crystal when combined with a vacuum tube circuit, such as shown by the diagram in Fig. 8, which will produce sustained oscillations at a frequency determined by the crystal.

Now in many respects, a crystal is like a piece of any other solid. Take a bar of steel, strike it in one way and, due to its mechanical vibrations, it will give out a sound of a certain pitch; strike the same piece of steel in some other way and another pitch may become audibly more pronounced. The crystal, as we have already seen, can be excited to mechanical vibration by alternating voltage; furthermore, it can in this way be vibrated at any frequency whatever, throughout a very wide range, depending upon the frequency of alternation of the voltage, but at any one of a number of different frequencies its readiness to vibrate is especially marked. A somewhat similar characteristic is found in the ordinary tuning fork. One can force the prongs to vibrate at any reasonable frequency, but at some characteristic frequency they will vibrate with large amplitude by very little outside help. A second fork in vibration at this same frequency, across the table from the first, may be all that the latter requires to keep it going.

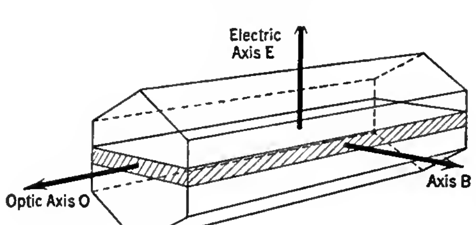


FIG. 3
Certain properties of a quartz crystal differ in the various directions indicated by arrows

For the present it is best to get acquainted with some of the more general facts about crystals that oscillate so that, later on, in dealing with a particular application of the crystal, we can feel more at home in following specific directions. An impedance (that is, a coil combined with a condenser) is shown in the plate circuit of Fig. 8. From the point of view of an electric circuit, a piezo-electric crystal is also a coil combined with a condenser, since, to the circuit, it acts as an impedance. Now such an arrangement of impedances may cause oscillations of current and voltage to start in the tube circuits. Thereby an oscillating voltage is set up at the electrodes of the crystal which is here shown connected between grid and filament. Such a voltage, as before described, excites the crystal to mechanical vibration. If the frequency of this excitation is even only approximately one of those values at which the crystal strongly prefers to go, the counter electric potentials set up by the

FIG. 4
Unless this small convex crystal is completely enclosed when an alternating voltage is applied, it shoots out from between its electrodes, as here illustrated. A natural frequency for this crystal is about one and a half million oscillations per second

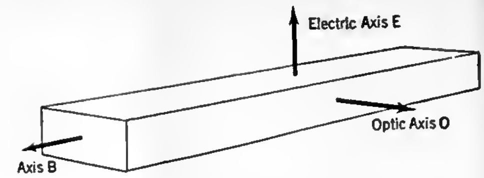


FIG. 5
A diagram of the crystal shown in Fig. 6. Arrows indicate directions similarly shown in the original crystal of Fig. 3. The natural frequency of this crystal is about 28,000 oscillations per second

elongations and contractions of the crystal so influence the action of the tube by way of the grid as to force the oscillations to the frequency chosen by the crystal. The tube drives the crystal but *the crystal dictates the frequency*. Because of the strong preferences, just mentioned, which the crystal shows for certain frequencies, such an oscillator operates with remarkable constancy of frequency.

In order to start the oscillator at some frequency preferred by the crystal, the coil and condenser must have values within rather liberal limits. In most cases, however, the condenser can be dispensed with altogether by choosing a suitable coil. Surprisingly large changes can be made in the inductance of the coil and in the plate voltage or filament current to the tube without affecting the output frequency seriously for ordinary purposes.

A tuned circuit, such as a wavemeter, coupled closely to the crystal oscillator, will cause small changes in frequency; but it would be very difficult to produce changes as large as one cycle in a thousand per second without "killing" the oscillator by doing so. It is usual also to find that the frequency of a crystal oscillator is affected somewhat by changes in temperature; but for one degree change in temperature a change of one cycle in thirty thousand per second would be unusually large. If special care is taken to keep a crystal at constant temperature, and to avoid undue coupling to other circuits, the frequency of a crystal oscillator may be made to hold as constant as any conceivable need can ever demand. In ordinary usage, without exercising any unusual precautions, crystals are found to hold frequencies at

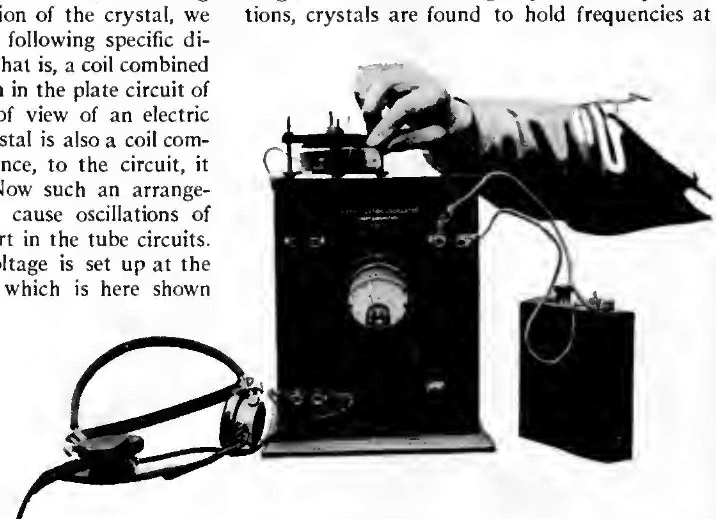


FIG. 6
A shudder runs through a quartz crystal when an alternating voltage is applied between its upper and lower sides

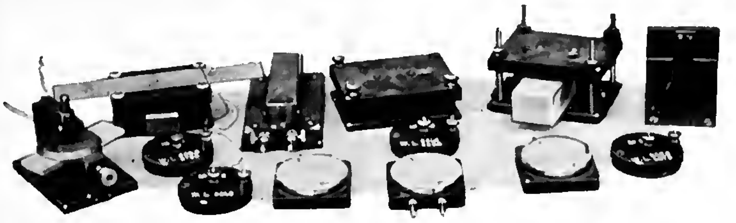


FIG. 7
Several experimental and commerical types of crystal mountings

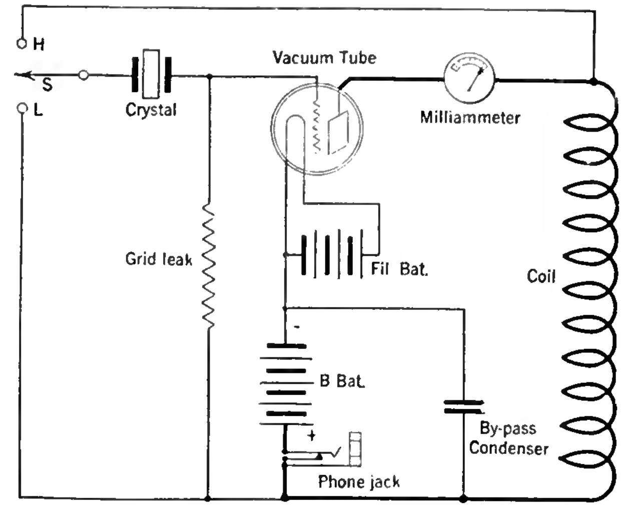


FIG. 9
A very convenient form of crystal oscillator circuit which is a combination of two circuits due to Professor Pierce, of Harvard. The General Radio Company, of Cambridge, Massachusetts, manufactures such an oscillator

a given value within approximately one or two cycles in ten thousand per second.

Accruing to the advantages of the quartz crystal as a unique controller of frequency in radio, is the multiplicity of frequencies to be found associated with one individual crystal. And in the constancy of its control, the crystal plays no favorites. Although all crystals are not equally ready to respond to the call to oscillate, nearly every crystal can easily be made to operate as an oscillator at either one of two different frequencies by using Professor Pierce's circuits, which are shown combined in Fig. 9. This circuit is simplified to the last degree; a crystal, a tube, and a coil are the main parts in it; a plate milliammeter is very useful but not absolutely essential. With the switch S at position H, the crystal oscillates at some high frequency; with the switch at L the frequency is much lower.

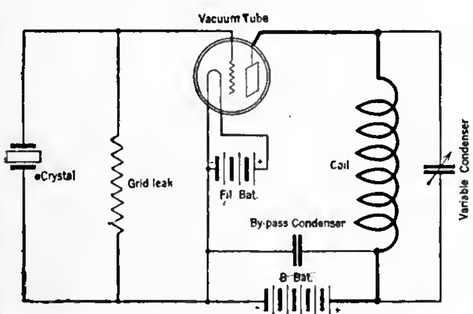


FIG. 8
One scheme of circuit which will oscillate at the frequency of the crystal. Apparatus wired to give crystal-controlled oscillations is collectively called a Crystal Oscillator

The values of frequency depend on the size of the crystal. A crystal about the size of a small spectacle lens, for instance, would give possibly 1,500,000 and 150,000 cycles per second for the two frequencies. Sometimes two different coils are needed for operation, one for each of the two switch positions. When oscillations begin, there is a sudden, or in some cases, a rather leisurely, reduction in the reading of the plate meter. If we care to add a condenser and tune the circuit, as already suggested by Fig. 8, there is usually at least one other frequency at which the crystal will be found to oscillate readily.

The various frequencies, at each of which the crystal may be made to oscillate at will, are related in value in accordance with complicated laws. The value for each frequency so obtained from a crystal must be separately determined by calibration in a laboratory equipped for the purpose. When these calibrations are at hand, a wide range of standardized frequencies become available to the experimenter when he makes use of the additional facts briefly described below.

HARMONICS ARE UTILIZED

To SPEAK of two or three (or more) of these preferred frequencies does not tell the whole story, for when the crystal oscillates at any one of its frequencies there are, simultaneously, many other frequencies available. Though crystals can be ground to give as high as 10,000,000 or as low as 25,000 (or less) cycles per second, it is too laborious to get these extreme frequencies in this way. If a frequency of 10,000,000 cycles is needed it is simpler to use that frequency as found in the circuit of, say, a 2,000,000 cycle crystal. By great good fortune electric oscillation frequencies in vacuum tube circuits, both with and without associated crystals, usually appear in crowds. Where the leader goes the others follow. The leader in this case is called the fundamental. The various individuals of the whole crowd are called harmonics. The fundamental frequency may be called harmonic number 1; it is the predominant frequency at which the oscillations take place.

But such oscillations as these produce effects equivalent to having other frequencies present at the same time, and these other frequencies are always whole number multiples of the fundamental frequency. Harmonic number 2 always has exactly twice the frequency of the fundamental, harmonic number 3 always has exactly three times the frequency of the fundamental, and so on. The fundamental is the more powerful, the other harmonics less powerful. Roughly speaking, the higher the number of a given harmonic, the less powerful it usually is. Ordinarily it is easy to find at least fifteen such frequencies and often it is possible to find more than a hundred, and every one of these frequencies will be remarkably constant and simply related to the fundamental.

A COMMERCIAL PIEZO-ELECTRIC OSCILLATOR
This instrument has been on the market for more than five years. All the batteries are included, which makes the unit readily portable

The New Inverse Duplex System

The New Inverse Duplex Circuit Embodying Some Fundamentally New Principles and Surpassing the Old System on all Counts—Excellent Selectivity, Meeting Modern Needs, Is Featured—Audio Transformers Should Have "Rising" Characteristics to Compensate Sharpness of R. F. Circuit

By DAVID GRIMES

THIS article constitutes the first of a special series written for RADIO BROADCAST to acquaint its readers with the latest fundamental improvements in a most fascinating circuit arrangement—the Inverse Duplex System. When the Inverse Duplex System was first introduced to the broadcast enthusiast, many of the present circuit refinements were unknown. In fact, at the time when the first Inverse Duplex System articles appeared in this magazine, in 1923, little else but regeneration and untuned radio frequency amplification were considered.

Since those far-off days in radio, many things have occurred, changing the entire character of the industry. Problems which then seemed insurmountable now no longer exist—solved as the occasion necessitated. Almost before these early Inverse Duplex System articles were off the press, things started popping! New tubes! New wavelengths! More stations! And didn't this raise havoc with design!

For instance, the original Inverse Duplex System circuits featured in these pages were exceptionally efficient, picking up stations 1300 miles away on a one-foot loop with only three tubes. But the set employed untuned radio frequency transformers designed to function well on 360 (833 kc.) and 400 (750 kc.) meters. Furthermore, the various constants used were specified for the UV-201 tube, which was promptly replaced by the UV-201-A type. Meanwhile many additional broadcasting stations were going on the air with wavelength assignments running from 240 (1250 kc.) up to 550 (545 kc.) meters. What else could be expected of the innocent untuned radio frequency transformers but inferior results on other wavelengths than those for which they were designed? The number of stations alone created a problem in selectivity that could not be taken lightly, and, whatever fixed or untuned radio frequency may or may not be, it is certainly not selective.

There still seem to be many radio experimenters who associate these circuit limitations with the basic principle of Inverse Duplexing. Of course many multi-tube reflex circuits were notoriously inefficient but the Inverse Duplex System and reflexing should not be confused for one single instant. It is true that both use the tubes twice for amplification. Their methods of doing this, however, are entirely distinct and separate. Extensive investigation on reflex action was conducted during the war by the Government with the conclusion that reflexing had many limitations. Out of this work was born the Inverse Duplex System, specially conceived to make the double operation of vacuum tubes perform as it should.

The first step after broadcasting conditions changed, was to incorporate into the Inverse Duplex System new and better circuits to meet the new commercial requirements. Tuned radio frequency was introduced about this time and several receivers employing tuned radio frequency amplification carried everything before them. It obviously remained for tuned radio frequency to be adapted to the Inverse Duplex System. This procedure sounded very simple, but neither this change nor the one necessary before the new tubes could be used was, in any sense of the word, easy. Too many complications arose and before any one circuit change could be made, it was important to determine all the effects on the overall amplification and efficiency.

Since 1923, concentrated effort has been exerted by those closest to the Inverse Duplex System, consisting of thousands of tests conducted under actual field conditions as well as in the laboratories. One by one, the various constituent circuits were whipped into shape and one by one applied to the Duplex principle. The progress was so steady and the results so gratifying that merely applying tuned radio frequency and ordinary audio amplification to the system no longer appealed. Nothing short of fundamentally new associated circuits would be considered!

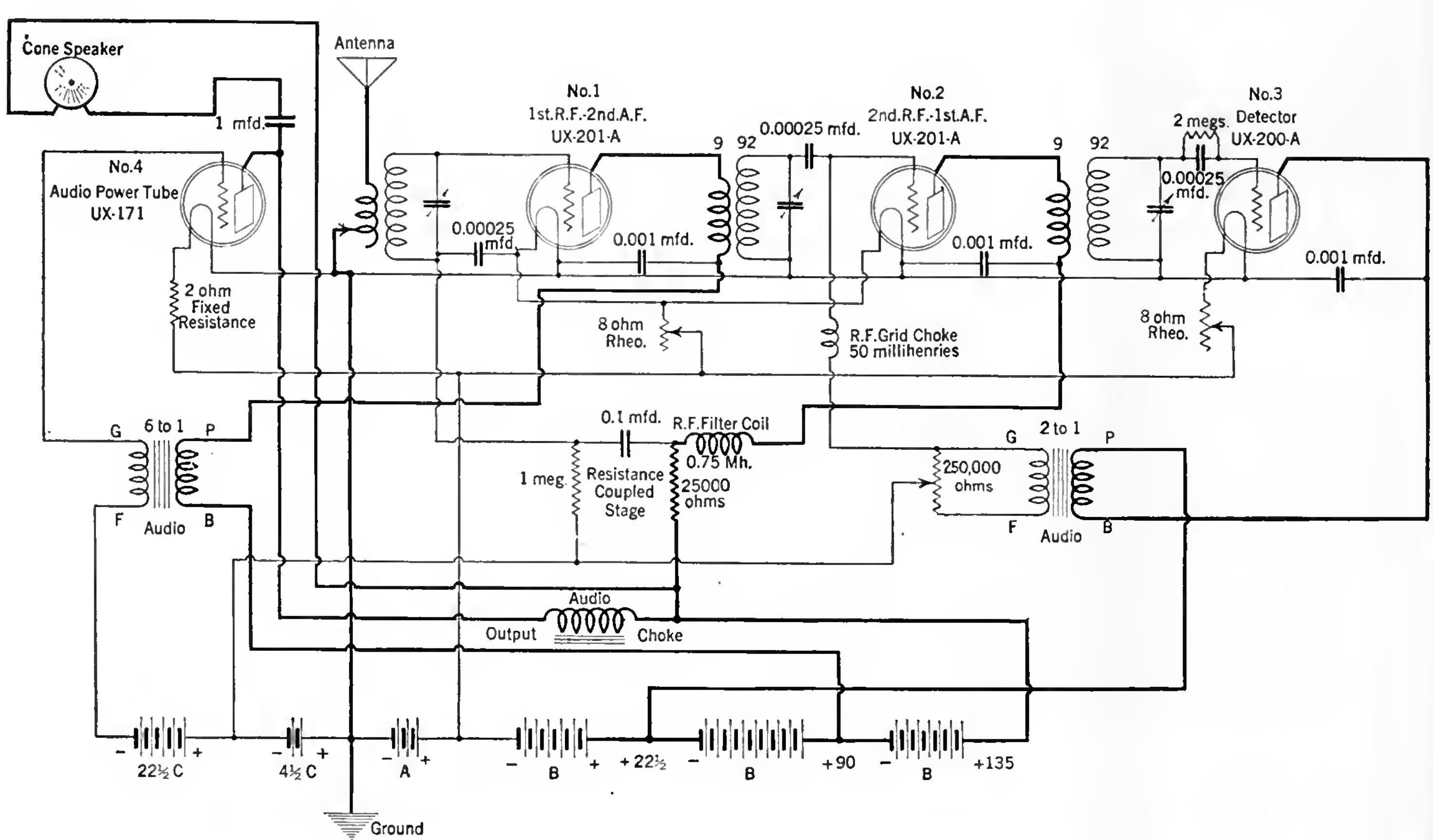


FIG. 1

FEATURES OF THE NEW SYSTEM

NOW, after three years of real engineering effort, the new Inverse Duplex System is presented as one of the most efficient circuits of the year.

Some of the outstanding features to be considered are listed below, and they will be discussed in detail as the series of articles progresses:

1. Excellent radio frequency selectivity at all wavelengths.
2. Substantially equal radio frequency amplification at all wavelengths.
3. Several special arrangements to secure real tone quality in the audio amplifying circuit.
4. Means for preventing detector-tube overload, thus retaining the bass notes on local stations.
5. Elimination of direct current from loud speaker windings, reducing burn-out tendencies.
6. Straight line volume control for smooth gradual adjustment from a whisper up to the choking point of the tubes.
7. Long length of tube life because of negative C battery bias on all amplifying tubes, radio frequency as well as audio frequency.
8. Small B battery drain due to the reasonable number of tubes used and the fact that all amplifying tubes are operated with the standard negative C bias on the grids.
9. Unique audio grid arrangement on first audio tube to overcome hand hum, prohibit the audio whistling caused by the A type tubes, and to permit the second and third condensers to be run on the same grounded shaft, if desired.
10. Certain circuit designs to permit the use of the new UX-171 power amplifying tube and the new UX-200-A detector.
11. Determination of audio phases for reduced radio frequency modulating effect on excessive signal strengths.

It was soon realized during the tests on tuned radio frequency that the circuit was inherently more efficient on the short waves than on the long waves. The fixed radio coupling between the primary and secondary windings of the tuned transformers made this so, and the actual results completely verified the theory. Efforts were made during the Inverse Duplex System adoption to remedy this fault but it was something that required an entirely new tuned radio frequency circuit. Other engineers were working on this problem of unequal radio frequency amplification as it almost offset the selectivity advantage the tuned radio frequency system possessed. Almost a dozen solutions have been offered as a result. In nearly every case, the difficulty has been overcome—the long-wave amplification being made equal to the short-wave amplification! But one very important thing has been overlooked and that one thing is selectivity—the very thing that gave tuned radio frequency its standing! All the systems based on increased coupling arrangements at long waves or increased "loss" methods at short waves, were broad either at one end or the other of the tuning dials.

The new Inverse Duplex System investigations finally disclosed the complete answer to this apparent enigma. The System made use of the inherent tendency of the audio circuit to feed back radio energy—a previous detriment turned into a great asset. A simple explanation will make this plain. Referring to Fig. 1, it will be seen that the radio frequency energy passes from the antenna to the detector through tube No. 1 and tube No. 2, constituting the first and second stages of radio frequency amplification respectively. The audio currents originating in the detector tube No. 3 then pass back through these tubes in the inverse sequence, going through the No. 2 tube as the first audio and the No. 1 tube

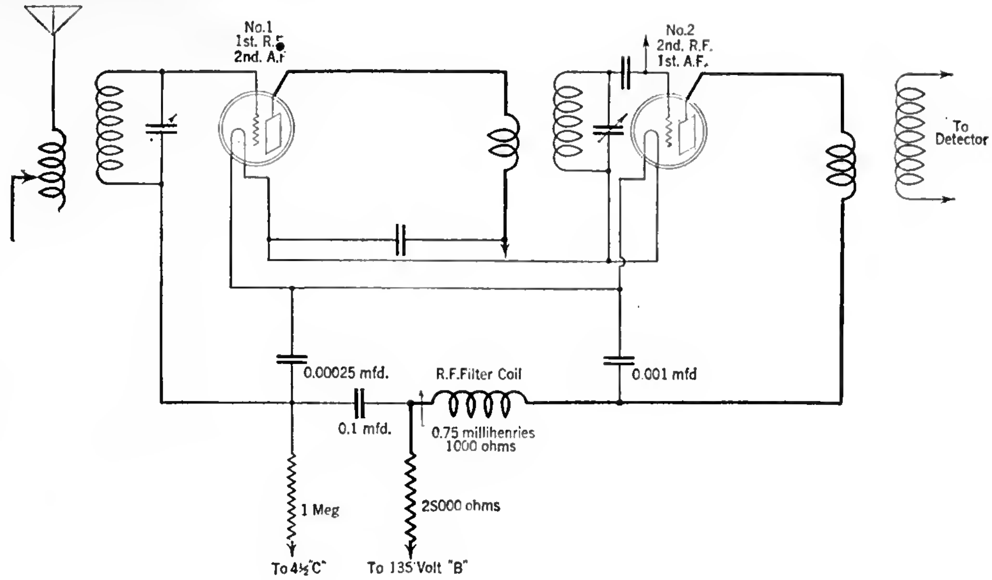


FIG. 2

as the second audio amplifying stage. The audio currents thus travel from No. 2 to No. 1 while the radio currents are passing through from No. 1 to No. 2 tube. Certain precautions must be taken to prevent the currents from passing through the wrong paths in view of these reversed sequence arrangements.

A little reflection will reveal that the radio frequency currents in the output of the No. 2 tube might easily leak back through the resistance coupling (which passes the audio currents from this No. 2 tube to the No. 1 tube) into the input of the first radio amplifier—the No. 1 tube. This would constitute a first-class feed-back that would be either aiding or opposing according to the phase polarity of the primary connections on the middle interstage radio frequency tuning transformer. The first thought in the research laboratories was to insert a large radio frequency choke coil in this resistance coupling to prevent all radio frequency leakage here without deter-

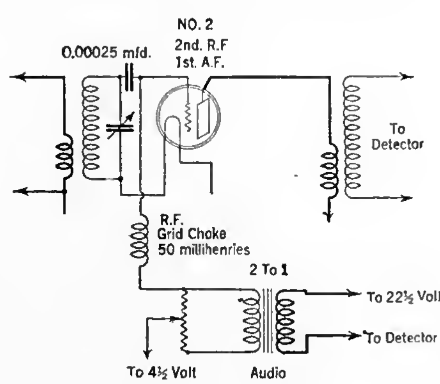


FIG. 3

ring the audio currents which were traveling their legitimate path. This worked perfectly, whereupon different values of chokes were tried in order to determine how small a choke could be relied upon. Then a discovery was made!

By properly poling the primary of the tuned radio frequency transformer between the No. 1 and No. 2 tubes, the feed-back could be made to reënforce the original signal in tube No. 1 and could be made to reënforce it progressively as the longer wavelengths were tuned-in on the antenna. Reference is here made to Fig. 2 which shows only that portion of the circuit with which we are now concerned. This radio-frequency choke coil could be so designed in combination with the plate and grid bypass condensers that the entire arrangement would constitute a filtered feed-back circuit affecting the long waves more than the short. Having hit upon the theory, it was worked out in practice quite simply. The constants of the coil were found to be 0.75 millihenries and 1000 ohms resistance. These values are not at all critical but, on the contrary, are subject to considerable latitude because the filter circuit is *not* a tuned or resonant device. It is, as its name implies, a filter.

FILTERING ACTION

FOR those readers who do not see this filtering action clearly, a brief description of its operation is here given. Assume, as a starting point, that the circuit has been tuned to a short-wave station of about 200 meters. The high-frequency currents flowing as a result in the plate circuit of the No. 2 tube are readily passed back to the filament by the 0.001-mfd. bypass condenser. The filter choke coil offers great impediment to the passage of these short-wavelength, high-frequency currents, really forcing the currents to take the path of least resistance through the 0.001-mfd. bypass. However, as the longer wavelengths are tuned-in, the lower frequencies of these longer waves encounter more and more difficulty in passing through the 0.001-mfd. bypass condenser and at the same time, pass more easily through the filter coil, which offers less impedance to the lower frequencies. Feed-back thus occurs at the long waves in an ever-increasing amount as the 550-meter setting is finally reached.

This feed-back, or reënforcement, is just sufficient to compensate the drop in long-wave amplification due to the fixed radio frequency coupling, so that an overall amplification is obtained as shown in Fig. 4, on page 268. The dotted line indicates the efficiency curve of the average tuned radio frequency circuit over the wavelength band used in broadcasting. The solid line at the top of the graph shows the amplification as obtained from the circuit combination just described. The amplification is shown to be practically constant over the entire range.

The excellent selectivity feature of this circuit at all wavelengths is next to be considered. This is a very important factor. Curves A and B in Fig. 4 show the resonance peaks of the tuned radio frequency and the Inverse Duplex System layouts respectively. It will be noted that the sharpness of tuning is about the same in the two cases at the short wavelengths. The straight tuned radio-frequency circuits have long been noted for their selectivity at these settings. On the other hand, curves C and D on the same diagram tell a different story. Not only is the height of the resonance curve greater, which means greater amplification, but the sharpness is much more pronounced in the new Inverse Duplex System as compared with tuned radio-frequency circuits. Other systems employed for boosting the height of the tuned radio frequency curve at the long waves still further broaden or reduce the sharpness of resonance—or selectivity!

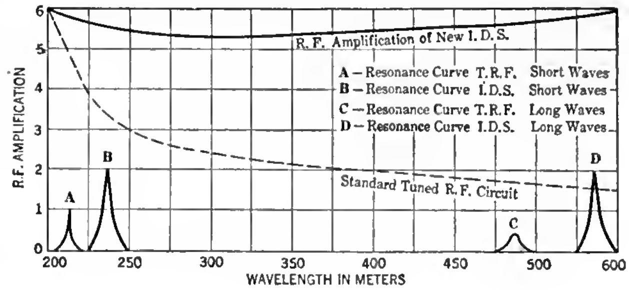


FIG. 4

It almost appears to be paradoxical—greater amplification with greater selectivity! It is as if you had suddenly transported your receiver much nearer the transmitting stations and then found to your surprise that they could be tuned out more easily than before. The explanation is simple, of course. This newly acquired gain in amplification has been the result of a reënforcing action which is equivalent to a decided reduction in the resistances of the several tuned circuits. Now the sharpness of resonance depends entirely on the resistances of the tuned circuits. Having, in effect, then, reduced these resistances, the sharpness of tuning, or selectivity, increases tremendously. This action of reënforcement is well known among engineers and is often referred to as "negative resistance," although in reality there is no such thing.

PREVENTING "HAND HUM"

ONE of the many obstinate difficulties encountered when tuned radio frequency was applied to the Inverse Duplex circuit was the tendency for the middle tuning dial to pick up audio induction hum and to squeal when the operator's hand was brought near it. The trouble was not anticipated but, when once it occurred, it was easily diagnosed, and a remedy prescribed. The variable condensers used in tuning constitute a fairly large amount of metal, particularly in area. These condensers were naturally located in the grid circuits of the audio transformers, as the grid circuits of the amplifying tubes were common to both radio and audio currents. Now any large capacity hanging on the grid post of the first audio transformer is apt to cause no end of trouble. Placing the hand near this condenser was practically equivalent to touching the audio grid post with the finger, and the unearthly squeal resulting hardly bears description. Incidentally, as any electric lamp or power circuit was brought near the set, this "grid collector" variable condenser would start to perform. The 60-cycle hum always resulting was very pronounced.

Fig. 3 on the previous page shows in a clear manner just how this trouble was overcome. The audio currents were kept entirely out of the radio circuit and the variable tuning condenser, by a multiple connection instead of a series one. The grid post of the first audio transformer connects directly to the grid of the No. 2 tube through a radio frequency grid choke coil. This coil passes the audio energy without any objection, but becomes an open circuit for any frequencies encountered in the broadcast wave band. The blocking condenser, 0.00025 mfd., passes the radio energy through to the grid but prevents the audio currents from running down through the radio circuit to the filament. This variable condenser is thus grounded for audio currents without effecting its tuning operation for radio currents. Of course, the third tuning condenser works into the grid of the detector so no difficulty is experienced here, there being no audio currents in this circuit. The left-hand or first condenser is not so susceptible to this hand whistle since it is in the grid circuit of the second audio tube. This audio stage is a resistance-coupled one anyway, which overcomes the situation just discussed. Inasmuch as the grid bias is supplied to the No. 2 tube through the audio circuit and radio frequency choke, the filament return from the tuning condenser may be connected to either side, and may therefore be combined with the detector filament return. Thus the rotors of the second and third condensers may be common and connected together for simplified control.

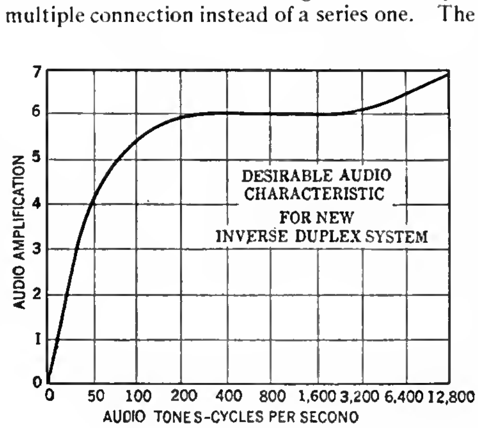


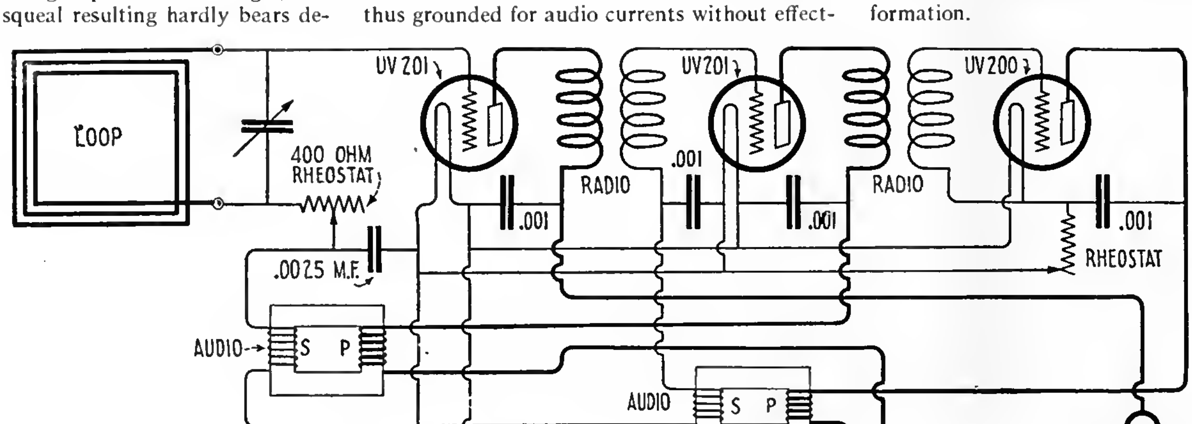
FIG. 5

The various developments in the audio circuit are quite separate and distinct from anything so far described. For best tone quality, the audio transformers should have a certain characteristic when employed in this new Inverse Duplex System. They, of course, should have good low-note amplification in order to give that timbre which cannot be present when the bass notes are not amplified efficiently. But the transformers should have a "rising" characteristic, *i. e.*, they should exaggerate the higher tones slightly. There are two reasons for this, both of them easily appreciated when pointed out.

In the first place, the 0.00025-mfd. blocking condenser in the grid of the tube in Fig. 3 is, in reality, across the secondary winding of the first audio transformer, as far as audio currents are concerned. This condenser reduces the high tones somewhat, and this has to be compensated.

In the second place, the more sharply tuned a radio frequency circuit is, the more it tends to cut off the high audio tones coming through. As previously brought out, the radio circuit used in the new Inverse Duplex System is exceedingly selective, and this tends to cut out some of the higher audio tones. Employing an audio transformer with a "rising" characteristic compensates this, and permits the selectivity without sacrificing the tone quality. This is an important point. Fig. 5 shows an ideal curve for this purpose.

The next article in the series will give further details on the development of the Inverse Duplex Receiver and will also offer constructional information.



"1300 MILES ON A ONE-FOOT LOOP"

Such was the title of an article describing the then ultra-modern Inverse Duplex System, which appeared in the April, 1923, RADIO BROADCAST. Above is the circuit, a three-tube affair, which created quite a sensation at the time of its original presentation. Woe betide the fan who constructs a set from this old circuit in these modern days, when selectivity is an essential and primary requirement

THE LISTENERS' POINT OF VIEW

Conducted by John Wallace

Radio Speakers Should Be Forbidden to Read from Manuscripts

WE HAVE a copy of a list of regulations and suggestions for radio entertainers prepared by Program Director L. J. Johnen of WLW. The list is a long one, but since it is probably typical of the requirements of most broadcasting stations you may be interested in reading a few of the paragraphs:

"The performer should always submit his program, written in advance so that the announcer may be prepared to present it in a dignified manner without having to word his announcements extemporaneously. No performer should essay a selection with which he is not entirely familiar. In this way he will save himself and please the radio audience.

"All addresses must be submitted by speakers for approval before being broadcast.

"No requests for money may be made.

"It should be remembered that the announcer has full charge of the studio. The performer should accept any suggested changes in his program, or in his position before the microphone, in the spirit in which they are given.

"It is, of course, understood that nothing offensive or suggestive of bad taste will be permitted.

"It is against the rules of WLW to permit direct advertising.

"Speakers should talk in an ordinary conversational tone, about two feet from the microphone, and directly into it. The face must never be turned away. A speaker should not speak into the microphone as if he were addressing a large audience.

"The distance from the microphone for singers and instrumentalists varies—the higher the pitch and the greater the volume, the greater should be the distance.

"Very loud singing or playing is objectionable as it detracts from successful broadcasting, often producing a shattered effect. The best choral effects are obtained when each person sings in a subdued manner.

"Pianists are cautioned to make very sparing use of the pedals—it is best not to use the sustaining pedal at all—and not to accentuate the bass notes, in order that the broadcast may be clear and distinct.

"Selections should be chosen with a view to pleasing the maximum number of listeners. The average audience likes familiar compositions, simple in melody, and universal in appeal. It is suggested that strange exotic selections be omitted from the program.

"Speakers are urged not to speak extemporaneously. They should always use manuscript, in order to prevent halting in their utterances. A page of typewritten copy, double spaced, usually takes about three minutes to read slowly and distinctly."

With these last two rules we are not in sympathy. Perhaps they are inevitable, certainly they obtain at every station, but still we think they should be thrown out. The admonishment is to speakers particularly. There is little enough excuse for radio speeches anyway, and what small justification there is is that the spoken word may be more interesting than the written one. In fact, in this day of cheap printing, there is little excuse for any speechifying. We concede just two situations in which a speech is more logically called for than a printed message: first, when an audience is made up of illiterates; second, when the speaker is endowed with an ability to put his stuff across better orally than he can in writing. A memorized speech, or one read from manuscript, is no improvement on one set up in type; the fact that someone other than one's self is reading it adds little to the interest. It is every bit as dry in the reading as it is when it appears in the newspaper the next day.

It is the existence and observation of the rule quoted above that has made radio speeches what they are to-day—about the dullest thing on the air. The very "halts" which the rule quoted seeks to eliminate are, in fact, an essential element in a good speech—just as legitimate as the words themselves. They indicate, in the case of a competent speaker, that that speaker is thinking. And what more could you ask? When a man is making a good speech he is *thinking out loud*. That's why a good speech is effective: the audience enters into the speaker's stream of thought and thinks with him. Some of his thoughts are inevitably new thoughts, thoughts that never occurred to him before that very instant. It is this fact, that the speech is developing, actually originating, before them, that gives it life for the audience. Not one speaker in a thousand can, while reading a speech, convey the impression that he is also thinking about it. The result is a colorless, dead thing. And, read over the radio, the same speech becomes even deader than dead.

Not long ago, we listened (briefly) to a speech by George Palmer Putnam delivered for the Eveready Hour and purporting to deal with explorations in Greenland. It is a matter of record that Mr. Putnam did engage in explorations in Greenland but it never would have been guessed from his speech. The talk was about as convincing and personal as if it had been culled from the "G" volume of an encyclopedia. True, Mr. Putnam made no stammering pauses, his words were carefully chosen, his rhetoric was irreproachable, the mechanism of the whole dissertation was faultless—and its net value was nil.

© Henry Miller

WHAT HAPPENED TO THE TOWERS OF PWX, AT HAVANA

The recent hurricane played havoc with radio towers. During the Florida hurricane, radio towers of broadcasting stations were partly destroyed, although repairs were quickly made

TELL US WHAT YOU LIKE IN RADIO PROGRAMS

WHAT say, O constituents, to a questionnaire?

Radio has been blessed with more than its share of questionnaires, and we have hesitated for a long time about using such a method of gathering information about what readers of RADIO BROADCAST think of radio programs. But we feel, and not without reason, that the readers of RADIO BROADCAST constitute a distinct class of radio listeners, and may be justifiably considered the upper strata.

And aside from the amusement to be had from phrasing your replies to these four questions, you may be helping to influence the character of programs. Every program director is always keen about knowing how his efforts are being received, and he can not always tell from his letters, for how does he know that they represent a true cross-section of his listeners.

The questions below are few, and some of them have the special virtue that they have never been asked before. Please use the space provided for your answers. Tear this sheet from the magazine, and if possible typewrite your replies. If the space provided is not sufficient, attach an additional sheet to this with your remarks. If you are interested in reading the replies—contribute some yourself. Address all questionnaires to

JOHN WALLACE,
RADIO BROADCAST,
Garden City, New York.

Please Answer These Questions

1. Do you listen to your radio evenings as you would to a regular show, or do you simply turn it on and use it as a background to other activities?

(This question may seem silly, but we ask it because we have a growing suspicion that radio programs aren't as reverently listened to as the broadcasters suppose.)

2. Do you regularly tune-in on distant stations or do you regularly rely on your local stations?

(They tell us that the DX hound is a fast-disappearing breed. Is he?)

3. If you had a hundred minutes to listen to all, or any part of the following broadcasts, how would you apportion your time? (Answer in spaces provided in the next column.)

Instrumental Music	*Serious*	___	minutes
	Light	___	minutes
	Popular	___	minutes
Vocal Music		___	minutes
Radio Play		___	minutes
Speech		___	minutes
Educational Lecture		___	minutes
Miscellaneous Novelties		___	minutes
TOTAL		100	minutes

(In answering this question, assume that each of the offerings is the best of its kind, say Coon-Sanders Nighthawks for the jazz the New York Symphony for classical music, Ford and Glenn for the novelties, and so on.)

4. What are the six best broadcasts you have heard?

(We could refresh your memory with some notable broadcasts, but that might influence your choice. Anything is eligible, from an especially good dog fight broadcast, to a high-powered soprano solo, heard four years ago.)

Please answer these questions briefly and mail them at once to Mr. Wallace, at the editorial offices of RADIO BROADCAST, Garden City, New York. We prefer to have you write your replies on this page. The results of the questionnaire will be announced just as soon as it is possible to compile them.

We do not mean that a radio speaker, or any speaker, need improvise his speech entirely. Let him fret over it as many nights in advance as he likes, provided, always, that he can, in the final rendition, eliminate any suggestion that it has been prepared. If he is sufficiently full of his subject and has an outline before him to keep him from going too far astray he can deliver just as fluent a speech as he could from a manuscript, and a far livelier one.

Whatever else may have been thought of William Jennings Bryan he was unquestionably a speaker, than whom there was no thanwhomer. As a reporter, we once had an opportunity to "cover" a speech by him. Before he commenced we obtained from him a copy of the outline he was to follow. It was just ten lines long. From it he talked for two hours. Never for an instant did his manner of speaking suggest that he had the faintest idea what he was going to say next; it seemed absolutely extemporaneous. Yet the whole thing was a perfect piece of fluent prose. We learned later that he had given that same speech some ten times before. The secret of its freshness, its seeming like a first performance, lay in the fact that the ideas he had expounded so many times before were couched that evening in an entirely new set of words and phrases. Had he followed a manuscript he never would have fooled anyone into thinking he was delivering a fresh speech—nor would he have kept his audience spellbound, as he did, for two hours.

Every radio speaker evidently cannot be a William Jennings Bryan, but any one of them can afford to emulate his methods with great profit. That is, they can follow his method, providing the broadcasting stations throw out the silly requirement of a manuscript. We much prefer a radio speaker who is flustered, stammering, incoherent, and ungrammatical and still sounds like a human being to one who is polished and suave and sounds like a stock-market announcer.

The studio rule which we would suggest anent this subject, and which we would urge posting conspicuously on all walls of the broadcasting station, would read as follows:

SPEAKERS ARE ENJOINED not to deliver memorized speeches, and are *positively forbidden* to speak from manuscript. Speakers who are possessed of burning messages in manuscript form are cordially invited to have them set up in type and distributed as pamplets or take a jump for themselves in the lake.

As for the other rule, tactfully worded as a suggestion—"The average audience likes familiar compositions, simple in melody, and universal in appeal. It is suggested that strange exotic selections be omitted from the program"—what can be done about that? The answer is, probably, nothing. We may rant and protest, scream and tear our hair but, alas, the doleful fact remains that the *average* audience *does* like familiar compositions. Of course we may call it an idiot, which it is, but due to its numbers it is a very influential idiot. And we shall have to continue to look elsewhere than to radio for serious compositions executed subsequent to the reign of good Queen Victoria. "Exotic" composers of the ilk of Strawinsky will, we grant, not be heard via radio for another twenty years; not until they are as commonplace and acceptable as the once bizarre Debussey.

ALMA PETERSON AND KATHRYN BROWNE

Two artists of the Chicago Civic Opera Company who are being featured in a series of Wednesday night programs through the Chicago Evening *American* studio of KYW, Chicago. Miss Peterson is a dramatic soprano and Miss Browne a contralto. They are heard through KYW from 7 to 8, Chicago time

THE TOLLEFSEN TRIO AT WEAF

These artists are heard as a part of the "Vikings" broadcast through WEAF and associated stations on Tuesday evenings from 8 to 8:30 eastern time. In the illustration: Mme. Augusta Tollefsen, pianist; Carl H. Tollefsen, violinist, and Paulo Gruppe, 'cellist

But what of the less frequently heard works of the hundred-per-cent-non-exotic composers that the radio audience has come to accept, composers such as Beethoven and Chopin, Brahms and Tschaikowski. Please, Oh Maker of Studio Rules, can't we sometimes be permitted one of their unfamiliar works? The ten or so titles that each one of them has succeeded in sneaking on to your white-list are becoming so tragically shopworn. Believe it or not, every one of them has twenty or more works in published form that are quite as "simple in melody and universal in appeal" as the few to which you have given your OK. And how can a piece help but be "familiar" if it is played often enough, and furthermore how, oh how, can a piece ever hope to gain that cherished goal of being "familiar" if it's never given a chance? It is a dreadful *impasse*!

The Banquet Broadcast Nuisance

IN THE November department you may remember, we had remarks to make concerning the extraordinary badness of the printed publicity emanating from radio stations. None of it, with about three or four exceptions, is worth the paper it is printed—or mimeographed—on. One of these exceptions is *The Gold Medal Station News*, a monthly publication of WCCO which is mailed to that station's listeners as well as to radio editors. The sheet is edited by H. A. Bellows, WCCO's manager, and he can invariably be counted on to make interesting comment on current radio affairs. We have long been bored by the broadcasting of banquets—the which still persists in the hinterlands—and Mr. Bellows decisively sets forth their shortcomings in the current number of the abovementioned *News:*

"Almost every day we receive one or more requests to broadcast banquets or similar meetings. Two or three years ago, when broadcasting schedules were hard to fill, there was a good deal to be said for sending out programs of this sort, but to-day, except in the rare instances in which banquets or meetings are arranged primarily for radio purposes, the listeners are properly indignant when they are asked to tune-in on broadcasting of this sort.

"If the sponsors of the average banquet could but realize the unfavorable reaction of the average listener to such broadcasting, they would never again ask for the privileges of the air. They do not hear the clatter of dishes, the insistent noise of the crowd, the lamentable waits, the uneven transmission, the echoes and the disturbances which irritate the radio listener; they do not stop to think that a thirty-minute speech, which may be only mildly dull while one is comfortably digesting a too large meal, is simply intolerable when it comes out of the loud speaker.

"Furthermore, the attempt to broadcast a banquet often spoils the affair itself. The speakers cannot freely address the people before them; they must talk steadily at the microphone. Much of the spontaneity which is the life of any banquet must be deliberately killed if the broadcasting is to progress with any approach to smoothness. The army of waiters must be silenced at the very moment when people want their empty coffee cups removed. Something of the deadened (why not frankly call it funereal?) atmosphere of the broadcasting studio must be introduced into the banquet hall, to the immense discomfort of everyone concerned.

"Of course there are rare exceptions. A banquet, like the huge affair of the radio industries in New York on September 15, may be definitely built around the idea of broadcasting. But if those responsible for the ordinary banquet could have attended one of the executive committee meetings preparatory to this radio dinner, and could have noted how every detail was resolutely subordinated to the requirements of good broadcasting, they would realize how far the usual affair falls short of these essentials.

"Luckily, more and more people are coming to realize that broadcasting a complete banquet is just as dull as printing in the newspapers verbatim copies of all the speeches, from 'Unaccustomed as I am to public speaking' down to the last tremulous 'I thank you.' They are learning that such broadcasting stirs up definite illwill, and so is undesirable publicity. There are, however, many who have not yet discovered this fact, and until all the banquet committees in the Northwest have found it out for themselves, there will be times when the manager of the Gold Medal Station would gladly sell his job for thirty cents in cash and a hiding place out of reach of the telephone."

The Log of a Listener

RANDOM discoveries while running around the dials the other night:

WOC, Davenport, Iowa—a report on the direction of flight of a flock of ducks sighted over Davenport, which must have been of valuable information to sportsmen, though it strikes us as a dirty trick on the ducks.

WSBT, South Bend, Indiana—"Well, folks, we want anybody who can do anything, play a mouth organ or something, to just please drop around here at the studio and . . ." So that's where they get their material!

WJAX, Jacksonville, Florida—". . . and this number is dedicated to . . ." But that's as far as we listened.

KOA, Denver—A talk by William H. Crawford, for twenty-five years confidential representative of the New York *Times*. Reminiscences of personal contacts with Pope Pius XI, Warren Harding, Calvin Coolidge, King Albert of Belgium, and the Prince of Wales. An interesting talk in spite of an obvious flavor of the manuscript in the speaker's phraseology.

KFQB, Fort Worth—Two of our pet abominations: a reading of telegrams and then a "for our next selection we will play *for you* . . ."

WSMB, New Orleans—Two knock-out dispensers of jazz-as-we-like-it. The Liberty Theater Syncopators playing some marvellous variations on the good old tune "Valencia," and then Buck Jones and his "Radio Revellers" in a fine demonstration of well-orchestrated dance music.

Communication

MR. JOHN WALLACE, Conductor,
The Listeners' Point of View.
SIR,

I read with great interest your article in the September RADIO BROADCAST entitled "The Curious Jargon of the Broadcasting Industry." I share your respect for these venerable terms "sign off" and "stand by"; but, after all, the latter has always seemed to me rather incongruous. Whenever I hear an announcer say "Please stand by," this always suggests to me a mental picture of a vast concourse of people, obediently rising to their feet, and "standing by," as though band were playing our National Anthem, or the home team were about to begin the seventh inning, which seems more probable.

Apropos of all this, hark you to the following.

A GROUP OF LISTENERS IN SAMOA

Natives of Pango-Pango, Samoa, listening-in on a Fada outfit supplied by Phil A. La Brie, who is touring the Far East introducing radio where it has not yet been generally accepted

During the recent fistic combat in Philadelphia, one of our local stations, while giving a detailed account of the affair from telegraphic reports, was responsible for the following gem of perfect politeness and precision: "Please sit by for the next round." Please sit by! The very term suggests solid comfort and relaxation, does it not? May not sitting be considered as the natural position of the great majority of listeners? But be that as it may. My object in writing was merely to call to your attention this unique example of the ever-changing terminology of radio.

Sittingly yours,
LEWIS G. PRAHL
Milwaukee, Wisconsin.

Broadcast Miscellany

TWO Canadian stations, CNRM, Montreal, and CNRO, Ottawa, are now being hooked up for a simultaneous broadcast on one night of each week. Of the four programs thus given in November two originated in Ottawa and two in Montreal. It is expected that the "chain" will soon be extended to include CNRT.

ON SUNDAY nights at 8 o'clock (EST) is being heard from WJZ a series of recitals by John DeBueris, a leading performer on the clarinet and basset horn. The clarinet is especially well adapted to radio reproduction and Mr. DeBueris' programs are well selected. The soloist has been a member of the Victor Herbert Orchestra, the Metropolitan Opera House orchestra, and, most recently, the Goldman Band.

FOLLOWING a tour of Europe H. V. Kaltenborn of the Brooklyn Daily *Eagle* has resumed his series of weekly talks on "Current Topics" via WOR Monday evenings at 8:30 (EST), the which we recommend to you. Commenting on letters from listeners, Mr. Kaltenborn, who has received a fair share of them, says:

"Applause letters are going out of fashion. More's the pity. Everyone who speaks, sings, or plays over the air needs the reaction that can only come from unknown listeners. When we face an audience its applause, interest, laughter, or its listlessness, restlessness, or frowns tell us what it likes or does not like. We know when it agrees and when it dissents. We can fight it when we must, coddle it when necessary, or wake it up by extra effort. But when we have done our bit over the air we don't know what the wild ether waves have been saying until the mailman brings the cheers and the knocks.

"Although I have been giving weekly talks over the radio for three years, I never got rid of a sneaking suspicion that I was wasting my oratorical fragrance on the studio air until I got my first reaction from someone who actually heard my talk."

WEAF has arranged a program especially designed to please the Saturday night listener entitled "The WEAF Revue." As its name suggests it is sixty minutes of rapidly changing events and to a degree serves to sum up all that has passed over WEAF's waves in the days of the week preceding it. The program includes old-time songs, hits and bits of comic opera selections, vocal and instrumental selections from grand opera, a little modern jazz and comedy, both musical and otherwise. In other words: a radio variety show for them as likes variety shows.

ALSO on WOR's program is an excellent quartette composed of Messrs. Christie, Gannon, Barnett, and Seebach. They are to be heard at 8:00 P. M. (EST) on Sundays. A typical program will run something like this: "Dinah," "Stars of the Summer Night," "Deep River," "Banjo Song," "Can't You Hear Me Calling, Caroline," "I'll Take You Home Again," etc.

IF, WHEN the Atwater Kent Sunday evening concert draws to a close, you feel like more music in kind, you have only to tune-in on WJZ, WRC, WGY, WBZ, or KDKA and listen to the Maxwell House Coffee Hour, which begins at 10:15 P. M. (EST). There are to be ten concerts in all, sponsored by this manufacturer, of a nature and quality much the same as the venerable Atwater Kent hour.

The artists who have signed contracts to appear in this series include among others, Efrem Zimbalist, violinist, who has been released for this broadcast through the courtesy of the Victor

Talking Machine Company; Marie Sundelius, soprano; Johana Gadski, soprano; Sophie Braslau, contralto; Toscha Seidel, violinist; May Peterson, coloratura soprano; Moriz Rosenthal; Isa Kremer, the Russian lyric soprano; also the Fisk Jubilee Singers and the noted Ukranian Chorus. Throughout the entire series the solo artists will be supported by a twenty-two-piece symphony orchestra under the direction of Nathaniel Schilkret.

WGY is proving a valuable training school for radio announcers. A few months ago George Markham, formerly in charge of the agricultural hour at WGY, left to become general manager of WDBO, at Winter Park, Florida. Now Witter T. Cook, a graduate of Massachusetts Institute of Technology, more recently an announcer of WGY and one of the WGY players, has accepted a position with the air forces of WDAE at Tampa, Florida.

THE Eveready Hour's broadcast of *Show Boat* a month or so ago proved to be one of the best of the novelties they have yet offered. An abbreviated version of the Edna Ferber story was arranged and Lionel Atwill read the narrative. When the progress of the tale called for one or another of the characters to speak, a different voice was heard and the rôle was carried much the same as in a regular radio "play." A background of music was provided throughout with occasional interludes of straight music, such as the variety show on the boat or the crooning singing of the darkies on the levee. The whole job evinced thorough preparation and was distinctly one of the two or three best novelties we have yet heard. In fact, we enjoyed it more than the book.

BY FAR the best of the radio book reviewers is Oliver M. Sayler. For a long time he has been giving a weekly review of plays and books through WGBS in what is called the "Footlight and Lamplight" broadcast. Mr. Sayler is the author of several valuable books on the theater. The plays he reviews are, of course, those current in New York. And each week he comments on three or four of the recently published books. These comments combine sound criticism with an entertaining manner of presentation. An idea of his style of speaking can best be given by a random quotation from a recent broadcast:

". . . The *Silver Stallion*, on the other hand, carries you so far back into the past that I for one doubt whether it ever did exist except in the strange mind of its author, James Branch Cabell. Without a word of warning you are whisked away into a land of ogres and miracles, a land of gay, sardonic men and rather helpless but beguiling women. Five times I tried to get started on this book and stopped. I gritted my teeth and went at it. Fifty or so pages and I was so wrapped up in the thing that you couldn't have torn it from me. And so, if you are awarded *The Silver Stallion* at your next bridge party, don't get discouraged. Break down the wall and enjoy the pageant the author has prepared for you.

"That pageant is misunderstood if you think of it only as a fairy story or as an attempt to imitate the old French legends. It is merely Cabell's way of saying things about life to-day that few would heed if he said them in common dress. Most of these things are iconoclastic. In this book you will find the bitterest, most devastating and scornful attack on woman that has been penned in modern times. And a thorough drubbing for the whole notion of heroes and hero-worship. If some woman writer doesn't rise to the challenge of *The Silver Stallion* I'll begin to think the things Cabell says of the sex are true!"

"Footlight and Lamplight" is broadcast Thursday evenings at 8:30 (EST)

THE advance program of WGBS, thanks to the inspiration or maliciousness of some compositor, recently carried a headline reading:

NANCY WILSON? 'CELLIST? ON AIR TUESDAY EVENING

As a matter of fact, Nancy Wilson is both Nancy Wilson and a 'cellist. But the typesetter's error (and our listening experience) suggests that the dubious mark might often and honestly be used in connection with a radio performer's alleged talent. For instance:

Waldo Slithers. . . . . Radio Humorist?
Olga Schlitz . . . . Lyric? Soprano?
Thomas Peep. . . . . Famous? Piccolo Player?

FOR the first time, we take occasion to felicitate a broadcasting station on its birthday. WBAL celebrated its first anniversary November 1. WBAL set out with the intention of being a distinct personality among broadcasting stations, and in the space of one year has well achieved this purpose. For a year it has been broadcasting evening programs ninety-nine per cent. of which have been purely musical. In addition to a "no-jazz" policy to which it has steadily clung, WBAL has also sought to distinguish itself by maintaining entirely its own staff of broadcasting features and refusing to depend on outside hook-ups to put over its programs. In short, the station has specialized, and concentrated its attention on a particular class of listeners, which is what we would have every station do regardless of what class it chooses to please.

THE STAFF OF WBAL, AT BALTIMORE

This broadcaster has established a strong place in its first year of operation because it has followed a policy which amounts to specialization. From left to right, seated: John Wilbourn, assistant studio manager and tenor ballad singer; George Bolek, program supervisor and staff pianist; Stanley W. Barnett, studio manager and announcer; Frederick R. Huber, director of broadcasting; standing: Gustav Klemm, program supervisor and director of WBAL concert orchestra; James Wilkinson, announcer and baritone

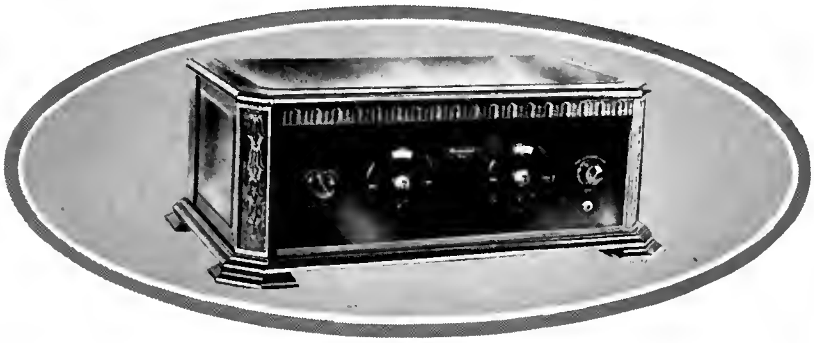
WGN'S DRAKE HOTEL CONCERT ENSEMBLE

This excellent hotel orchestra is heard each day and evening playing during the station's luncheon and dinner concerts. Left to right: Leon Benditzsky, pianist; Armand Buisseret, violinist; Henry Selinger, violinist and director; Frederick Meinken, organist; Leon Lichtenfeld, 'cellist; Edward Karstens, bass 'cello

The "Hi-Q" Receiver

By LESLIE G. BILES

The Latest Development of the Popular Hammarlund-Roberts Receiver, with Shielded R. F. and Detector Stages



READY FOR SERVICE

Resplendent in a polished cabinet, the "Hi-Q" is—to use the vernacular—"all set" for action

Automatic Coupling Between Primary and Secondary Tuned Coils Is Attained as Condenser Dials Are Turned

IT WAS in November, 1925, that RADIO BROADCAST described the first Hammarlund-Roberts Receiver. Since then, new design features have come into common use and many of these recent advances have been combined in the new Hammarlund-Roberts "Hi-Q" Receiver illustrated in this article.

The original Hammarlund-Roberts receiver consisted of a stage of tuned neutralized tuned r. f. amplification, a regenerative detector, and a two-stage transformer-coupled audio frequency amplifier. The "Hi-Q" receiver consists essentially of two stages of neutralized, tuned r. f. amplification, a non-regenerative dectector and a two-stage transformer-coupled audio amplifier. Because of the additional stage of r. f. amplification, the use of a new type detector tube, and several other improvements, in sensitivity and selectivity this new receiver represents a considerable advance over the original model. In bettering the receiver, the designers have kept in mind the advisability of simplicity of control and, therefore, we find this receiver with only two main tuning dials. The only other apparatus visible on the front panel is a tapped antenna switch, a volume control, and an output jack.

The new and interesting features in this receiver make the editor of RADIO BROADCAST feel that it is well worth while to outline these features in a general way, and also to give some information concerning the arrangement of the apparatus. It is not intended to give complete constructional data in this article but rather to acquaint home constructors with the general features of the receiver. Even so, the experienced home constructor will find sufficient information in the various pictures and diagrams to build the set.

Briefly, this receiver incorporates the following features:

FIRST: Dual tuning whereby three tuned radio frequency circuits are controlled by only two dials, making the tuning quite simple.

SECOND: Complete shielding of the radio frequency circuits so as to prevent direct pickup by the coils of the receiver, and unwanted interstage coupling.

THIRD: Automatic variation of the coupling between the primary and secondary coils of the radio frequency transformers so as to obtain high efficiency.

Fourth: A high efficiency detector circuit which permits the use of the new type 200-A detector tube.

FIFTH: Arrangement of the circuit so as to permit the use of a semi-power tube in the output.

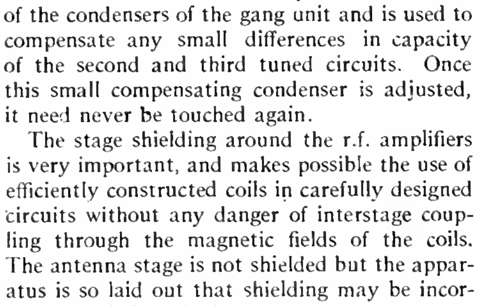
These various features are taken up in more detail in the following paragraphs.

As mentioned above, the receiver incorporates three tuned circuits. The antenna stage is controlled by the left-hand dial which operates a single variable condenser. The two tuned radio frequency circuits are controlled by the right-hand dial through the use of a gang condenser. A small variable condenser is in parallel across one of the condensers of the gang unit and is used to compensate any small differences in capacity of the second and third tuned circuits. Once this small compensating condenser is adjusted, it need never be touched again.

The stage shielding around the r.f. amplifiers is very important, and makes possible the use of efficiently constructed coils in carefully designed circuits without any danger of interstage coupling through the magnetic fields of the coils. The antenna stage is not shielded but the apparatus is so laid out that shielding may be incorporated if it is desired.

AUTOMATIC COUPLING VARIATION

AUTOMATIC coupling variation is becoming more commonly used, and, in the "Hi-Q" receiver, this coupling variation is accomplished automatically by mounting the primary coils on movable supports. On the rear of the variable condensers there are placed small cams, and, when the condensers are turned out, these cams function to push the primary coil further and further away from the secondary coil. The coupling between the two circuits is loosest when the variable condensers are set to receive the high frequency, or short wavelength, stations.



FIXED VERSUS VARIABLE COUPLING

This diagram clearly shows the advantages which accrue from the use of some form of variable coupling between the primary and secondary tuned coils

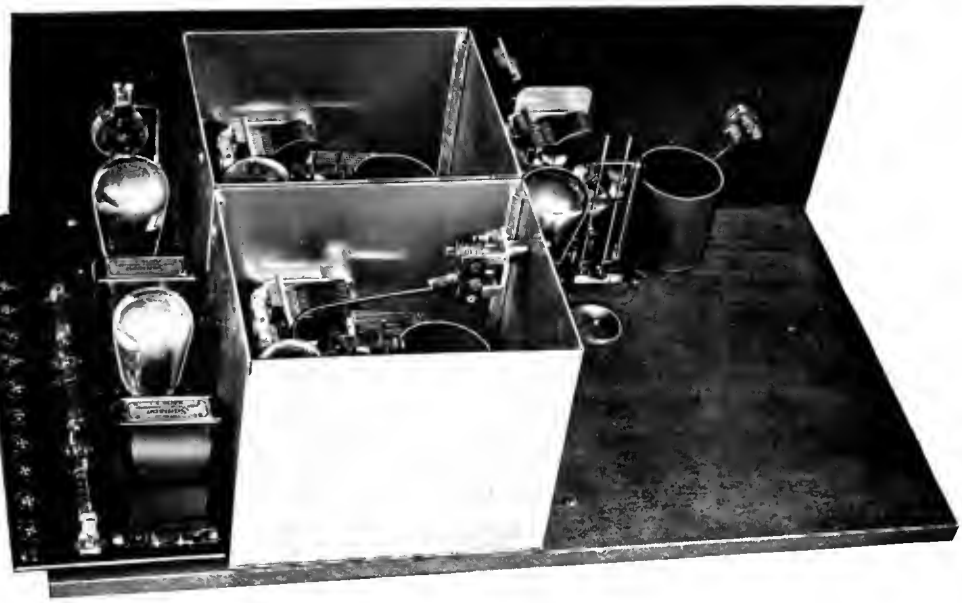
The reason why this coupling variation is necessary is that in most tuned radio frequency receivers the amplification on the long wavelengths is very poor in comparison to the amplification on the shorter wavelengths. This disadvantage of uneven amplification can be overcome by increasing the number of turns on the primary of the radio frequency transformers. Generally, however, when this is done, the receiver will break into oscillation on the shorter wavelengths, hence the problem is to obtain high gain on the longer wavelengths by the use of large primaries, but to arrange the circuits so that oscillations do not occur when short wavelength stations are being received.

Loosening the coupling between the primary and secondary coils has practically the same effect as decreasing the number of primary turns. The designers of this receiver have made it possible to obtain the essential variation in coupling without the use of any extra controls. The coupling is loosened just sufficiently to prevent oscillation on all wavelengths as they are received, and, as a result, the radio frequency circuits are always working at a point slightly below maximum amplification.

The detector circuit, as mentioned above, has been arranged for the use of a 200-A detector tube. When this tube is used the detector circuit must be slightly different than when a 201-A is to be the detector, in that the grid leak return must then connect to the positive filament. For a 200-A, it must connect to the negative filament. The 200-A detector tube is quite sensitive and will give considerably greater signal strength than can be obtained when using a 201-A although there is some attendant tube hiss with the more sensitive tube.

The output has separate B and C battery terminals so that any type of tube may be used in the second stage of audio. If a 112 tube is used the C battery voltage should be 9 for 135 volts of B battery and $10\frac{1}{2}$ for a plate voltage of $157\frac{1}{2}$. A 171 tube may also be used, providing a special arrangement in the output circuit is incorporated.

All types of tubes may be used in the receiver. The circuit arrangement is such as to make this easily possible. The two r.f. tubes have a fixed resistance in series with the volume control so that, for different types of tubes, fixed resistances may be used so as to obtain the correct filament voltage. The detector, and first and second audio stages, have separate filament control resistances so that changing these will permit the use of any type of tube. The designers recommend the following tube combinations:



A DIFFERENT ANGLE

Of the same receiver shown below, but photographed before it was placed in a cabinet

COMBINATION No. 1

UX-201-A or CX-301-A in sockets No. 1, 2, 3. and 4
UX-112 or CX-312 in Socket No. 5.
1—6-Volt Storage A Battery.
3—45-Volt B Batteries.
2—4½-Volt C Batteries.

COMBINATION No. 2

UX-201-A or CX-301-A throughout.
1—6-Volt Storage A Battery.
2 or 3-45-Volt B Batteries.
1 or 2—4½-Volt C Battery.

NOTE: If only 2 45-volt B batteries are used, only one 4½-volt C battery is necessary, and the two negative C battery binding posts should be connected together. The + 90-volt and + 135-volt binding posts should also be connected together.

COMBINATION No. 3

UX-12 or CX-12 throughout.
1—1½-Volt Dry Cell A Battery.
2—45-Volt B Batteries.
1—4½-Volt C Battery.

COMBINATION No. 4

UX-199 or CX-299 throughout.
1—4½-Volt Dry Cell A Battery
2—45-Volt B Batteries
1—4½-Volt C Battery.

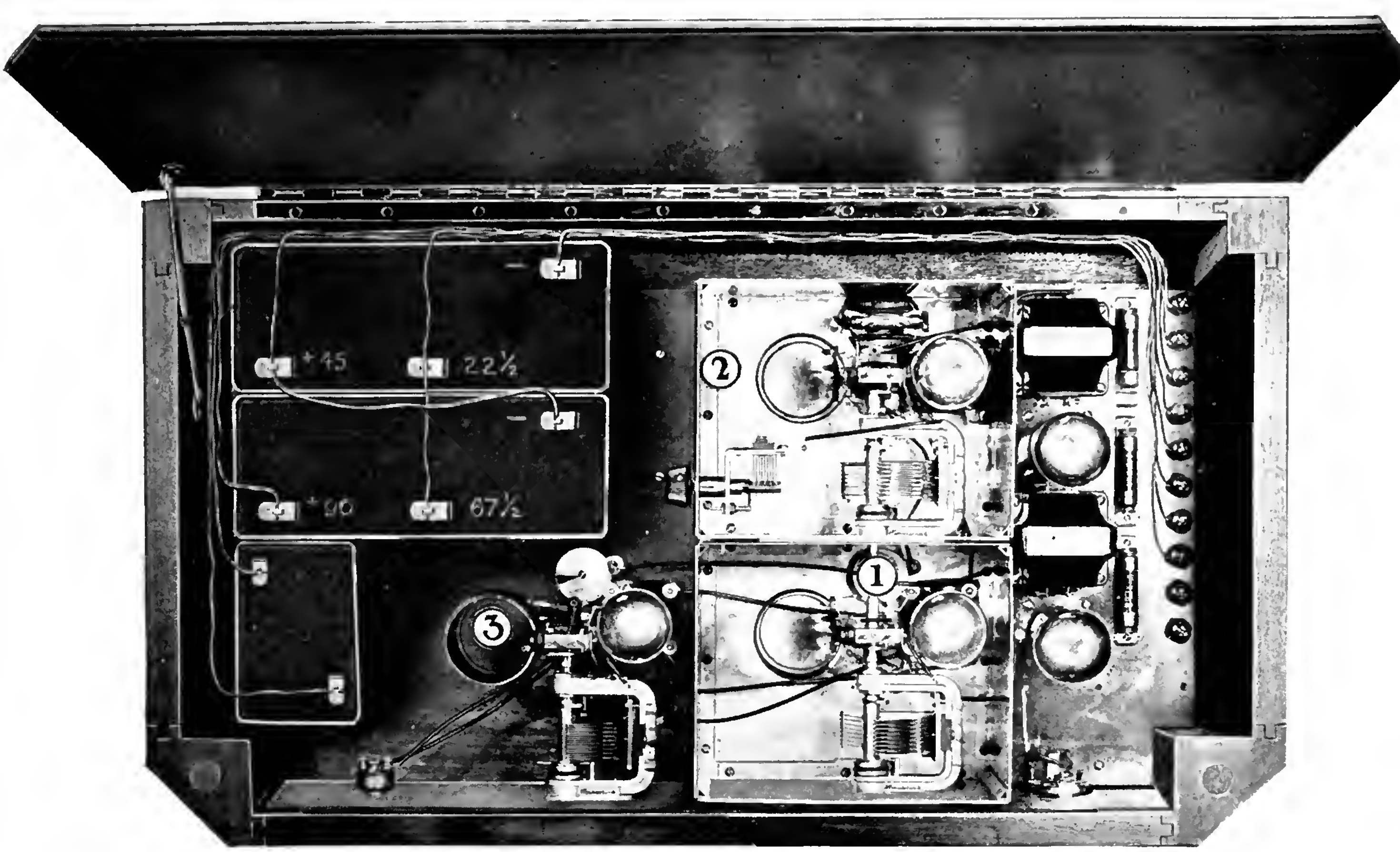
COMBINATION No. 5

UX-199 or CX-299 in Sockets Nos. 1, 2, 3, and 4
UX-120 or CX-220 in Socket No. 5.
1—4½-Volt Dry Cell A Battery.
3—45-Volt B Batteries.
1—22½-Volt C Battery.
1—4½-Volt C Battery.

In combination No. 1, a 171 or 371 may be substituted for the 112 or 312. If a 171 is used, it will require a 40-volt C battery and four 45-volt units for the B battery. The 40-volt C battery should have its minus connected to the terminal marked—C. The plate current of this type tube is quite large, and it cannot be safely passed through the windings of the average loud speaker It is recommended that if this tube is used, a choke coil, such as is used in B line power-supply devices, be placed directly across the terminals of the loud speaker jack. As the resistance of the loud speaker winding is considerably higher than the resistance of such a choke, practically all the plate current will pass through the choke coil and so prevent the loud speaker windings from being damaged. At the same time, the impedance of the choke coil to the voice currents is very high, so that all of the signal energy will pass through the loud speaker. and no loss of volume will be noticed.

ROBERTS NEUTRALIZATION

THERE are a few more notes concerning this receiver which should be of interest. In the first place, both of the r.f. stages are neutralized by the well-known Roberts method of neutralization. By equalizing or neutralizing the r.f. stages in this way, the electrostatic feed-back through the capacity of the element of the tubes is eliminated, and oscillations of the r.f. amplifier are prevented. The equalizing condensers are conveniently located so that they can be adjusted with

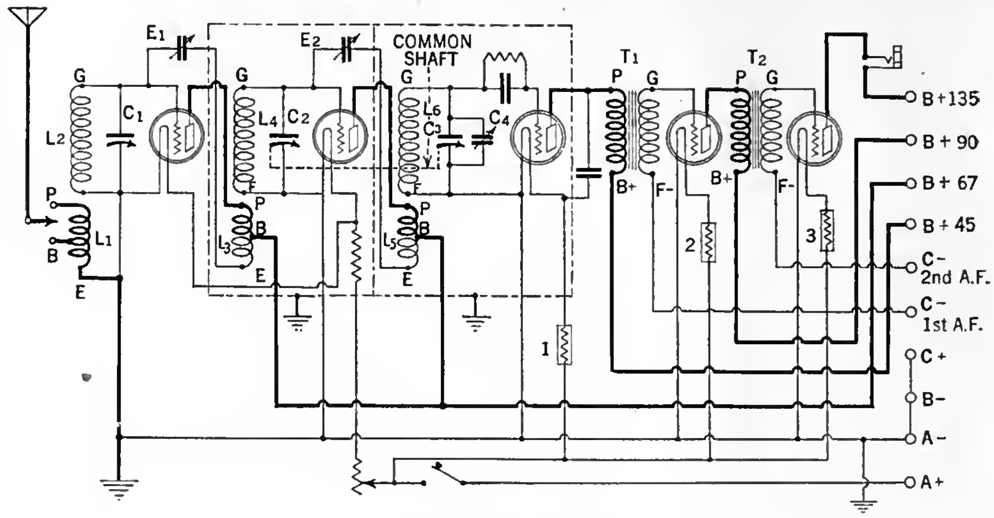


BENEATH THE LID OF THE HAMMARLUND-ROBERTS "HI-Q" RECEIVER

The layout of the apparatus has been carefully thought out, and every unit has been placed to best advantage. The numbered sections are the second r.f. stage, detector stage, and first r.f. stage respectively the aid of a long stick sharpened like a screw driver at one end. The use of a metal screw driver is apt to affect the setting or, in slipping, might very easily cause a serious short circuit, and should never be employed for this purpose. The antenna circuit is equipped with a tap switch so that either a long or short antenna may be used.

The photographs and circuit diagrams in this article illustrate the arrangement of parts. The list of parts used in this receiver is given below:

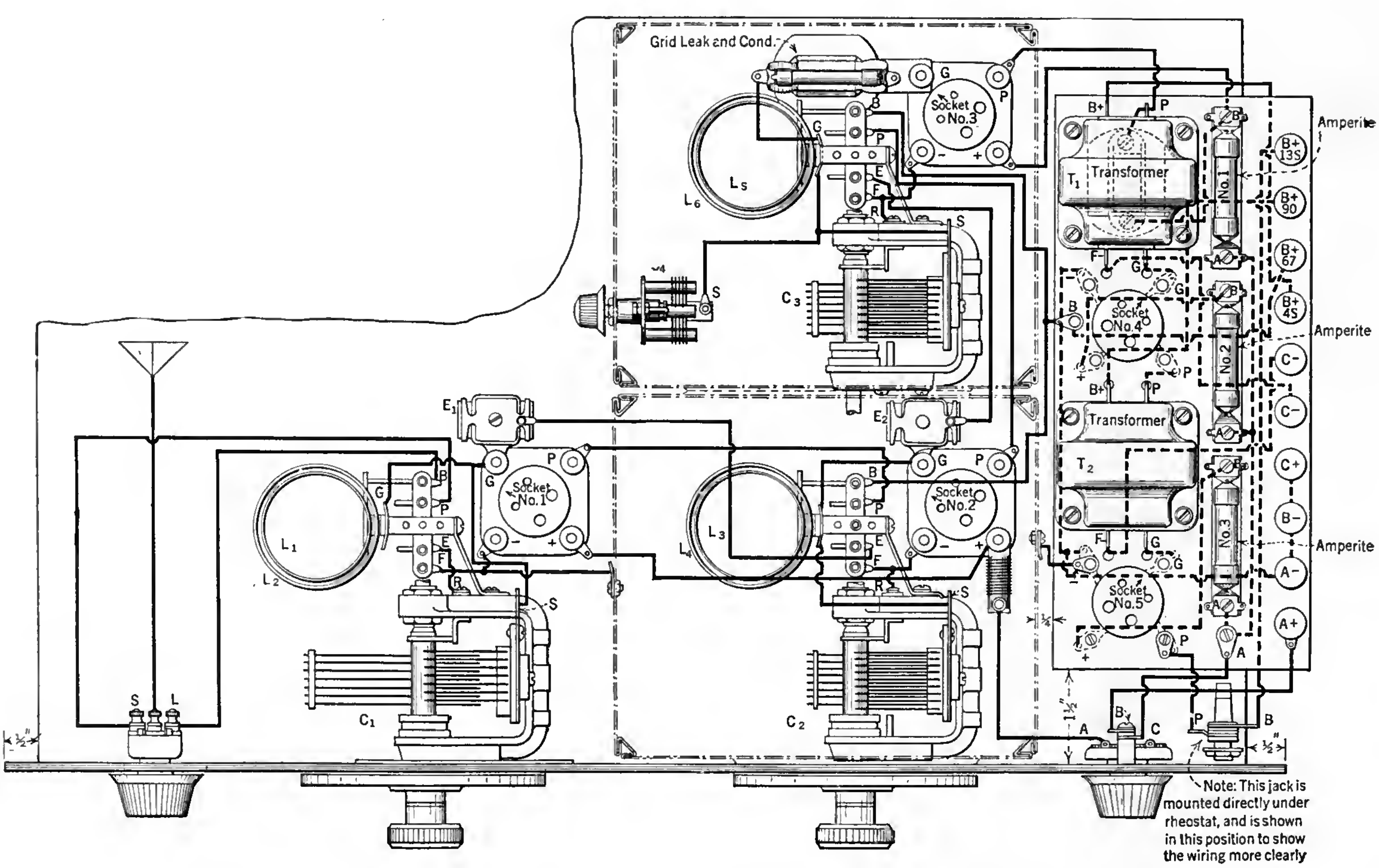
2—Samson Transformers, Type HW-A3 (3-1 ratio)	$10.00
3—Hammarlund 0.00035-Mfd. Midline Condensers	14.25
3—Hammarlund Auto-Couple Coils (Set of 3 Coils)	10.00
1—Hammarlund Jr. Condenser, 9 plates, 32 Mmfd.	1.80
2—Mar-Co No. 192 Vernier Dials	5.00
3—Benjamin No. 9040 Sockets (With Bases)	2.25
2—Benjamin No. 9049 Sockets (Without Bases)	1.00
2—Amperites, No. 1A (With Mountings)	2.20
1—Amperite, No. 112 (With Mounting)	1.10
1—Carter No. M-10-S Combined Rheostat & Filament Switch, 10-Ohm	1.00
1—Carter No. 1 "Short" Jack	.25
1—Carter No. 12 "Imp" Aerial Switch	.70
1—Sangamo 0.00025-Mfd. Fixed Condenser	.40
1—Sangamo 0.001-Mfd. Fixed Condenser	.50
1—Pair Sangamo Grid-Leak Clips	.10
1—Durham Metallized Resistor, 3 Megohms	.50
10—Eby Engraved Binding Posts	1.50
1—Hammarlund-Roberts Hi-Q Foundation Unit (Containing drilled and engraved Westinghouse Micarta panel, drilled Micarta subpanel, two complete shields, two equalizers, extension shaft, resistance unit, wire, screws, nuts, and all special hardware required to complete receiver).	10.50
TOTAL	$63.05



THE CIRCUIT DIAGRAM

Note that the grid return of the detector tube connects to the negative filament post. This is for a 200-A tube

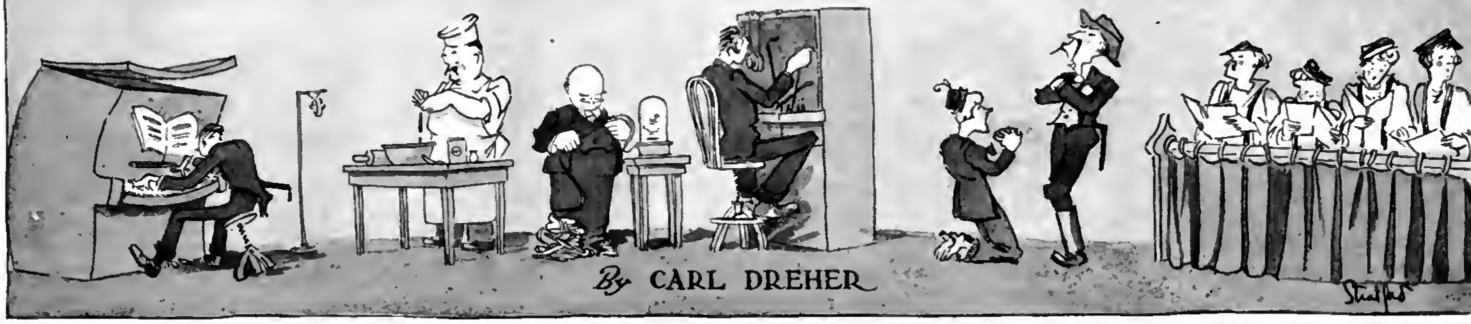
The above set of parts have been placed on the market in complete kit form at the price indicated at the foot of column of individual prices. A booklet, giving point to point connections, and many other useful data, has been published by Hammarlund-Roberts, Incorporated.



A PICTURE DIAGRAM OF THE THEORETICAL CIRCUIT SHOWN ABOVE

The dotted lines clearly show the position and arrangement of the two shields in both diagrams. The lettering on the coil units corresponds to that which will be found on the commercial units

AS THE BROADCASTER SEES IT



By CARL DREHER

Why Censorship of Programs Is Unfortunate

IN 1923, the New York *Times* expressed the then-prevalent attitude of broadcasters toward controversial material in the following words:

"The radio audience is so large and represents such a varied interest that the censor must eliminate anything which might injure the sensibilities of those listening."

Of course if this idea were strictly followed nothing verbal could be broadcast, except the alphabet, market reports, and bedtime stories for children. If anything has been definitely established it is that some people can manage to be offended, no matter what precautions are taken to keep them happy. The lengths to which they will go, in an effort to find something to become sore about, are almost incredible. One such sufferer recently wrote to a newspaper protesting against the exhibition, in the New York Aquarium, of a jewfish and a porkfish, as a slur against the race of Israel. Maybe some humorist on the staff of the paper wrote the letter, but, if so, he did not carry the idea to a more absurd extreme than one sometimes finds in practice.

Since 1923 we nave been getting away, to a great extent, from the idea of complete, meticulous inoffensiveness in broadcasting. It will take only a few more universal pannings like the one recently received by the British Broadcasting Company when it refused to broadcast George Bernard Shaw's birthday speech unless the author refrained from saying anything controversial, to bring about a sane attitude toward this problem.

The time of a broadcasting station is worth money, and not everyone can be allowed to broadcast. But when a man of admittedly distinguished sapience and eminent position is refused the privilege of talking to several hundred thousand people eager to hear him, simply on the ground that some listeners may not like his opinions, the situation becomes so absurd that all sensible people must feel the impulse to throw their radio sets out of the window. Are robust, adult individuals, who want grown-up intellectual fare and can stand seeing others eat something they may not care for themselves, to be left out of consideration altogether? The timorous broadcasters who raise their hands in horror when some Brann of the ether wants to call a spade a spade make me, for one, rather tired. Is life worth living at all if one is always in a sweat about "adverse criticism" and a possible brick heaved through the window? It may be to the infirm and the aged, but surely broadcasting is not exclusively in the hands of valetudinarians. And, from the business standpoint, is there not as much danger in boring everyone with a respectable intelligence quotient, by radiating only what is dull and safe, as in taking a chance with the "Old Subscriber" and "Pro Bono Publico" class?

The present trend toward freer expression on the air will continue, I believe, until one can say in a broadcasting studio whatever is written by the editors of newspapers, or spoken by publicists, or printed in books. Those who do not like what is said by some speaker at some station will have to listen and make the best of it, or tune-in elsewhere, or retire to the Aleutian Islands, where the seals will not offend them with unwelcome ideas. Whatever problems are raised by a reasonable progress toward freedom of expression, whatever difficulties crop up, whatever the cost of that development, it is better to proceed resolutely than to be reduced to the ultimate absurdity of trying to please everyone in a world full of contention, competition, and diverse opinions. If broadcasting is to reflect life it must accept life.

Deterioration of a Word

IN THE popular lingo, the word "static" has come to mean simply "noise." Originally the term had a specific meaning in the radio field: disturbance in reception caused by natural electrical discharges. That was when radio still occupied her secluded niche in the temple of technology. Then the saint was dragge forth into the market place, and worshippe by the many in place of the few. Th motley crowd that now pressed agains her lacked the feeling for niceties in defi nition which had characterized the priests and "static" came to be applied to an racket issuing from a loud speaker. Unde this heading were crowded indiscriminatel all the rich varieties of noises, natura and artificial, which radio is capable o producing. Finally, as a figure of speech "static" was lifted out of radio alto gether; the word is now mouthed alon Broadway by every vaudeville comedia out of a job (or in the job when he ha one), and his wit is copied by all the door openers, taxi-drivers, and waitresses. Onc a chaste and restricted expression, it no means anything and belongs to everybody Once a problem which haunted the sleep less nights of great engineers, it now pro vides a derisive epithet for the countles thousands whose brains are never awake.

Concerning B. C. Operators

IF I may be permitted to intone an ex hortation to my fellow knob-turners o the broadcast control rooms, it will b in the direction of urging them, one an all, to learn something about the quantita tive side of what they are doing. To many broadcast technicians, when aske how they would accomplish something o other in their business, answer in suc phrases as the following: "You connec the line to a 77-Z amplifier and the outpu of that goes to a pad and from the pa you connect to a 23-X equalizer. The you also have a 46-PQ monitorin amplifier and 199538-TT loud speaker.' And they go on and on, telling how unit are connected according to blueprints without really knowing why and wherefore The actual essential relations of the equip ment, the operating boys tend to leave t the design engineers.

This is all wrong in a number of ways Intricate equipment of the sort used i broadcasting can only be intelligently operated by men who know the design background. They need not be conversant with all the factors which agitate and perplex the design man, but they must know something about the quantitative conditions of the final product, or they might as well yield their places to stenographers. Many an intelligent girl who serves industry for $30 per week could be trained to operate a broadcast station when it is running right, quite as well as some of the operators who think in terms of type numbers and add a smattering of badly sent Morse to this talent. In science and technology, you know nothing unless your knowledge is in quantitative form. Those individuals who stop with clamping wires under nuts will keep right on doing so until they become too old to read the inscriptions next to the binding posts. Progress is limited to those who know a little more than they must know in order to keep the station on the air. The robots aforementioned may be usable in some industries, but I predict that their days in broadcasting are numbered. Twice a year enterprising young men swarm forth out of the high schools and colleges, and some of them head for the broadcasting stations. They radiate question marks, and think in terms of TU's, rotating vectors, and integrals. What chance has a poor wireless operator against them? A lot, I venture to answer, if . . . if he spends a few hours a week reading the proceedings of the engineering societies, the technical telephone reviews, and the like. None at all, if he devotes those hours to rolling the bones and perusing the fifteen-cent fiction weeklies. Let the boys think it over before they find themselves back in the mess-rooms of 3000-ton freighters, with the bright lights and liberty far, far away across a tossing horizon.

Technical Notes of Interest to Broadcasters

WORLD RADIO for July 30, 1926, contains a brief description of "A New Microphone," forwarded by the Riga correspondent of the publication. It is the invention of a Russian professor, M. Bonch-Bruievich, who explains that it consists of "an extremely fine membrane between two perforated condenser plates. The plates are charged with a constant high-tension current, and the membrane is connected to the grid of the valve. In order to secure the best results, it is necessary to have a special amplifier which amplifies the highest notes more than the low ones." This is, of course, a characteristic of electrostatic transmitters in general, of which this is a special form. From an accompanying photograph it appears that this condenser transmitter is three or four times as large as American types. Presumably the object of placing the diaphragm between two plates, instead of adjacent to one only, is to secure a greater variation in capacity and to generate a higher audio e.m.f., by utilizing a push-pull principle. As the diaphragm withdraws from one plate, it approaches the other, decreasing the capacity in the first space and increasing it in the other; both of these changes may be used to generate an audio potential, and by suitable connections these potentials may be added. This theory of operation is not part of the short article in *World Radio*, and may be far from the mark. In any case, the constructional complications of Prof. Bonch-Bruievich's double condenser transmitter must be serious, and only very marked electrical advantages could outweigh this fault in actual broadcast service.

A NEW BOOK ON SOUND

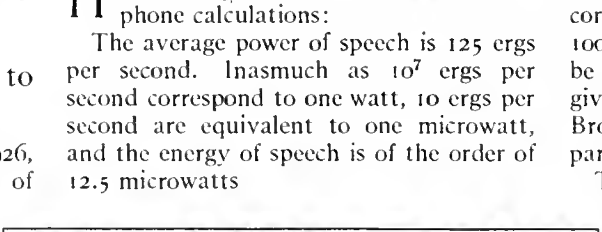
WITHOUT having seen a copy, I venture to say that I. B. Crandall's new book, *Vibrating Systems and Sound* (Van Nostrand & Co.), will contain much material of interest to technical broadcasters. The author is a well-known investigator in the field of electrical sound measurements, and some of his results in the Bell Telephone Laboratories have attracted wide attention among physicists and telephone engineers.

J. E. JENKINS and S. E. Adair, of 1500 North Dearborn Parkway, Chicago, issue a *Bulletin No. 1*, describing audio frequency apparatus in the line of microphone, output, input, and interstage transformers, as well as choke coils for audio circuits. The diagrams shown are of interest to broadcast operators.

TO BE PASTED ON THE WALL

HANDY figures to remember in telephone calculations:

The average power of speech is 125 ergs per second. Inasmuch as 10^7 ergs per second correspond to one watt, 10 ergs per second are equivalent to one microwatt, and the energy of speech is of the order of 12.5 microwatts



DR. ALFRED N. GOLDSMITH

Who gave a radio course at the College of the City of New York during the period from 1913 to 1918. He is now chief broadcast engineer of the Radio Corporation of America

Inasmuch as even with close talking only a portion of the total energy emitted by a speaker is absorbed by the microphone, the speech input to a telephone system is of the order of 1-10 microwatts.

A commercial telephone transmitter, being resonant to the mean speech frequency, amplifies the sound input by about 1000 times, corresponding to a gain of 30 TU's. The electrical output is therefore 1000-10,000 microwatts, or 0.001 to 0.01 watt (zero level).

A high quality carbon transmitter, with its vibrating system tuned to a frequency well above the ordinary speech band, lacks the amplifying qualities of the commercial microphone. It is about one one-thousandth as sensitive as the latter, corresponding to a level 30 TU's "down" (below zero level).

A normal high-quality condenser transmitter is down another 30 TU's approximately, and its energy output is therefore of the order of 0.01 microwatt with normal speech inputs.

In converting power ratios to gain or loss in TU's, it follows from the formula.

$$TU = 10 \log_{10} P$$

where P is the power ratio, that a TU of 10 corresponds to a power ratio of 10, a TU of 20 to a power ratio of 100, a TU of 30 to a power ratio of 1000, etc., since the logarithm to the base 10 of 10 is 1, that of 100 is 2, that of 1000 is 3, etc. Multiplying the power by 10 always indicates an addition of 10 TU's to the level; dividing the power by 10 requires subtracting 10 TU's. Since the voltage amplification ratio (if the impedance remains unchanged) is the square root of the power ratio, TU's corresponding to various voltage amplifications are also readily calculated mentally. For example, a TU of 20 corresponds to a voltage amplification of 10, a TU of 40 corresponds to a voltage amplification of 100, etc. Various other relationships may be worked out; some of these have been given in the "Technical Operation of Broadcasting Stations" articles in this department.

The usual gain of a telephone repeater is of the order of 25 TU's.

Broadcast telephone circuits are limited to inputs varying from zero level to plus 8 TU's to avoid cross-talk into parallel circuits.

Radio and Swinging Fists

BEFORE the government took charge of radio, back in 1912, resorts to the manly art, as a means of settling QRM disputes, were not uncommon. Insults and challenges were conveniently dispatched through the air, and actual hostilities sometimes followed. In other cases the prospective candidates for slaughter met as agreed, after threatening each other in astounding terms via Continental Morse, only to find, face to face, that they were both pretty decent fellows. The procedure was then to adjourn to the nearest saloon (there were saloons in those days) and to swap radio lies over the bar. Nevertheless, some eyes were blackened, and a certain amount of blood-letting undoubtedly occurred, in the primitive days of radio. The general opinion among the old-timers sucked into the whirlpool of broadcasting has been that the latter is an effete art, and many of them bewail the passing of the day when sopranos were unknown on the air and nothing could be heard but curt masculine dots and dashes.

This notion must now be revised. Reports come from Dortmund, in Westphalia, Prussia, that some months ago an altercation occurred at the local broadcast studio, as a result of which the director thereof was fined three hundred marks and costs. It seems that a humorist holding forth before the microphone included in his repertory an anecdote calculated to imperil the morals of the devout Westphalians. The program director of the station, his hair on fire, rushed into the studio and remonstrated with the artist, if we may call him such. He remonstrated, apparently, with his fists. It would have saved him some money if he had directed his fleet footsteps toward the control room and persuaded the operator to pull the switch and take the offending monologuist off the air.

Clearly, however, fights are still possible in radio, and the old-timers should not despair. If they live long enough they may see a few homicides under the antennas yet.

The "Lightning Jerker"

THE *Lightning Jerker* is a magazine devoted entirely to the interests of the professional radio operator. The editor is R. E. Nelson, and the office of publication 1110 Capitol Bldg., Chicago, Illinois. As far as size goes, the *Lightning Jerker* is nothing more than a pamphlet, but what it lacks in thickness it makes up in lucid, enlightening discussion of the professional radio operator's problems. These problems are concrete enough, and there is nothing pedantic or windy about the solutions of the operator-editors of the paper. Mainly devoted to marine radio at present, it is desirous of including B.C. men on its subscription list. They would do a lot better reading it than poring over the columns of *Hot Hound* or *Stupid Stories*.

Abstract of Technical Article

ABSTRACT OF "ANALYSIS OF THE ENERGY DISTRIBUTION IN SPEECH," by I. B. Crandall and D. MacKenzie, *Physical Review*, Series 2, Vol. XIX, No. 3, March, 1922.

THIS paper is of interest to broadcasters, not only because of the practical significance of its conclusions, but as an illustration of the type of acoustic research on which the technique of modern broadcasting rests to a great extent.

The object of the research in this case was to determine the energy distribution of speech with respect to frequency, to find out, that is, whether high or low tones carried the energy, and to what extent. The method used is shown in Fig. 1. Here we have a condenser transmitter of the type described by Wente in the *Physical Review*, Vol. XIX, No. 5, May, 1922. (See "Technical Operation of Broadcasting Stations—No. 13." The Condenser Transmitter, RADIO BROADCAST, December, 1926), feeding into its associated amplifier, which in this case has three resistance-coupled stages. The output of this amplifier is divided between the halves of a special "twin amplifier"—but the twins in this instance are not alike; the functioning of the apparatus, in fact, depends on the difference between them. The lower stage is untuned and therefore transmits the full electrical response of the system, through an 11:1 stepdown transformer to a thermocouple and microammeter. The upper stage is tunable to any frequency within the speech range by variation of the condenser and inductometer in the circuit, and passes only a narrow band of frequencies, the energy of which may be measured on an identical thermocouple-microammeter combination. It is therefore possible to determine what percentage of the full energy of the voice of an observer speaking to the condenser transmitter resides in any particular band of audio frequencies.

The method used by Crandall and MacKenzie involved noting the deflections of the two instruments for a 50-syllable sentence of connected speech, and also for a list of 50 disconnected syllables. There were six speakers, four men and two women. The total number of observations was 13,800. The successive syllables were

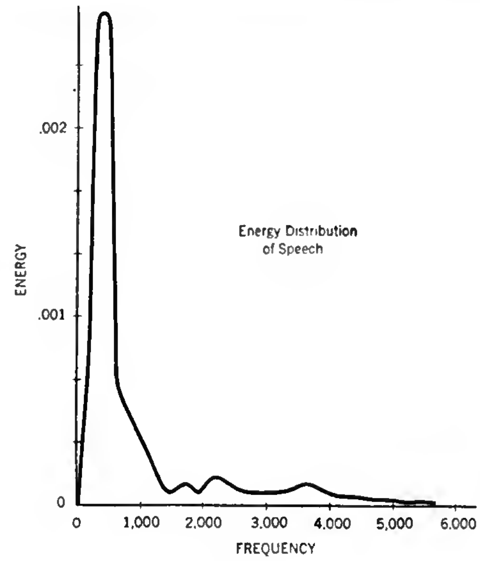


FIG. 2

pronounced slowly, and the microammeter deflection read in each case.

Numerous secondary measurements were made for the purpose of calibration, and to correct for the internal characteristics of portions of the apparatus. The relation of the unmodified output of the untuned half of the twin amplifier, to the initial input, was known in all portions of the speech range. The damping of the series resonant circuit was chosen for sufficient resolving power and energy-sensitiveness over the speech range. The centers of the frequency bands measured were at 75, 100, 200, 300, 400 to 3200 by steps of 200; 3500, 4000, 4500, 5000 cycles per second. Beyond 5000 cycles, the energy was too low to be measured. There were 23 frequency settings in all. With corrections for varying volume, varying area of tuned circuit response curves, and varying frequency sensitivity of the equipment, the over-all error of the measurements was estimated as about 5 per cent.

The result of the 13,800 measurements is shown in Fig. 2, which is a composite curve of energy distribution against frequency, for all the voices tested. This curve shows that the energy of speech is concentrated at the lower frequencies, with a peak at about 200 cycles. The peak for male voices is about 100 cycles below that of female voices; the shape of the curves is similar. Most of the energy of the voice is below 1000 cycles, and, it may be added, most of it is carried by the vowel sounds. When it comes to articulation, however, the higher frequencies are exceedingly important. This field was not entered by the au-

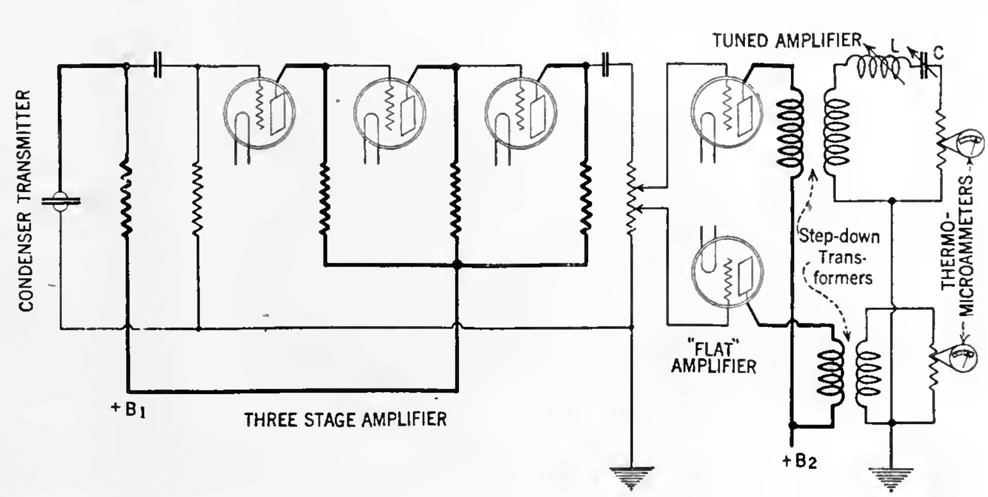


FIG. 1

thors of the paper now under discussion, and may best be reserved for a later abstract.

It should be noted that these results hold for the "frequency distribution of energy in speech in terms of the mechanical energy of a more or less ideal transmitter diaphragm." This follows from the fact that one source of error in the experiment cannot be eliminated. At audio frequencies, the wavelength is short and comparable with the diameter of the transmitter, with consequent inequalities in reflection at the various frequencies. There are standing wave effects in the space between the speaker's mouth and the transmitter. Thus the work of Crandall and MacKenzie is only roughly valid for the absolute energy distribution of the voice; it is strictly true (within the known limits of error of the tests) rather for the voice considered as a part of a telephone system. Since the telephone system used in the work described was substantially that of a broadcast station of the present day, the results hold closely for broadcast systems, although the tests and publication antedated the main development of broadcasting and the job was done by men connected with the wire telephone business.

The judicious broadcast technician will not require much interpretation of the conclusion to be drawn from the curve of Fig. 1. He already knows that amplifier overloading is most apt to occur at the low frequencies.

Latest Scientific Marvel of the A. P.

THE heading of a boxed article in the New York *Times* for September 20, 1926, is "Dancers Are 'Receiving Sets'; No One Else Hears Radio Music." The text reads as follows:

> BERKHAMPSTEAD, ENGLAND, Sept. 19 (AP).—At a hotel dance here last evening twenty couples danced to radio music which could not be heard by the spectators. The dancers were all their own receiving sets and wore inconspicuous headphones.
>
> The sight of the folks dancing looked almost mad to all who did not know of the experiment being tested by scientists who had worked on the problem for three years.

If this stunt is an invention, then the production of fireproof chewing gum would be an invention. If it takes a scientist three years to evolve a capacitive pick-up for forty pairs of headphones, then my iceman is a scientist. If it is news, then Mr. Hugo Gernsback's demonstration of the same magic (See *Radio News* for February, 1926) should have been headlined in 60-point type at the very least.

Technique of Field Operation

GRAPHIC description of prompt action to meet an emergency in field broadcasting, culled from the log of Mr. James Foreman at WJZ:

> Clipped one announcement of Olsen's off air when a stew made a dive for mic to greet his beloved.

MR. JULIUS WEINBERGER

A graduate of Doctor Goldsmith's course of 1913, who later became associated with him in conducting the radio course at the College of the City of New York, Mr. Weinberg is now a development engineer in the Radio Corporation

This, incidentally, is not altogether funny. The fact is that out of three or four dance hours broadcast by a metropolitan station, at least one will show such an experience. One of the merrymakers, generally with more cubic centimeters of alcohol under his belt than he was built to hold in a seemly manner, approaches the microphone in his cavortings and, suddenly, there bursts on his whirling brain the effulgent idea of talking to his dear ones far away. Why not, especially as the service is free? What else is radio for? So he yells his message, usually something on the order of "Hello, Shylvia!" into the transmitter. Unless the field operator happens to see him make his approach, the clown gets away with this much, for even the best radio man's reaction time is slightly more than two words in length. But further communications are lost to the world, for the operator throws the line key off, while his assistant rushes out from behind the palms, sometimes taking one with him as a suitable weapon, designed for this purpose by nature, if not by the hotel management. With the retreat of the impromptu broadcaster, the engagement generally ends, and the amplifier goes back on the air. The gap remains, and must be explained, as the sample above shows.

Memoirs of a Radio Engineer

XVI

I HAVE mentioned previously, in this series, the radio course given at the College of the City of New York by Prof. Alfred N. Goldsmith, during the years 1913-1918. My turn to take this

RIGHT

The printing telegraph set-up at the College of the City of New York

LEFT

The telegraph and telephone laboratory of the College of the City of New York in 1917 course came in 1917. My classmates were Maurice Buchbinder, Jesse Martsten, Herbert Kayser, and Joseph D. R. Freed.

In the same year, before the college sessions began, Julius Weinberger, a graduate of the course and the College in 1913, became associated with Doctor Goldsmith. Mr. Weinberger spent about a year, after his graduation, in civil engineering, followed by three years in the radio laboratory of the Bureau of Standards in Washington. The radio course (Physics 90-91) as given in 1917, included a Saturday morning laboratory period, under the supervision of Mr. Weinberger. Both Doctor Goldsmith and Mr. Weinberger corrected the students' reports, which were quite voluminous, some of my own running to twenty closely written pages. Doctor Goldsmith gave two lecture hours a week to the class of five men, and devoted as much time as he could to the laboratory work. The apparatus consisted of regulation commercial transmitting and receiving equipment, measuring instruments, both domestic and foreign, and the necessary electric power machinery, switchboards, etc. Before starting on the experiment, the students, who generally worked in squads of two, had considerable reading and theoretical preparation to go through with. The report normally started with a dissertation on theory, then a description of the apparatus, connection diagrams, and procedure; tables of observations; computations; and final numerical results.

A sample page of one of my reports is shown herewith. It shows the diagram of connections of a Bergmann Electricitäts Werke arc. But by far the best reports in the class were those of Joseph Freed. The calligraphy, arrangement, and lucidity of description were incomparable. All of us spent a great deal of time on these write-ups. I know I devoted as much time to my radio work as to all my other courses combined, and I believe this was the general rule among the small groups of students who elected the radio course.

The corrections of Doctor Goldsmith and Mr. Weinberger were made in red ink, frequently mixed with a justified quantity of scientific venom. These were the final polishing touches of engineering instruction, after the rough cuts had been made by Professor Parmly and the other instructors in previous technological courses. When a portion of a diagram was not clearly marked, a question, like "Range?" was sure to be found appended in red ink when the report once more reached the student's hands. Excess significant figures were stricken out. Various qualifying phrases and corrections of dubious reasoning were inserted. At times I dragged into my reports various *obiter dicta* and slightly facetious remarks, which were frowned upon by Doctor Goldsmith when they occurred in formal reports. In a report on "Detectors; Operating and Electrical Characteristics," I remarked, "One of Austin's early combinations was tellurium-silicon, and it is rediscovered every year, if not every month, by amateur investigators, the discovery being made public in a magazine on each occasion." In the margin, in Doctor Goldsmith's handwriting, there appears the remark, "A sad truth of *no scientific interest.*" In the same folder I wrote about a detector stand whose construction did not meet my august approval, "With the removal of the crystal it might, however, make a good spark gap." To this wise crack the Doctor appended a "No," underlined three times, indicating a degree of irritation. This squelched me for a while, but in a later experiment I said of a Rendahl variometer, "Its operation is readily understood if sufficient diagrams, with arrows, be drawn." This witticism Professor Goldsmith deleted, adding a marginal rebuke, "Draw them, or else eliminate the statement. Be more businesslike in the general tone of reports." Weinberger also paddled me occasionally, generally in the form of flat contradictions of my most assured statements. I wrote, "The calibration curve of this condenser is linear, *of course* . . ." The underlining was Mr. Weinberger's, and he added dryly, "Usually a rare occurrence." When I complained piteously, "owing to the difficulty of handling the cubic equation, Eccles' formula was not used in calculating," J. W., with characteristic directness and practicality, advised me, "Look up, on page 100 of *Machinery's Handbook* methods of solving cubic equations."

There was nothing academic about that radio course, and most of the things we learned there remain applicable ten years later. There is the case in which I reported, "The measured capacity of the small mica condenser does not accord with the marked capacity by over 10,000 cms. Which is wrong?" Doctor Goldsmith answered, "Measured values *always* take precedence over manufacturer's labels."

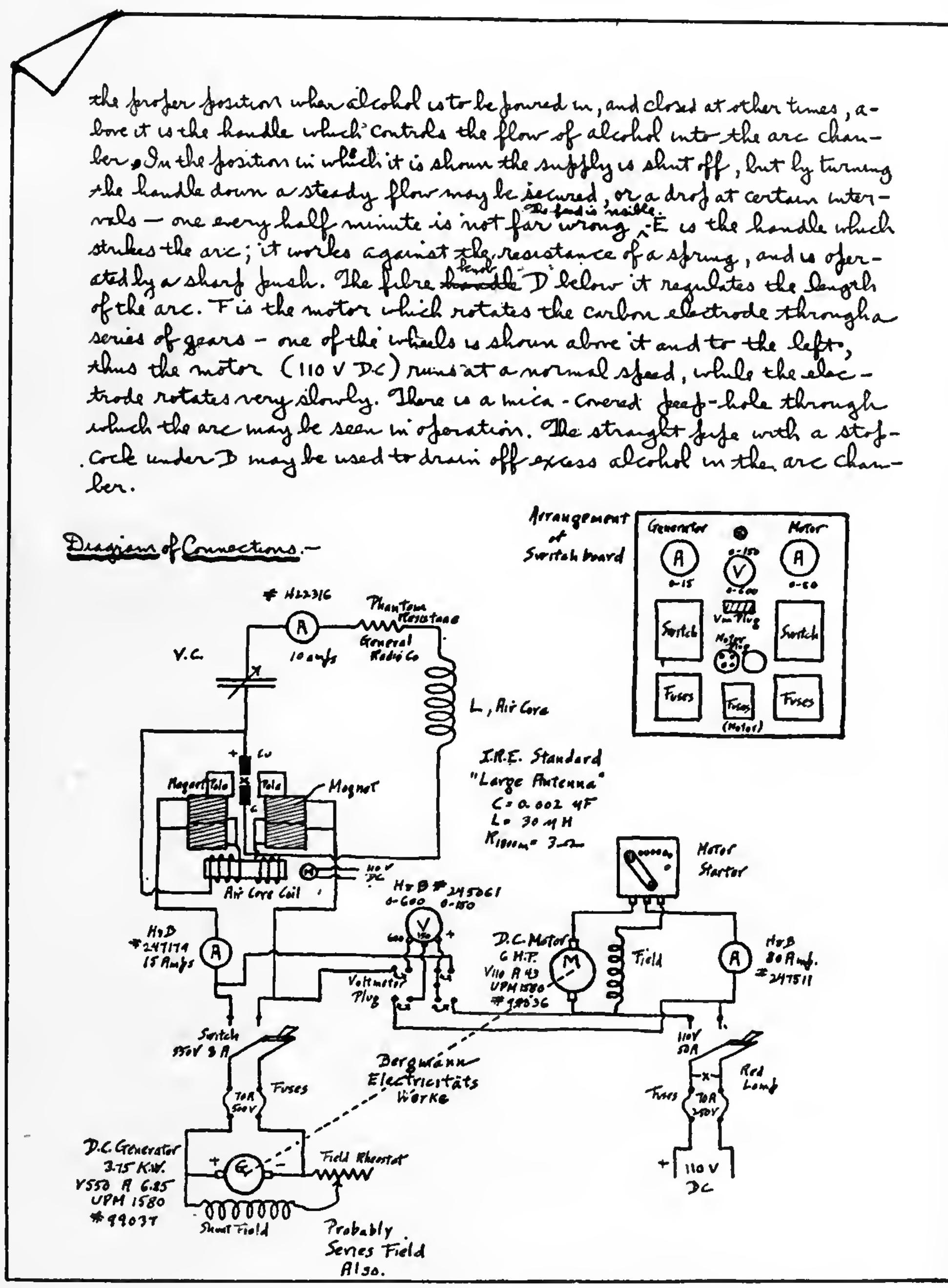

the proper position when alcohol is to be poured in, and closed at other times, above it is the handle which controls the flow of alcohol into the arc chamber. In the position in which it is shown the supply is shut off, but by turning the handle down a steady flow may be secured, or a drop at certain intervals — one every half minute is not far wrong. The feed is visible. E is the handle which strikes the arc; it works against the resistance of a spring, and is operated by a sharp push. The fibre ~~handle~~ knob D below it regulates the length of the arc. F is the motor which rotates the carbon electrode through a series of gears — one of the wheels is shown above it and to the left, thus the motor (110 V DC) runs at a normal speed, while the electrode rotates very slowly. There is a mica-covered peep-hole through which the arc may be seen in operation. The straight pipe with a stop-cock under D may be used to drain off excess alcohol in the arc chamber.

Diagram of Connections.—

A PAGE FROM MR. DREHER'S LABORATORY NOTEBOOK—A. D. 1917

NEW APPARATUS

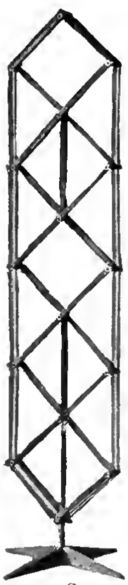
Equipment of the Radio Industry Submitted to the Radio Broadcast *Laboratory for Test and Inspection*

Radio Broadcast *Photographs*

1

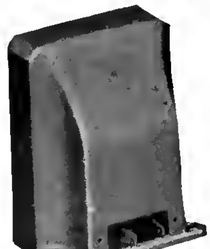
2

4



3

5

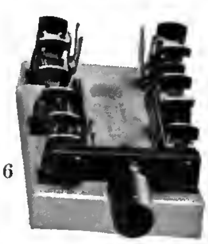


7

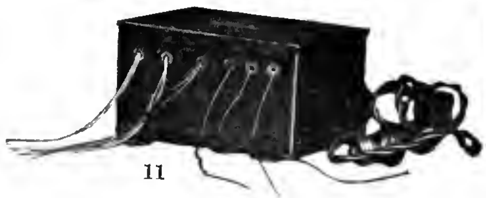
8

9

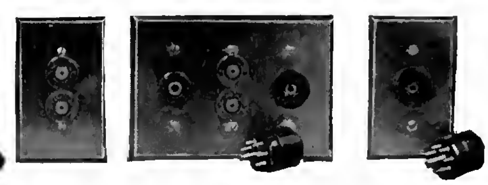
10



6



11

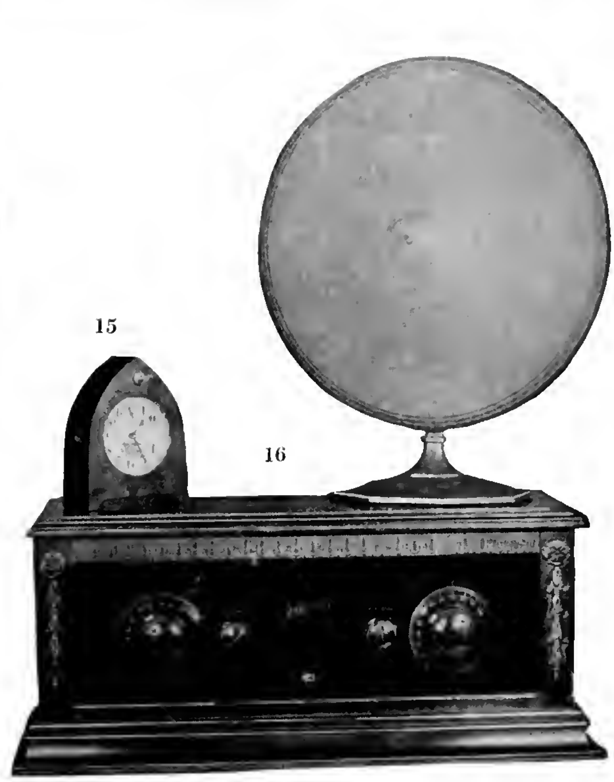


12

No.	Name of Apparatus	Manufacturer	Use of Product	Price	Remarks
1.	Marie Louise Console Cabinet	Knickerhocker Talking Machine Co., 831 B'way, N. Y. C.	Decorative housing for radio receiver and accessory equipment.	$275.00	A beautiful *objet d'art* from an excellent cabinet maker. Will accommodate such receivers as the Atwater Kent Nos. 20, 30, and 32.
2.	"Metrodyne" Receiver	Metro Elec. Co., 2161 North California Ave., Chicago, Ill.	Broadcast reception.	$48.50	A six-tube receiver producing good quality.
3.	Loop, "Volumax"	Weber Elec., 4527 Broadview Rd., Cleveland, Ohio.	Signal pick-up device.	$14.50	An unusual loop that has proved a very efficient collector.
4.	Resistor Unit	Amsco Products Inc., 416 Broome St., N. Y. C.	For use in voltage supply devices, etc.	$0.65	Guaranteed accurately rated within five per cent. on either side of rated value.
5.	Rheostat	Amsco Products Inc., 416 Broome St., N. Y. C.	Regulates current and voltage supplied to filaments of tubes.	$0.75	A compact rheostat having an air-cooled resistance unit.
6.	Double-Pole Double-Throw Switch	Fahnestock Elec. Co., East Ave. and 8th St., Long Island City	General use in battery charging and other circuits.	$0.75	A throw-over switch provided with Fahnestock clip connectors.
7.	Audio Transformer, "Symphonic"	Samson Elec. Co., Canton, Mass.	Amplifier of audio frequencies.	$9.00	Turns ratio 3.25 to 1.
8.	Audio Transformer, No. R200	Thordarson Elec. Mfg. Co., 500 W. Huron St., Chicago, Ill.	Amplifier of audio frequencies.	$8.00	Turns ratio 2.3 to 1.
9.	Line Protector	Precise Mfg. Corp., 254 Mill St., Rochester, N. Y.	Automatic overload relay for use in A-battery circuits.	$3.75	Opens battery circuit in case of accidental short circuits.
10.	Output Transformer	General Radio Co., Cambridge, Mass.	Coupling device between last audio stage and loud speaker.	$5.00	Same physical dimension as regular G. R. audio transformer. Turns ratio 1 to 1.
11.	B-Power Unit	Dongan Elec. Co., 2991 Franklin St., Detroit, Mich.	Supplies plate potential to all tubes of the radio receiver.	$17.50	Combined line transformer, condenser block, and filter choke for use in power supply circuit, employing a 216-B tube.
12.	Wall Plug Units	Yaxley Mfg. Co., 9 S. Clinton St., Chicago, Ill.	Wall outlets for connecting batteries, etc., to the receiver.	$1.00 $2.50 $4.50	(1) Antenna and ground connections; (2) Battery plug and receptacle; (3) Antenna and ground jacks, and battery plug and receptacle.

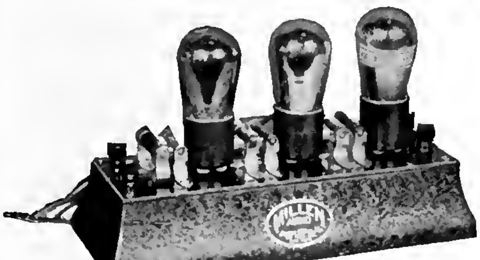
13

14



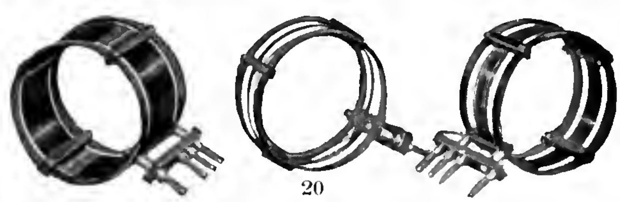
15

16



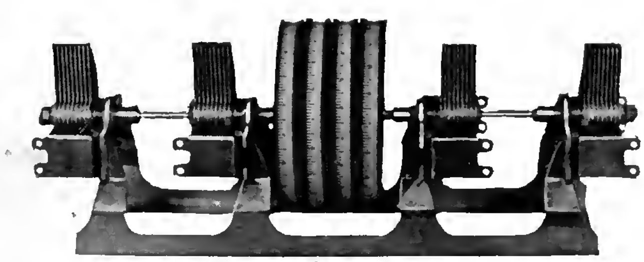
17

19



20

18



21

22

No.	Name of Apparatus	Manufacturer	Use of Product	Price	Remarks
13.	Voltage Supply Device	Cornell Mfg. Co., Lawson and Annabelle Sts., Long Island City, N. Y.	Supplies voltage to all tubes of the radio receiver.	$39.50 $49.00	Type B ($39.50) supplies only B potential while type CB ($49.00) supplies B and C voltages. A Raytheon tube is employed.
14.	Dual Condenser	Bruno Radio Corp., 23rd and 4th Ave., Long Island City, N. Y.	Capacity element for tuning circuit of receiver.	$11.00	Consists of a pair of "ganged" condensers for the simultaneous tuning of two matched circuits.
15.	"Radiolarm" Clock	Herbert M. Hill, 117 Highwood Ave., Leonia, N. J.	Combined clock and filament switch for turning on and off receiver at prearranged times.	$9.00	Gets you up for the early morning gymnastics!
16.	"Oriole" Radio Receiver	W-K Elec. Co., Kenosha, Wisc.	Broadcast reception.	$125.00	A high class Six-tube receiver employing the "Trinum" circuit.
17.	Unit Audio Amplifier	Jas. Millen, Inc., 105 Fifth Ave., N. Y. C.	Complete audio unit for attachment to output of detector circuit for reproduction of broadcast programs.	$25.00	Resistance-impedance-coupled amplifier with tone filter.
18.	A Battery Filter	The Abox Co., 215 North Michigan Ave., Chicago, Ill.	Filter device, for use with an A-battery charger.	$19.50	Does away with the A battery, furnishing A current directly from the charger.
19.	Audio Transformer, AF3	Ferranti Ltd., 130 W. 42nd St., N. Y. C.	Amplifier of audio frequencies.	$12.00	Turns ratio, 3.5-1.
20.	Tuner Coils	Aero Products, Inc., 1772 Wilson Ave., Chicago, Ill.	Inductance units for use in short-wave tuning circuits.	$12.50 a set	Low loss inductances for short-wave sets. The coils are also obtainable for use in tuned radio frequency sets for use on the broadcast band.
21.	Gang Condenser	Alden Mfg. Co., 52 Willow St., Springfield, Mass.	"Gang" capacity element for use in multiple tuner circuit.	$15.00	The four condensers may be turned simultaneously by the pressure of three fingers on the milled edges of the dials.
22.	Radio Receiver	J. B. Ferguson, Inc., 532 Pierce Ave., Long Island City, N. Y.	For broadcast reception.	$75.00	A six-tube shielded receiver of excellent sensitivity and good quality output.

The Rola Pedestal Reproducer, listed as item 15 on page 49 of the New Apparatus pages of Radio Broadcast for November, 1926, now sells for $36 instead of $45 as listed then

A Combined Amplifier and A.C. Operated Power-Supply Unit

Radio Broadcast Photograph

FIG. 1

This is the two-tube R. B. "Lab" Receiver. Used in conjunction with the line power-supply device described in this article, very excellent results are obtainable. The receiver may be connected to the power supply by a cable, such as that shown tapering off to the left of this page, which indicates connection to the unit at the bottom of the page. The loud speaker is one of the large size Western Electric cones. Compare this photographic layout with Fig. 7 on page 288

A Unit Comprising a High-Quality Three-Stage Amplifier with Power Tube, Using the Mains as a Source of B Power Supply—A and C Potentials for the Output Tube Also Obtained from the Same Source

By JAMES MILLEN

ONE of the essentials for good quality in audio frequency amplification is the use of a power or semi-power tube in the output stage. The use of such a tube, in turn, requires high B and C voltages. While such voltages may readily be obtained from B batteries, it is more economical, due to the high plate current drawn by the power tube, to employ a device which supplies these voltages from the house lighting system. A unit of this type, in addition to supplying the necessary B potentials for all the tubes of the receiver, may be combined with an audio amplifier and can be designed to supply A and C potentials for an incorporated output stage power tube.

The tendency in modern radio receiver design is to separate the r.f. and detector end of a radio receiving set from the audio amplifier end. There are several very excellent reasons for such practice, but perhaps one of the most outstanding is that, having a good audio amplifier, a number of different sets and circuits may be built and experimented with, without the necessity of duplicating the rather expensive audio amplifier. Then, again, the audio amplifier, if a separate unit, may be located down in the cellar or some other out of the way place, along with the associated power supply, whether of the battery or lamp socket variety, while only a small and compact unit, comprising the r. f. and detector circuits, need be placed on the living room table.

A third reason, which is rapidly becoming important, is the use to which a separate audio amplifier may be put in connection with the "rejuvenation" of the old type phonograph and its conversion into one of the new "Electrola" or "Panatrope" variety. More will be said of this latter use in RADIO BROADCAST in the very near future.

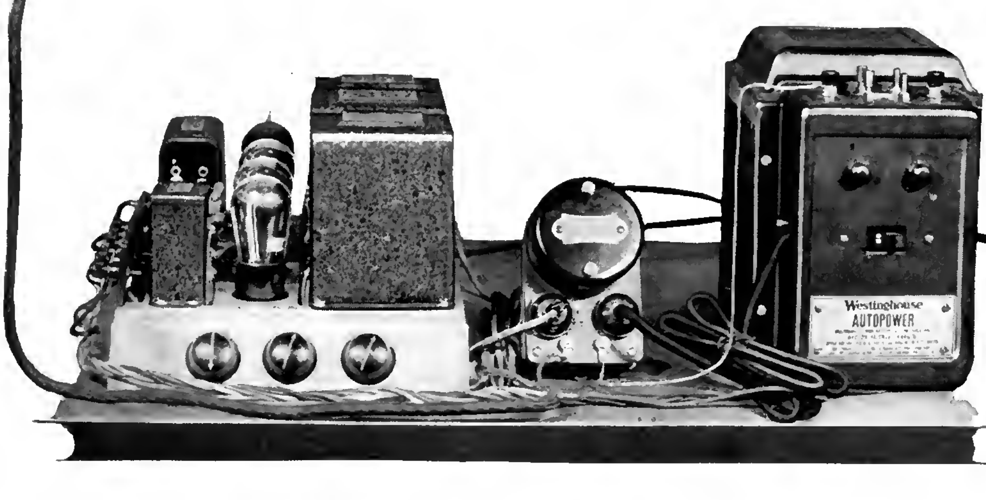
It is the purpose of this article to describe a combined power-supply device, powered by the a. c. house lighting system and high quality audio amplifier which may be wired by the most inexpert from an assembled kit of parts now available on the market. The audio amplifier part of this unit is designed for connection to the output of a detector tube. The majority of commercial units of this type have included merely a single stage (a power stage) of audio amplification, it being necessary to utilize the first stage of audio in the receiver proper in combination with the unit.

Many fans possessing old sets, overlooking the fact that even the first stage of audio frequency amplification in a receiver is capable of delivering quite distorted signals, have looked upon a power amplifier unit as a panacea for the poor quality signals they are receiving, and after purchasing an expensive unit, have been disappointed with the result obtained by connecting it to the output of an existing single stage of audio amplification.

The assembly described here, and designed by the author, is connected directly in the plate circuit of a detector tube, which may be preceded by the usual stage, or stages, of r. f. amplification.

Three stages of audio amplification are incorporated in this unit. The first is impedance-coupled; the second and third, resistance-coupled. The fourth socket in the amplifier-power supply device is for the Raytheon rectifier tube. The output power tube, preferably an UX-171, has a plate potential of approximately 200 volts, which is supplied through the transformer, and a grid bias of about fifty volts.

Though there are any number of different ways in which an amplifier and B power unit may be mounted, one of the most practical, and



Radio Broadcast Photograph

at the same time the neatest and least expensive, when a kit of parts is to be purchased, is on a cast iron hollow base, such as is used in the unit shown in the lower picture of Fig. 1 and elsewhere. All the wiring may be run under the base so as to enhance the appearance of the completed unit. The controls may be mounted on one of the sides, and a number of the small parts, such as bypass condensers and fixed resistors, can be placed out of sight. Mechanically, the cast metal base is a substantial piece of apparatus which will withstand a great deal of abuse, while, electrically, the all-metal construction results in the effective shielding of the various parts as well as the complete unit.

THE POWER AMPLIFIER

THE last stage of amplification in the modern high quality amplifier must be of the so-called power or semi-power type. It takes energy to bring out the low notes, and only an amplifier that is capable of feeding some real energy into a loud speaker is capable of properly reproducing the low notes.

Tube overloading is the most common cause of distortion, and the only practical way to prevent tube overloading is to use a semi-power tube with a high C voltage and the corresponding B voltage.

Of all the different power and semi-power tubes available to the radio public at this time, the UX-171 is by far the most sensible tube for use in obtaining quality amplification in connection with the home radio set.

This tube does not require the very high plate voltages needed for the UX-210, and at the same time, due to its lower plate impedance, results in better tone quality when used with speakers of the Western Electric 540 AW type. It is not possible to get anywhere near as much volume, without distortion due to overloading, from the 112 as with the 171.

As an UX-171 tube is employed in the final or power stage, an output device is essential for the protection of the loud speaker. In the unit described, a tone filter is employed in the output. It consists of a 30-henry inductance and a 4-mfd. condenser mounted in a compact container with suitable terminals. Aside from serving as a protective device, the output filter results in improved tone quality and more stable operation of the amplifier in bypassing the audio frequency current in the plate circuit of the last tube around the otherwise common plate impedance (the 8-mfd. filter condenser) of the power supply device.

THE AMPLIFIER

IN THE amplifier, by which is meant those two tubes preceding the power stage, at least two good reasons are responsible for the use of the impedance-coupled first stage rather than a resistance-coupled one. The first reason for using the Impedaformer in place of a resistance input unit, is so that provision is made for the use of one of the new detector tubes recently placed on the radio market, if the constructor so desires. These tubes draw considerably more plate current than the UX-201-A tubes. In fact when operated at 90 volts, as recommended by some tube manufacturers, the plate current of a special detector tube may be as much as six milliamperes. The normal plate current of a UX-201-A type tube, when used as a detector, is nearer one milliampere. Even the new metallized filament coupling resistors (0.1 meg.) will not safely carry over two milliamperes. The Impedaformer will, however, safely

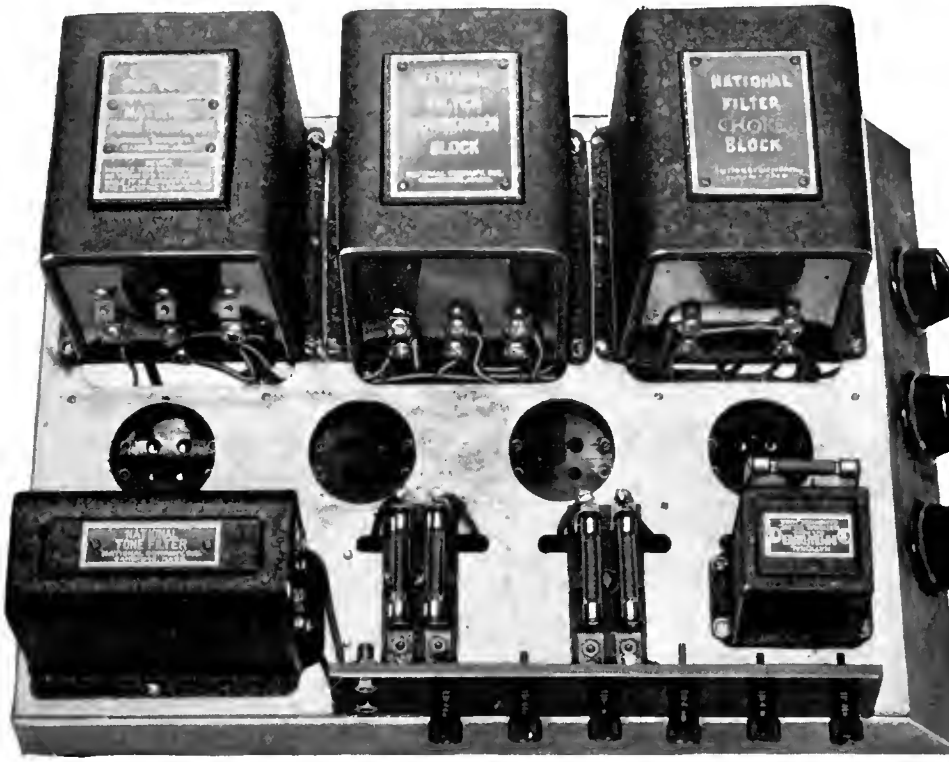


FIG. 2 Radio Broadcast Photograph

Top view of the completed unit. The condenser block is placed between the power transformer and the choke coils in order to reduce any possibility of the choke coils picking up stray magnetic flux from the transformer

and continuously carry considerably more than six milliamperes, so that its use in place of a resistance coupling unit will prevent any possibility of trouble from this source. Another reason is that the National Impedaformer specified, contains, in addition to the impedance, coupling condenser, and grid resistor, an r.f. choke coil which serves to keep the r.f. currents in the detector plate circuit from getting into the audio amplifier where it would cause distortion. The use of a radio frequency choke coil also results in much smoother regeneration when the detecor circuit employed is of the regenerative type.

There was a time, not so long ago, when there were several worth-while objections to resistance-coupled amplification. Fortunately, all of these objections have been eliminated, so that this economical and certain method of securing exceptionally fine audio quality may now be unhesitatingly employed in the better types of amplifiers.

The first of these former disadvantages to the use of resistance-coupled amplification was the necessity of securing from dry B batteries the high voltage—180 volts or so—required for the optimum performance of this system of amplification. The advent of devices supplying these high-voltages settled that question.

A second former objection was the fact that a two-stage transformer-coupled amplifier produced greater volume than a three-stage resistance-coupled amplifier. High-mu tubes did much to settle that question.

It is only within the last few months that resistors entirely satisfactory for resistance-coupled amplifiers have been available. The impregnated paper type formerly used for this purpose were neither noiseless nor permanent in value. After a few months' use, amplifiers employing such resistors frequently showed bad signs of distortion. Metallized resistors proved the cure for this.

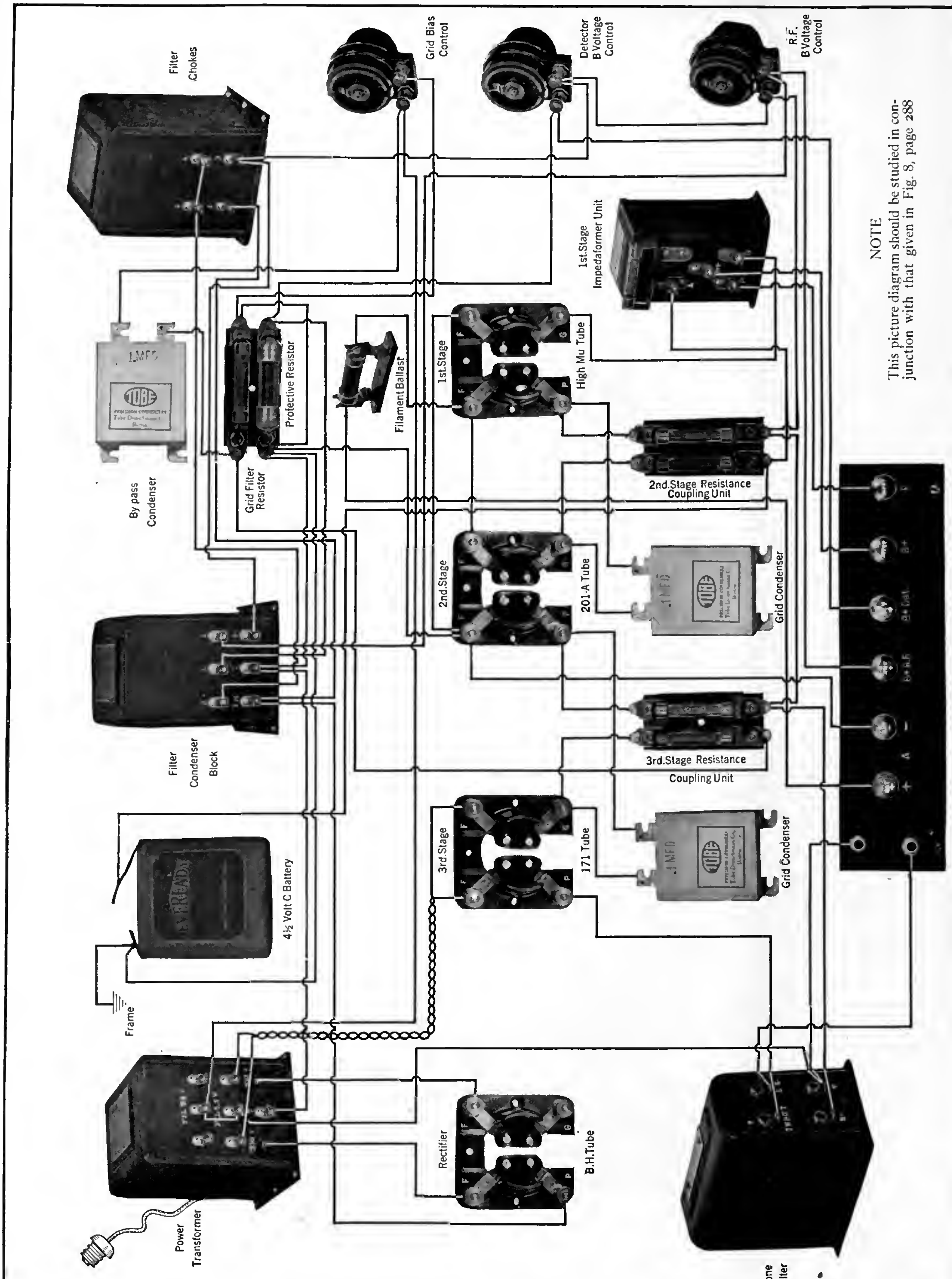
The power supply apparatus consists of a transformer, double choke, Raytheon tube, condenser block, and the necessary resistors.

The transformer was designed to be universally adaptable to any B power or amplifier circuit, and consists of a 500-volt secondary with mid tap, a 5.5-volt secondary for the filament of either an UX-171 power tube or an UX-213 rectifier, and a 7.5-volt secondary for use with either the UX-216-B or UX-210 tubes. When used in this amplifier, the 5.5-volt secondary is used to light the filament of the UX-171 amplifier tube. As the 7.5-volt secondary is located between the 110-volt winding and the high-voltage secondary, it serves most excellently as an electrostatic shield to prevent the introduction of power line noises into the radio set, by the simple expedient of grounding the mid tap.

The two 0.1-mfd. buffer condensers, so essential for the smooth operation of the Raytheon rectifier tube, are con-

FIG. 3 Radio Broadcast Photograph

The apparatus is mounted on a substantial cast iron base. The greater part of the wiring is run under this base



NOTE
This picture diagram should be studied in conjunction with that given in Fig. 8, page 288

tained within the transformer case and are properly connected to the transformer windings.

As a safety measure, the two high-voltage secondary leads are not connected to terminals on the transformer case, but are brought out in the form of long insulated flexible leads which may be run directly to the protected terminals on the Raytheon rectifier socket. Thus, the possibility of shock, due to carelessness in touching an exposed metal terminal, is eliminated.

WIRING THE AMPLIFIER

AS SUPPLIED in kit form, all of the different components of the amplifier are securely mounted on the metal base ready to be wired.

The wire used should be of a well insulated flexible type.

First wire the power section. The two flexible leads on the transformer are run directly to the two protected filament terminals of the Raytheon socket and soldered in place. Care must be exercised in soldering connections to the sockets to see that no soldering paste or flux gets between the contacts, or an arc will result when the amplifier is put in operation. The grid terminal of the Raytheon socket is not used.

Now connect the two a.c. filament leads to the 171 tube, twisting them together, as indicated in Fig. 8 and in the illustration on page 286.

The rest of the connections of the power supply apparatus are perfectly straightforward, and, after all of the apparatus in this unit has been connected together the amplifier proper may be wired. The two leads from each of the grid condensers (in the grid circuits of the second and last audio tube) should be run directly to the grid and plate terminals of the proper sockets, as shown. While wiring, keep in mind the fact that the wires are finally to be grouped together and bound into cables as mentioned above. Ordinary grocer's string is quite satisfactory for this purpose and, if given a coat of shellac when finished, the string will be firmly held in place.

The soldering lug visible on the bakelite socket strip in Fig. 5 between the second and third tube sockets, screws through the cast iron base and casings of the individual units, and is for the purpose of grounding the metal base. It is connected to the negative filament lead at the adjacent tube negative filament prong.

The negative terminal of the C battery is the long strip. The short strip is the positive. The positive C terminal may either be connected to the metal clamp that holds it in place or to the ground lug previously referred to. Both of these points are grounded. This battery supplies the grid biasing voltage to the first two audio tubes. The grid bias for the last tube (the UX-171) is obtained by taking the voltage drop across resistor R_3.

INSTALLING THE AMPLIFIER

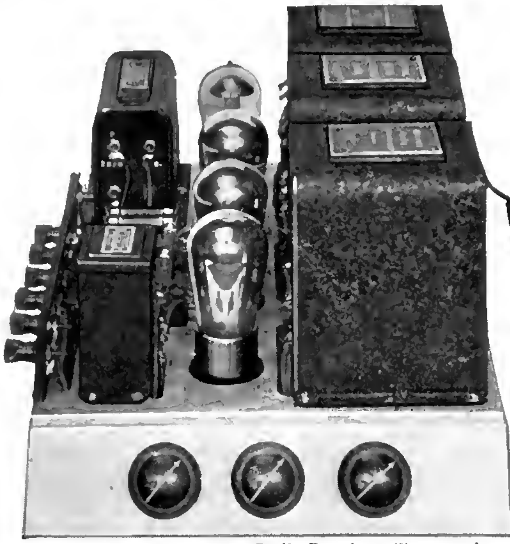
WHEN the amplifier has been finished, it may be connected to either a set especially designed for the purpose, such as the two-tube R. B. "Lab." circuit receiver described in this issue of RADIO BROADCAST by John B. Brennan, or else may be used in place of the audio amplifier in any set the builder may happen to have.

The A supply required for the first two tubes of the amplifier, and the tubes in the main set, may be obtained from a storage battery. In order to simplify matters, an A power unit, such as the Westinghouse "Autopower," shown in the layout of Fig. 1, may be utilized.

The Westinghouse unit consists of a fairly low capacity storage battery which is kept charged by means of a trickle charger of the dry contact rectifier type. Its use makes the set entirely operated from the mains and results in a receiver the batteries of which require a minimum of attention. Replacement of the small grid battery in the amplifier unit will be necessary only about once yearly.

The most convenient way of controlling the amplifier-power supply unit set, and A-power unit, is by means of one of the automatic relay switches. Fig. 7 shows just how the equipment is connected together. Where the set and amplifier are not too far apart—and it is recommended where possible that they be placed not over 10 feet apart—the use of a cable, such as the Yaxley, will be found a very convenient and neat method of connecting the various units together.

The input to the amplifier is in most cases, except for some types of regenerative receivers, secured by connecting the input post which on the amplifier unit is marked "B" to the adjacent +B det. post in the same unit. A wire is then



Radio Broadcast Photographs

FIG. 4

The three variable resistors mounted on the end of the base are adjusted to meet local conditions when the amplifier is installed. They then require no further attention

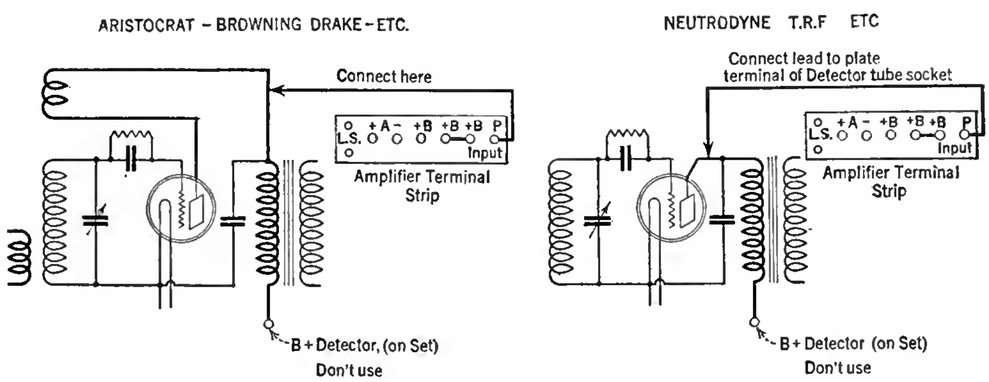
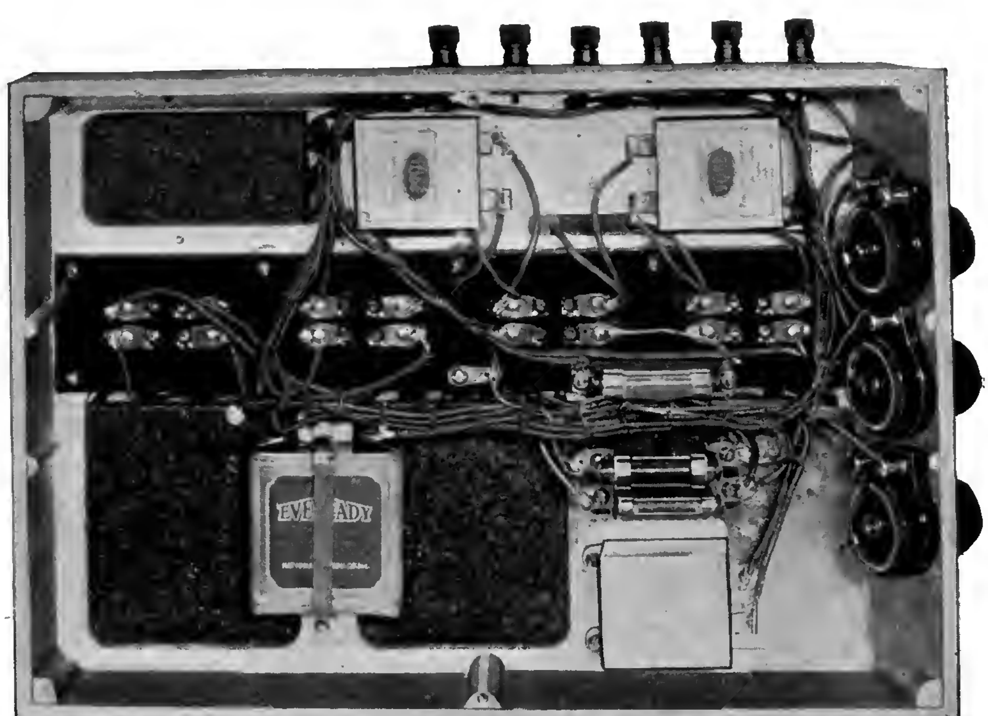


FIG. 5

Showing how the line power-supply device may be connected to either the regenerative or non-regenerative form of receiver



Radio Broadcast Photographs

FIG. 6

A neat wiring job is secured by cabling the various leads, as shown in this illustration taken beneath the cast iron base

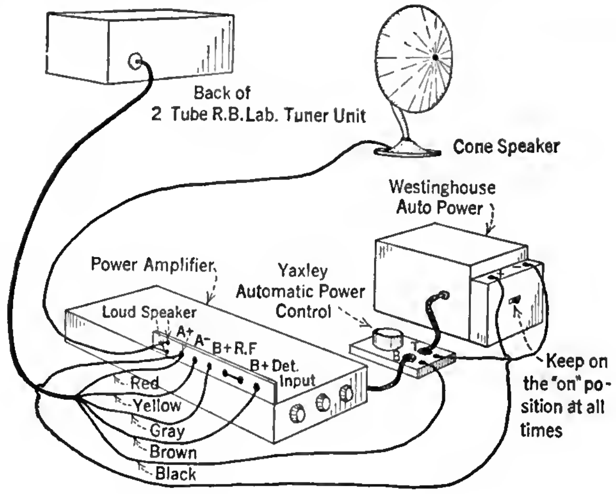


FIG. 7

The wiring of the photographic layout shown on the first page of this article, whereby the R. B. "Lab" Receiver may be used in conjunction with the power-supply device described here. Mr. Brennan's article starting, on page 289, explains the colors indicated in this diagram

List of Parts

National Three-Stage Amplifier Kit	$84.00
The prices of the individual parts in this kit are as follows:	
T_1—1 Power Transformer	$16.50
C_1—1 Filter Condenser Block	17.50
L_1—1 Filter Choke Unit, Type 80	10.00
L_2—1 Tone Filter	7.50
L_3—1 Impedaformer	5.50
1 Terminal Strip	——
1 Cast-Iron Base	——
1 4-Gang Socket	3.00
C_2, C_3—2 Tobe 0.1-Mfd. Condensers	1.20
C_4—1 Tobe 1.0-Mfd. Condenser	.70
R_1, R_2, R_3—3 Electrad Variable Resistors	4.50
R_4—1 10,000-Ohm Fixed Resistor	.65
3 Lynch Double Resistor Mounts	1.50
R_5—1 Lynch No. 2 Filament Ballast	1.00
R_6, R_7, R_8, R_9—4 Lynch 0.1-Meg. Metalized Filament Resistors	3.00
R_{10}—1 Lynch 0.25-Meg. Metalized Filament Resistor	.50
R_{11}—1 Lynch 0.5-Meg. Metalized Filament Resistor	.50
1 Eveready No. 703 4½-Volt C Battery	.35
BH—1 Raytheon Tube	6.00
1 Coil Flexible Wire	.50

Accessories

1 High-Mu Tube	$2.50
1 201-A Tube	1.75
1 171 Tube	4.50
1 Yaxley Automatic Control Switch	5.00
1 Westinghouse Autopower, 6 Volts	30.00
1 Loud Speaker, Western Electric 540 AW	32.00
1 Corbett type S-25 console	32.50

run from the other input terminal (marked "P" on the amplifier) to the plate terminal of the detector tube socket on the main receiving set.

No connection is made to the plus B detector post on the set.

In the case of the two-tube R. B. "Lab" circuit receiver, the lead from the input (P) post on the amplifier is run to the output post on the set (See Fig. 7).

In the case of some other sets, such as the "Aristocrat" and Browning-Drake, the input (P) lead should be connected to either the opposite side of the tickler coil from the detector tube plate lead or else to the plate post of the audio coupling unit. This is necessary in order not to interfere with regeneration. The "plus B det." post on the set is not used. See Fig. 5.

OPERATING THE AMPLIFIER

THE first step in operating the amplifier is to insert the various tubes. Generally a high-mu tube in the first stage, a UX–201–A in the second, and a UX–171 in the output will be found most satisfactory, although it may be better, under some conditions, to use high-mu tubes in both the first and second audio stages. The reason why a UX–201–A is preferable in the second stage at times is due to the possibility of the second high-mu tube being overloaded on strong signals. The proper places for the different resistors specified in the table on this page are indicated in Fig. 8.

When all is ready, turn the three variable resistors to their highest value of resistance and turn on the power. If all the wiring has been carefully and accurately done, and the set tuned to a local station, reception will be had. The three variable resistors may then be adjusted for best results. Generally the use of the full value of resistance will be found most satisfactory. Under no condition should all the resistance be "cut out." Stops are provided on the resistances specified in the list of parts so that excessive currents cannot be passed.

No matter how good an amplifier one has, unless a good speaker, such as the Western Electric 540 AW or 548 AW, is used, the best of quality cannot be realized. Furthermore, the cone should not be placed too close to the set, but preferably in another corner of the room.

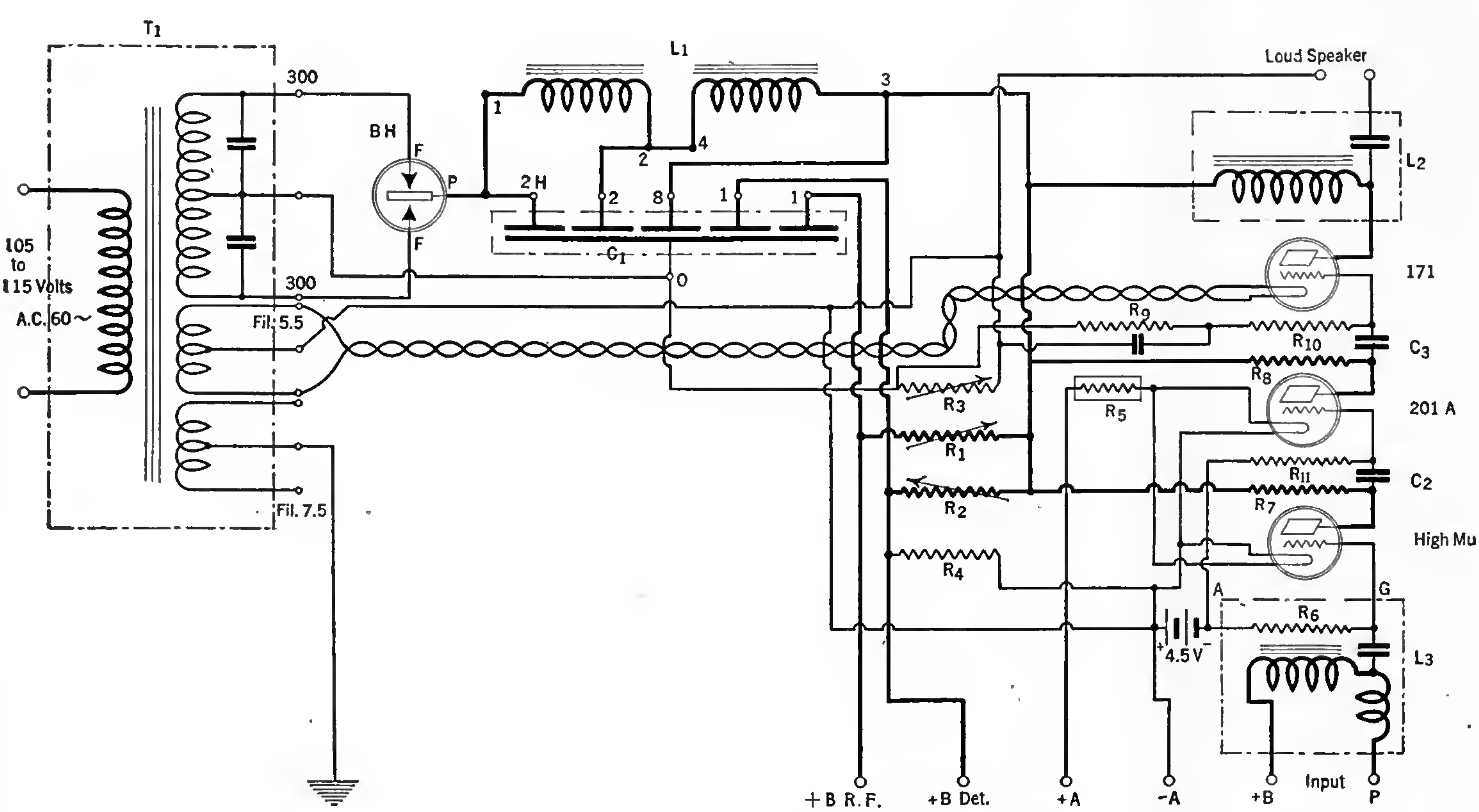


FIG. 8

The wiring diagram of the power-supply device described in the article. The 7.5-volt filament winding is grounded to form an electrostatic shield between the 110-volt winding and the high-voltage secondary winding on the power transformer

How to Construct a Two-Tube Shielded "Lab" Receiver

An Amplifier—Detector Unit for Use in Conjunction with a Separate Audio-Frequency Amplifier—A Loading Coil Permits Greater Transfer of Energy—Complete Shielding is Easy of Accomplishment and Aids Materially the Selectivity in Congested Districts

By JOHN B. BRENNAN

Technical Editor

Radio Broadcast Photograph

THE COMPLETE RECEIVER INSTALLATION

Consisting of the two-tube tuner unit, power audio amplifier, loud speaker, trickle charger A battery, and automatic control, is shown housed in a Corbett cabinet

WHEN radio broadcasting made its bow, some six or seven years ago, the types of receivers then in vogue closely followed the orthodox designs of the day—queer to us now in comparison to the fine pieces of radio furniture which may be purchased to-day.

He considered himself high and mighty who boasted of a little box housing a tuner circuit plus another box on whose front dangled the precious audiotron with its double filament. Those were the days when the neighborhood hardware store was sorely pressed to supply the demand for flashlight cells with which the high and mighty one built up his B-battery.

The art has progressed. But a strange coincidence is the fact that, to-day, designers of radio receivers are swinging around the circle, so to speak, and the more important receiver developments are crowding closely the styles of yesteryear.

Then it was that receivers were built up on the unit principle. That is, first one would obtain the tuner coil box and connect to it the crystal detector and phones. Graduating from this stage on to the next the experimenter would follow with the annexation of a vacuum tube detector and unit amplifier of some sort.

To-day that system—to be sure, in slightly altered form—is coming into its own again, and rightly so, for it has many points in its favor.

Much has been said about the ability of the tuner coils and the wiring of a receiver to pick up unwanted signals without the aid of the antenna. To many this has manifested itself as broadness of tuning and lack of sensitivity. To overcome this undesirable property, the tuner unit must incorporate some means for excluding the unwanted signals or at least to make all the signals enter the receiver through the antenna. Building the tuner unit in a metal cabinet, as described in this paper, very definitely overcomes this difficulty.

In selecting a circuit suitable for the tuner unit, the R. B. "Lab" circuit has been chosen, since it has all the meritorious qualities of a desirable circuit. In no way does this supersede the R. B. "Lab" circuit receiver which was fully described in the November, 1926, Radio Broadcast. That was a complete receiver in itself, audio channel and all, and the description in that issue resulted from the natural desire on the part of experimenters of the "Lab" circuit to have before them a suitable receiver design embodying the fine points of the circuit.

Unquestionably, to shield the coils within a receiver is highly beneficial, providing it is done correctly, and because of these beneficial qualities, the receiver described here has been shielded practically completely.

Slight variations in the R. B. "Lab" circuit, as outlined in the November, 1926, issue, have been made in the circuit used here, to suit the mechanical and electrical requirements set for this model.

To obtain maximum transfer of energy from the antenna to the receiver, involves the use of some sort of antenna tuning device. The antenna loading coil employed in the tuner unit described here furnishes exceptionally well the means to this end.

Four taps have been provided in this coil so that the circuit is resonant at approximately 1200, 857, 666, and 600 kc. (250, 350, 450 and 500 meters) successively as the switch arm is turned from left to right. The value of this loading coil is most apparent when it is desired to shift tuning from a short-wave station to one operating on a longer wavelength.

Shielding makes possible the use of a type of coil such as a solenoid, in the radio frequency stage input circuit which is more efficient than one of the confined electromagnetic field type, and, further this shielding aids in preventing the wiring of the circuit itself in picking up unwanted signals.

A separate audio channel for this two-tube unit may employ the same parts as the receiver described in November, and doubtless this point will find favor with those who already have that material on hand or for those constructors of the November R. B. "Lab" circuit who wish to convert their receiver into the two-tube tuner circuit with its separate amplifier.

The amplifier itself presents no very great problem of construction and, when completed, may be stowed away in some remote part of the console cabinet or perhaps in the basement with the storage A battery and its attendant charger, etc. Elsewhere in this magazine is described a combined audio power amplifier and plate power supply device which is very well adapted for use with the tuner unit described here.

The Facts About This Receiver

Name of Receiver	R. B. "Lab" Two-Tube Receiver
Type of Circuit	R. B. "Lab" Circuit; one stage tuned neutralized radio frequency amplification plus regenerative detector.
Number of Tubes	Two; r.f., 201-A type; detector, special detector such as 200-A, or ordinary 201-A tube.
Frequency Range	1500–545 kc. (200 to 550 meters).
Novel Features	Tapped antenna loading coil; C battery detector; complete metal housing.

The receiver described here is essentially a tuner unit in which is incorporated an r.f. and a detector tube. To it must be connected some sort of audio amplifying device of quality to reproduce with fidelity the sounds entering the microphone of the transmitter. The tuner unit has been intentionally housed in a metal cabinet which affords the advantage of shielding the circuit wiring from undesirable signal pickup.

THE ALUMINUM SHEET FOR SHIELDING

BEFORE collecting the various parts necessary for the construction of the tuner unit, it is well for the prospective builder to read over the description thoroughly and acquaint himself with the various sketches and construction lay-outs. In this same connection, the reader should not fail to review what has been published on the "Lab" circuit in the June, September, and November, 1926, issues of Radio Broadcast. This will serve to familiar-

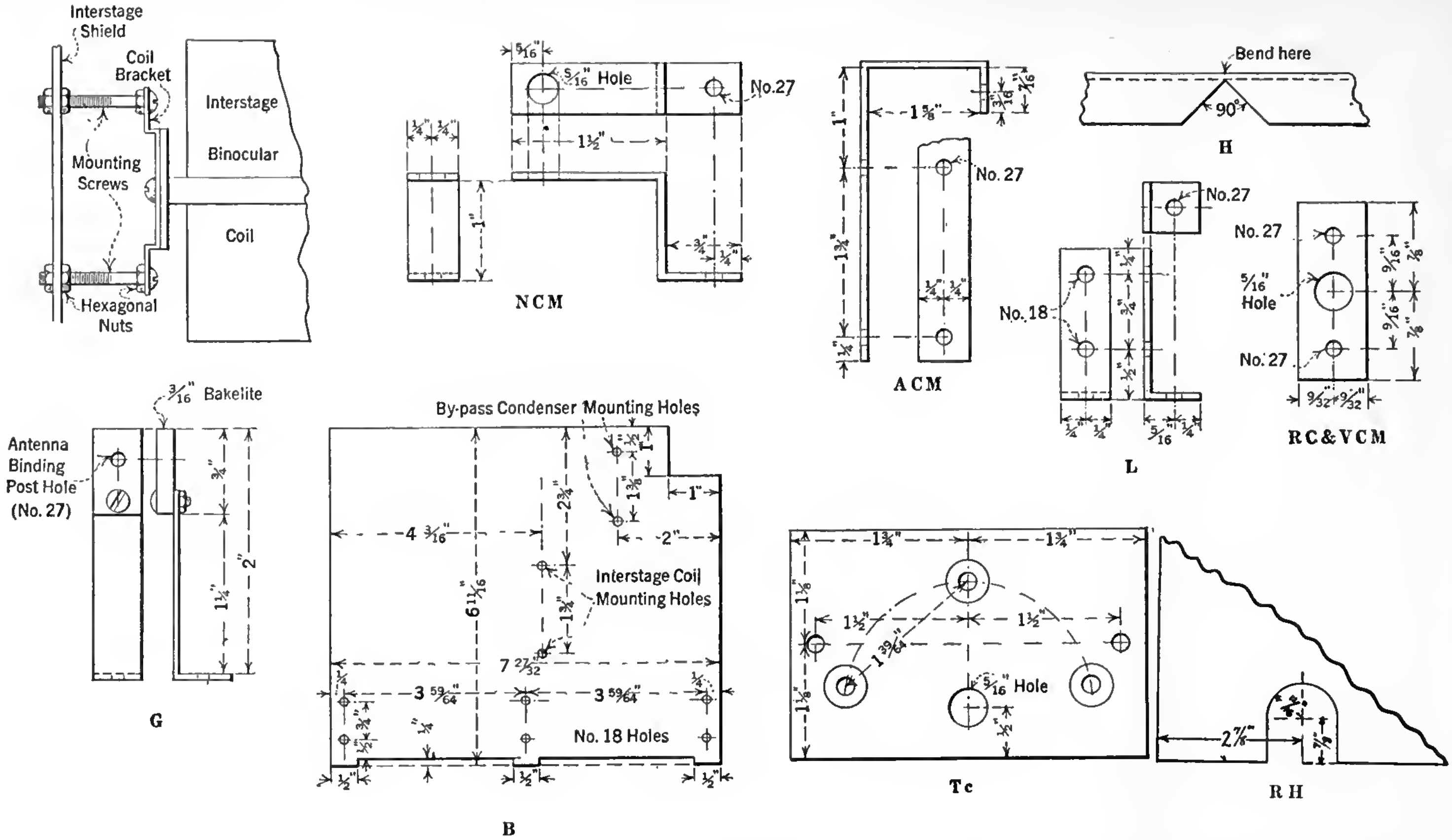
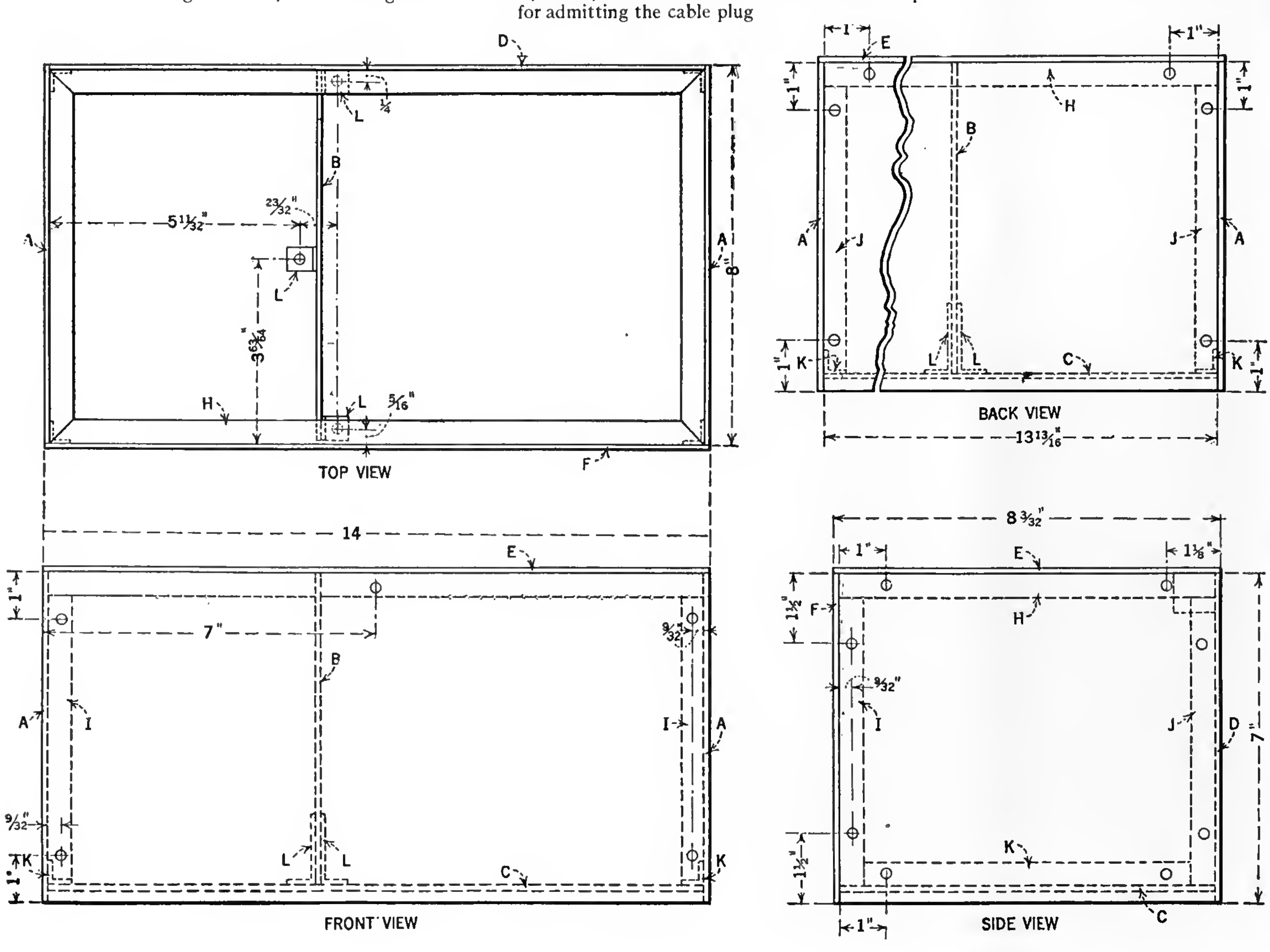


FIG. 1 AND 2

Prepare the various mounts and other brackets, etc. from the sketches shown above. Identification of these parts may be made by referring to the material list shown on page 291. The assembly details of the metal box are fully outlined in the diagram below (Fig. 2). The top view shows the method of fastening the walls, the lid being removed. R H, above, indicates the dimensions for the receptacle hole to be made in the back wall for admitting the cable plug

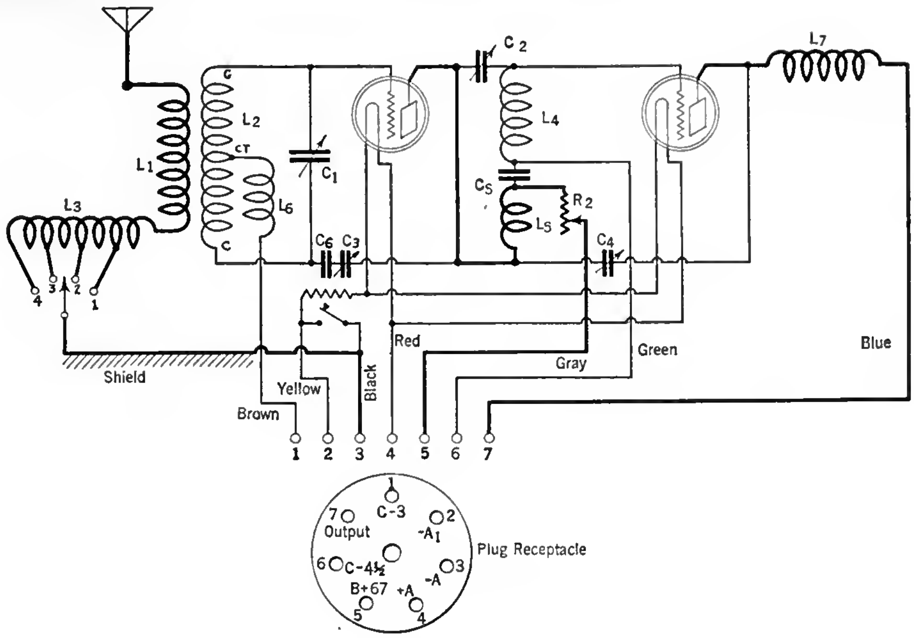


ize the builder with his problems, and guard against error.

With regard to the aluminum sheet necessary for the cabinet material, it is well to obtain a large sheet of standard size, which usually comes 18 inches wide and about six feet long. When purchased this way, the price per pound is less by about 25 per cent. than if only a part of the sheet be purchased, and the surplus may be used by the constructor in other ways.

The various pieces of cabinet material may be cut out roughly with a hack saw and then filed to size, or if one is so disposed, the services of the local tinsmith or machine shop may be employed to produce a more finished workmanlike job. This procedure will tend toward greater accuracy than when the job is filed down to size by hand. So, too, the brass angle strip may be laid out, center punched, and then drilled at the local machinist's. Unless one is used to drilling metal with a hand drill, the worth of having as much of this kind of work done outside cannot be fully appreciated.

Much care must be exercised in center punching the various hole marks—especially so on the main panel—because the use of a dull center punch will often result in incorrectly spaced holes. If you are attempting the drilling of the holes yourself, first drill them with a small sharp drill,—say a No. 33 or 35. Then, it is a simple matter to enlarge the holes with the correct size drill to the specified size. In doing this work, the Stevens tapered reamers are of inestimable value.



THE CIRCUIT OF THE TWO-TUBE TUNER UNIT

Is quite similar to that of the "Lab" receiver described in the November, 1926, RADIO BROADCAST. Comparison between the two will show that the circuit shown here differs from the other in that first an antenna loading coil has been added, secondly the C battery method of detection has been substituted and, thirdly, the volume control has been placed in the radio-frequency amplifier circuit. By placing the volume control in this position, the operator is able to prevent overloading of the detector, especially on strong local signals. The condenser C6, in series with the neutralizing condenser C3, is employed as a protective device in case the plates of C3 become shorted. While not shown in the several photographs, this condenser is mounted directly on the back plate of the tuning condenser C1

PARTS REQUIRED FOR METAL CABINET

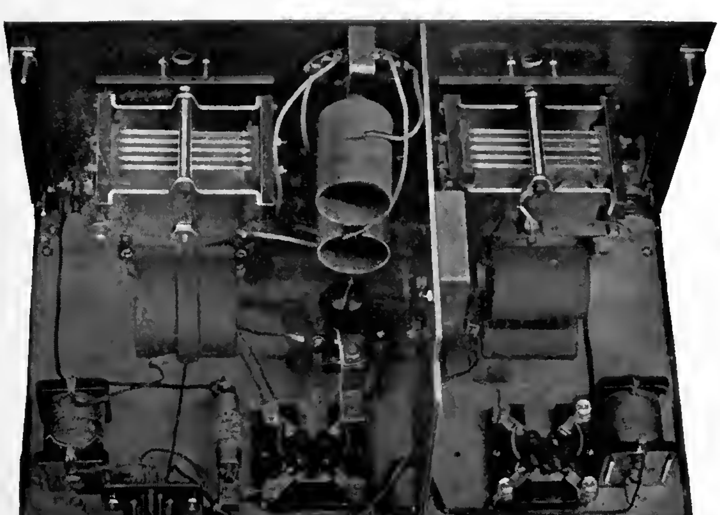
THE table presented here serves not only as a parts list of the material necessary to the assembly of the metal box, but furnishes a key to the various lettered parts appearing in the sketches accompanying this article, Figs. 1 and 2 in particular.

PART LETTER	NAME	SIZE	NO REQ'D.
A	Side Walls	8" x 7" x 3/32"	2
B	Compartment Wall	6 11/16" x 7 27/32" x 3/32"	1
C	Base	13 13/16" x 7 29/32" x 3/32"	1
D	Back Wall	13 13/16" x 7" x 3/32"	1
E	Lid	14" x 8 3/32" x 3/32"	1
F	Front Panel	14" x 7" x 3/32"	1
G	Antenna Binding Post Bracket	1/2" x 2" x 1/16"	1
H	Top Bracket	1/2" Angle Brass	1
I	Front-Side Brackets	" " "	2
J	Side-Back Brackets	" " "	2
K	Side-Base Brackets	" " "	2
L	Compartment Brackets	1/2" Brackets	3
Rc	Insulator Mount For Regen. Cond.	9/16" x 1 3/4" x 3/16"	1
Tc	Insulator Mount For Tuning Cond.	2 1/4" x 3 1/2" x 3/16"	2
ACM	Antenna Loading Coil Mount	1/2" Flat Brass	1
NCM	Neutralizing Cond. Mount	1/2" Flat Brass	1
VCM	Volume Control Mount	9/16" x 1 3/4" x 3/16"	1

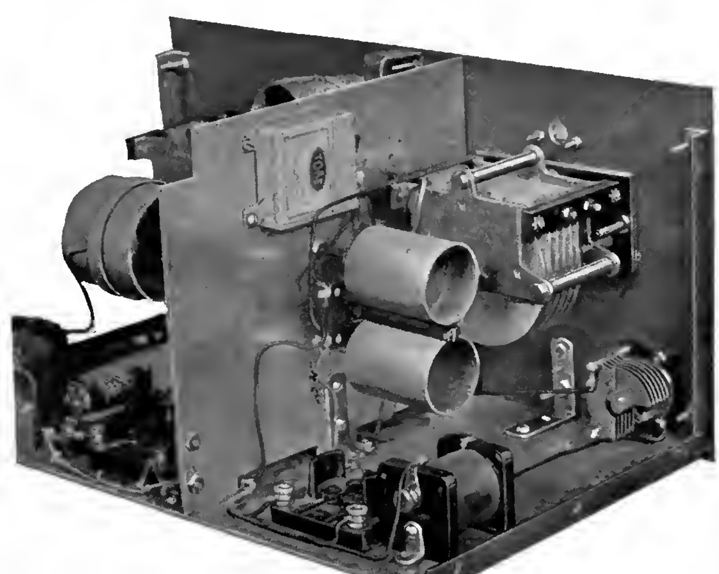
After all the panels, etc., have been laid out and drilled in accordance with the drawings they may be set aside for the moment and the various insulated mountings drilled in accordance with the instructions in the diagrams on page 290. These mountings are necessary to the construction of the tuner unit in preventing the tuning condensers, regeneration condenser, and volume control from coming in contact with the main metal panel, which is at ground potential.

As noted in the parts list, the builder must obtain approximately 96 inches of angle brass and 36 inches of ½-inch flat brass strip.

The angle brass is cut up and drilled to form the connecting pieces for the cabinet. Reference to Fig. 1 will show the location of the various holes and also the several sizes of bracket lengths. The bracket H, that one which is formed into a rectangle to fit to the four sides



RADIO BROADCAST Photograph



RADIO BROADCAST Photograph

LOOKING AT THE INSIDE

Of the receiver reveals the simplicity of assembly of the metal box and also the parts employed in the circuit. These views indicate quite clearly the method employed in mounting the tuning condensers on bakelite mounts which are then fastened by means of screws to the back of the main panel

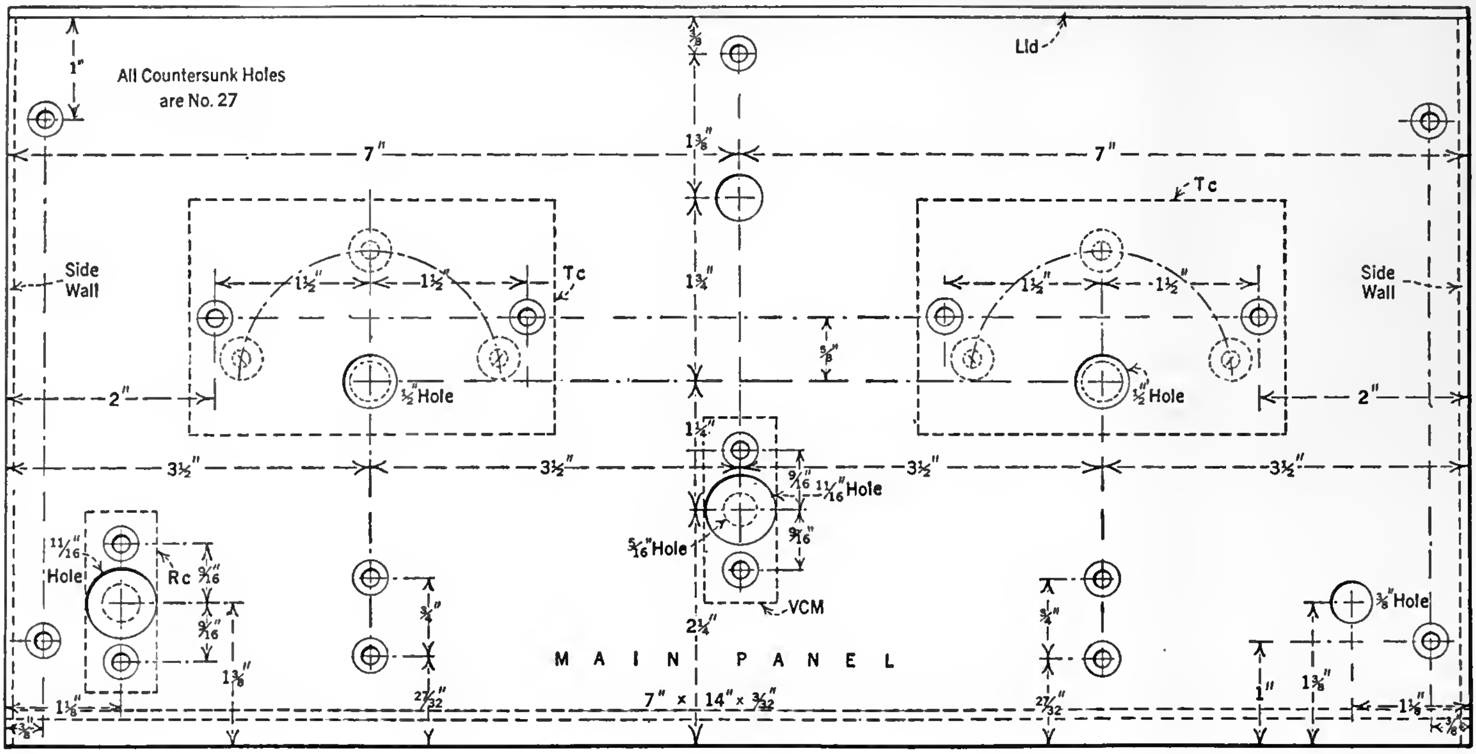


FIG. 3
All the dimensions necessary for locating the holes on the main panel are shown here. In spotting the center-marks of these holes, do not scribe heavily the lines to form the intersection at which a hole is located. A light pencil line will suffice, for such may be rubbed off later. Drill all the holes with a small drill first, then enlarge with larger drills, or with Stevens tapered reamers, to the size specified

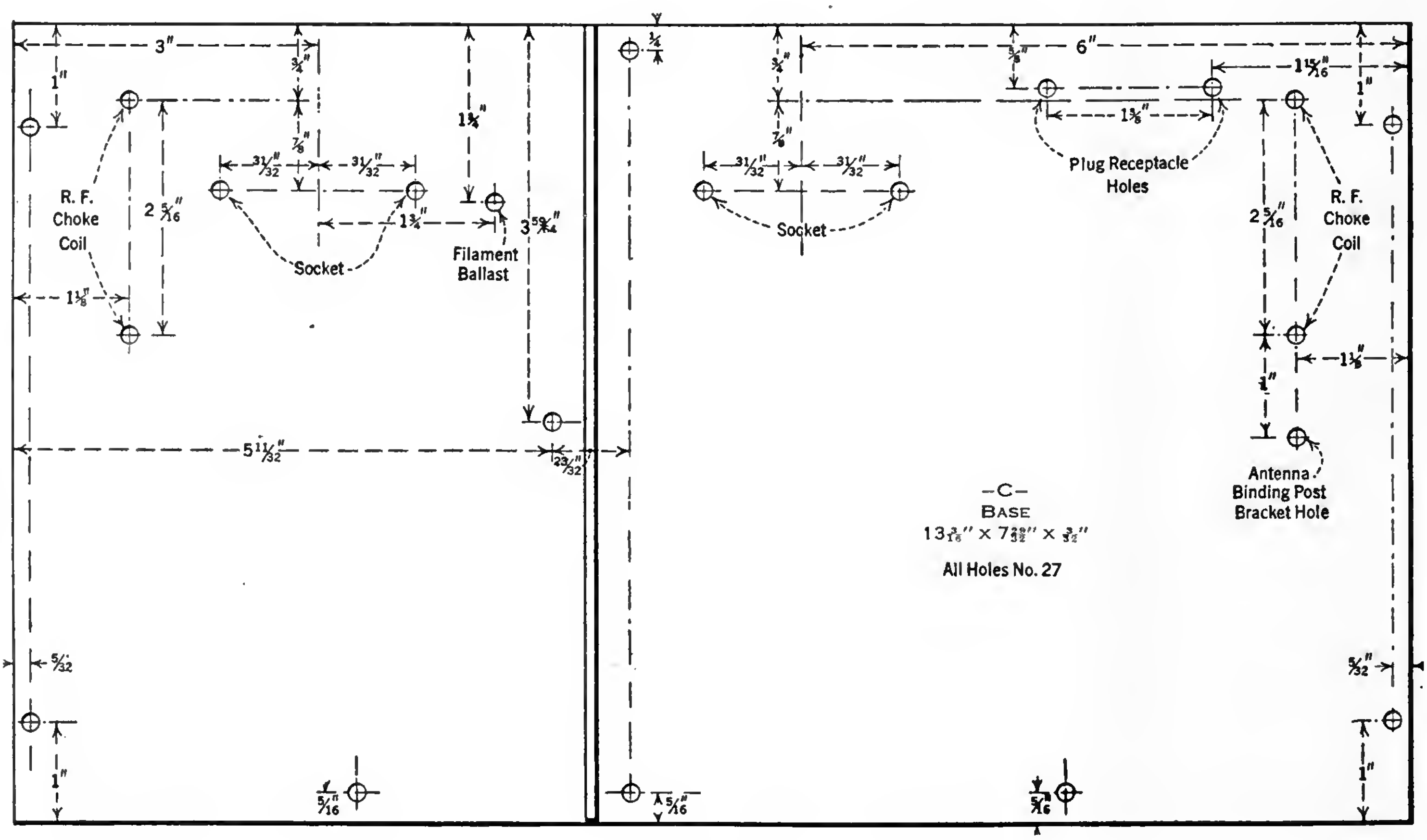
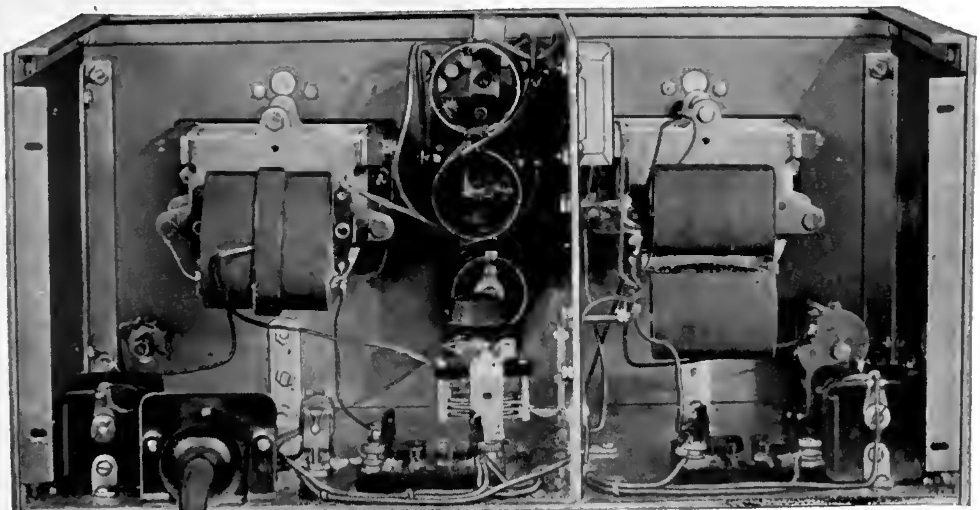


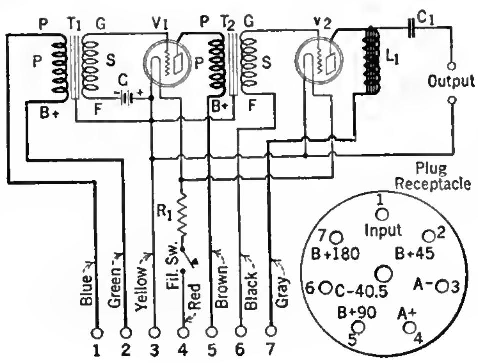
FIG. 4
This diagram shows the placement of the holes in the base for mounting such parts as sockets, choke coils, etc. Note that the antenna binding post bracket is located at the right, directly forward of the r. f. choke coil for the antenna circuit. The post, unfortunately, is not shown in the illustrations which accompany this article



RADIO BROADCAST Photograph

THIS BACK VIEW

Indicates how completely the interstage shield isolates the antenna circuit from the interstage circuit. Behind the binocular coil located in the center of the picture may be seen the 4-point tap switch. The filament and other leads to the connector plug are cabled and bound, as may be observed



THE AUDIO AMPLIFIER

Shown on page 294 is wired in accordance with the circuit diagram which appears above

of the metal cabinet at the top, requires approximately 44 inches of angle brass. It is bent and cut in the manner indicated in H Fig. 1.

It is to be noted by reference to Fig. 3 that the tuning condensers are mounted on their respective rectangles of bakelite in such a manner as to prevent the heads of mounting screws from coming in contact with the metal panel. This is accomplished by deeply countersinking these mounting screw holes so that the heads of the screws are well below the surface of the bakelite. The hole in the metal panel is sufficiently large enough so that the shaft, when properly mounted in its center, does not touch the panel.

MOUNTING THE APPARATUS

AFTER this work is done, the condensers, on their insulated mounts, may be fastened to the main panel as may be the filament switch, tap switch, regeneration condenser, and volume control. The filament switch and antenna tap switch may be mounted directly on the metal panel without the aid of insulation, as these units have their mountings at ground potential. The volume control and regeneration condenser are insulated from the panel by means of the bakelite strip VCM and RC, details of which are shown in Fig. 1.

On the metal base may be mounted the two sockets, two radio frequency choke coils, the filament ballast, antenna binding post bracket, terminal receptacle, and interstage shield. The sockets should be raised off the metal base by means of several washers placed under the socket at the mounting holes. This is so that the UX type tubes do not have their prongs shorted by contact with the base.

At this point the dials may be mounted at the front of the main panel, and then the base and main panel are fastened together by means of the brackets provided for this purpose. The neutralizing condenser is fastened by means of its bracket to the "p" post of the radio frequency stage socket. The protective condenser C_6 in series with the neutralizing condenser C_3, is mounted on the back plate of the tuning condenser, C_1 by means of a $\frac{6}{32}$ brass machine screw which passes through the threaded hole at the end of the condenser C_6. The other terminal of this condenser connects by wire to the neutralizing condenser.

The Gen Win coil units, or, if desired, home-made coils made in accordance with the specifications outlined in Fig. 5, are then located at their respective positions in the receiver. The solenoid coil (the antenna coil), is mounted by means of its brackets directly under the screw heads of the spacer rods of the Cardwell condenser which tunes the secondary circuit of the radio-frequency amplifier stage.

The tapped binocular coil (the antenna loading coil) is mounted on a specially prepared bracket, ACM, details of which are shown in Fig. 1, and fastened to the top center screw hole on the main panel. The other binocular coil—the interstage coil—is mounted on the interstage shield by means of two 1-inch round-head brass machine screws. First the screws are passed through the shield and secured with nuts. Then another set of nuts are screwed on the screws for about $\frac{3}{16}$ of an inch from their ends; the coil is placed on the screw ends and finally fastened with a third set of nuts which firmly hold the coil bracket between the second and third sets of nuts. This mounting is clearly illustrated in Fig. 1. The bypass condenser is also mounted on the interstage shield at the holes provided.

Having accomplished all this, the next step is to wire the receiver. First the filament circuit for both tubes is completed from the Yaxley connector plug receptacle to the sockets, switch, and filament ballast. It is only necessary to connect the minus A terminal of the receptacle to some point on the metal base to complete the circuit to the filament switch and tap switch. In making the other connections from these two units, be sure that the ungrounded terminals are employed since connection has already been made to the side which is common to the mount-

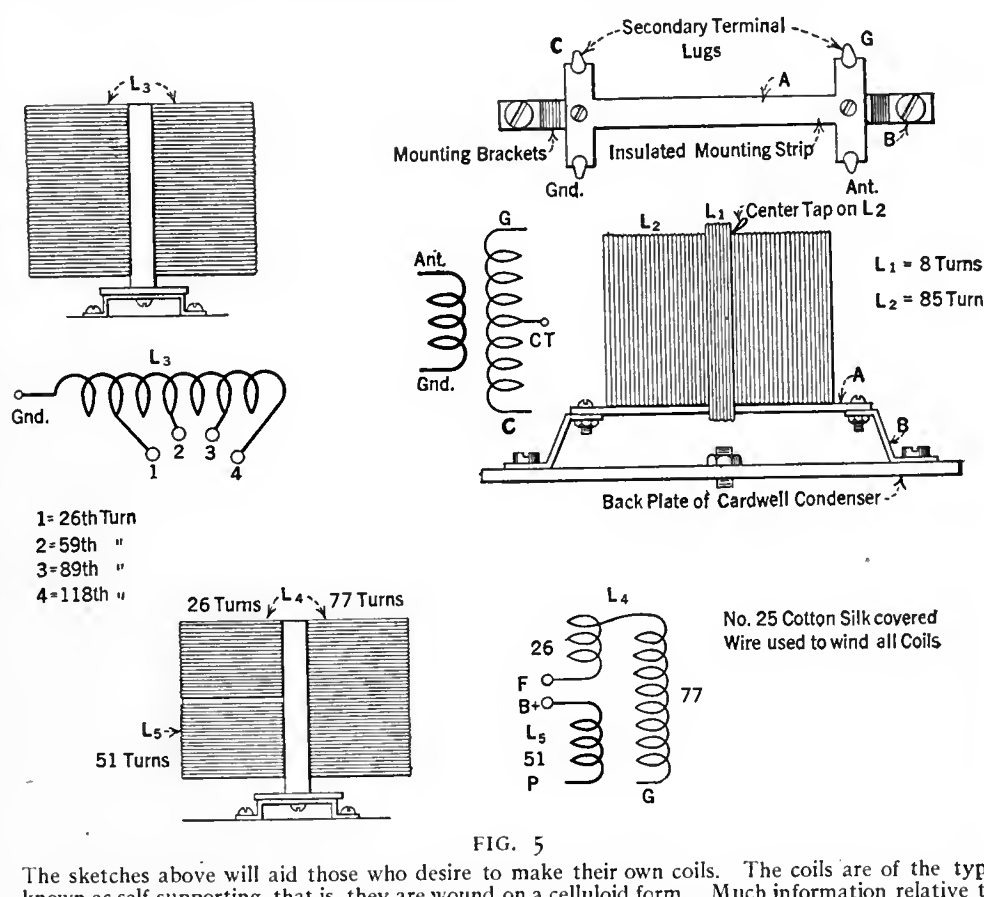
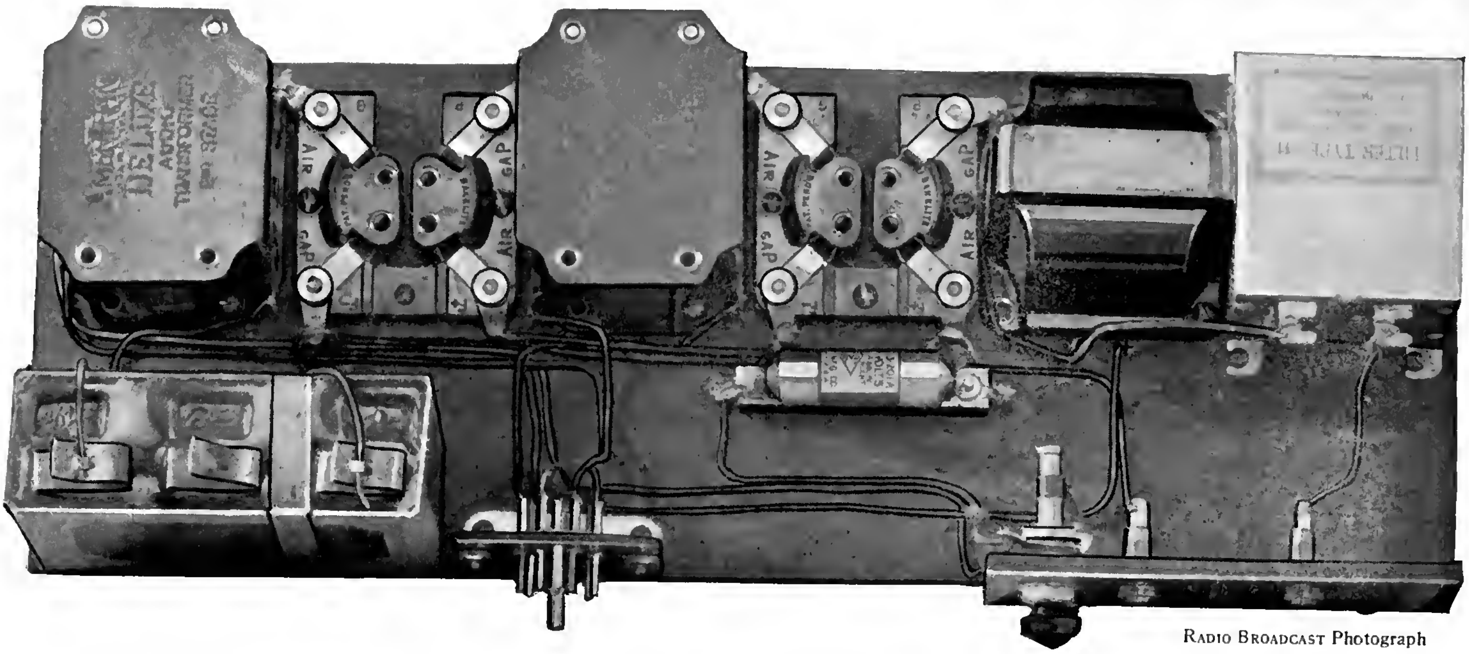


FIG. 5

The sketches above will aid those who desire to make their own coils. The coils are of the type known as self-supporting, that is, they are wound on a celluloid form. Much information relative to the winding of coils may be obtained from the article on coil winding appearing in the March, 1926, RADIO BROADCAST. On the terminal strip of some of the manufactured solenoids, that post marked "F—" should be the C post. The sketch above shows the correct connections



RADIO BROADCAST Photograph

A COMPLETE AUDIO AMPLIFIER

Consisting of Amertran transformers, Airgap sockets, Samson output impedance, Tobe condenser, Yaxley plug, together with the necessary $4\frac{1}{2}$-volt C battery, etc., may be assembled on a base board and stowed away in the cellar or in the lower compartment of a cabinet, as illustrated in the photographs appearing on pages 289 and 295

ing bushing by virtue of connection being made from minus A to the base. The several filament wires may be bound by means of cord to form a cable.

After the filament circuit is completed, the rest of the wiring may be made as direct as possible, that is, from point to point without the usual care of making right angle turns.

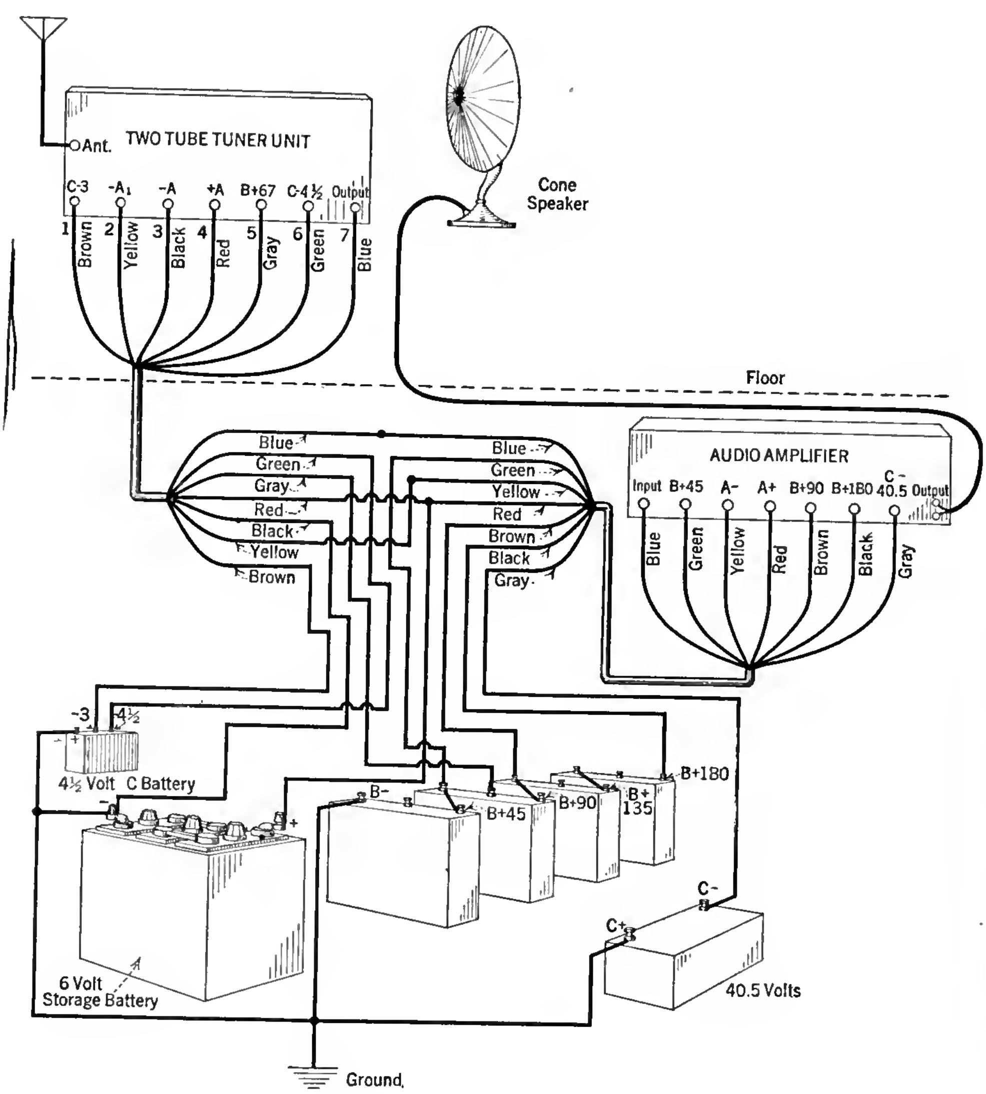
Now the antenna loading coil may be unfastened from the back of the main panel, the angle brass, H, put in place, and the antenna coil remounted over the angle brass. From this point on it is only a matter of fastening the sides, back, and top to the angle brass. As an aid in this, it will be well to frequently refer to the numerous illustrations and sketches accompanying the article.

The builder must, even under the most favorable circumstances, employ his own ingenuity in duplicating the construction described because he has not the opportunity to have before him a model but rather the scale drawings and other sketches that enter into the building of this tuner unit.

Constructors of this two-tube tuner unit will find much that is new and intriguing in departing from the accepted paths of receiver design wherein the audio amplifier is an integral part of the receiver itself. The audio amplifier illustrated above is very simply laid out on a board and, if it is so desired, may be housed in a metal or other box. It works very well with the two-tube R. B. "Lab" receiver.

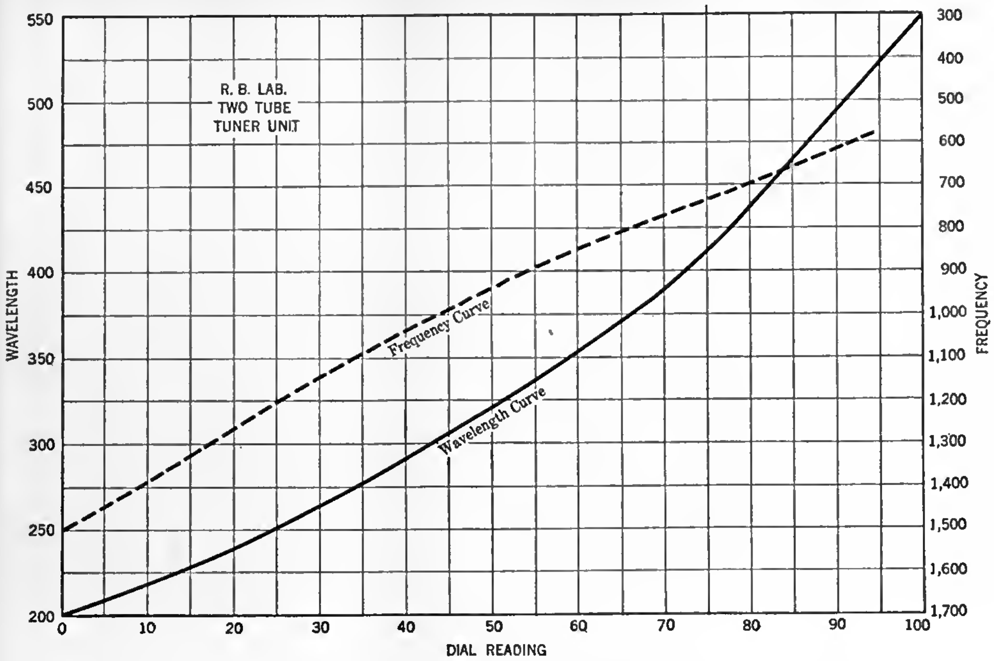
To operate the two-tube tuner unit, connect it to an audio amplifier as shown herewith or to any combined power supply and audio amplifier such as the one described elsewhere in this issue by James Millen.

When all the connections have been completed and the antenna is attached to its binding post, turn on the filament switch and rotate the dials, turning them somewhat in unison. For a long wavelength station, the antenna loading coil tap switch should be turned so as to include the entire loading coil, and for a short wavelength station, this coil should be adjusted to one of the lower taps. Turn the regeneration condenser so that the rotating plates mesh completely with the stationary plates. If a station is broad-



THE ACTUAL HOOK-UP

Of the two-tube tuner unit, the loud speaker, the batteries, and the audio amplifier is easily accomplished by following the circuit shown above. Two Yaxley 7-wire cables aid materially in making this job a simple one



AN APPROXIMATE TUNING CHART

Which will aid constructors in locating dial positions for the stations they are in the habit of listening to

casting, reception will be manifest by a loud squeal. Adjust both tuning dials until the squeal is loudest, back off the regeneration control until the squeal ceases, and in its place will be heard the signals. The volume control enables one to adjust the volume to the desired intensity. With the receiver connected to the amplifier in the manner indicated, the switch on the tuner unit will also control the operation of the audio amplifier.

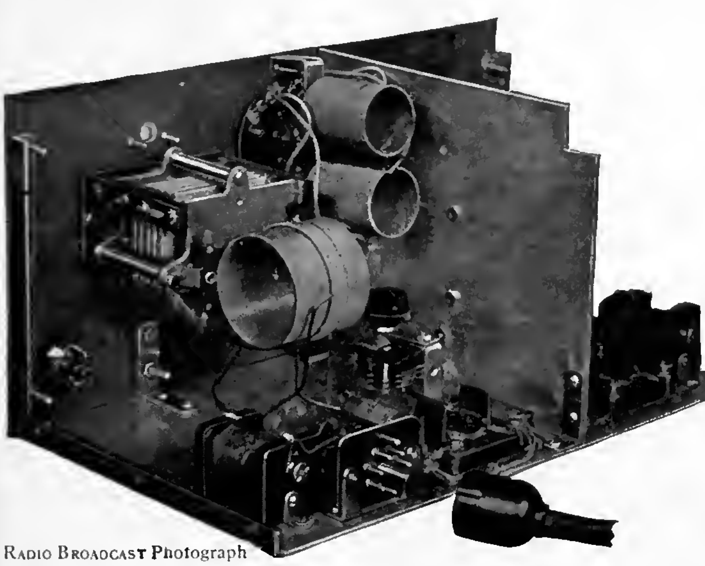
To neutralize the receiver, take a stick about 1 inch wide and cut a wedge at one end which will engage with the knurled surface of the knob on the neutralizing condenser. The procedure is outlined on page 42 of Radio Broadcast for November, 1926. Another method is as follows: remove the plus A filament connection to the radio frequency stage socket *after a station has been tuned-in* and then adjust the neutralizing condenser until the signal received is either entirely eliminated or at a minimum. The receiver is then neutralized and the filament wire may be replaced. It will be necessary to retune the two main condensers with each new adjustment of the neutralizing condenser until a final setting has been obtained.

The first part of this list of parts embraces only those employed in the actual circuit itself and does not include the hardware and metal material necessary for the construction of the metal cabinet, these parts being given in the second half of this list.

L1, L2, L3, L4, L5—1 Kit Gen-Win R. B. "Lab" Circuit Coils	$8.50
L6, L7—2 Radio Frequency Choke Coils, Samson No. 85	$6.00
C1, C2—2 Tuning Condensers, Cardwell Taper Plate, Type 169E	9.50
2 National Dials	5.00
C3—1 Neutralizing Condenser, Precise Type 940, 10-Mmfd.	$1.25
C4—1 Regeneration, Condenser, Precise Type 940, 50-Mmfd.	1.50
C5—1 Isolating Condenser, Tobe Deutschmann, 1-Mfd.	.90
C6—1 Protective Condenser, Sangamo, 0.001-Mfd.	.35
R1—1 Filament Ballast, Brach $\frac{1}{2}$-Amp.	1.00
R2—1 Volume Control, Electrad Royalty Variable Resistance, 0–500,000 Ohms, Type L.	1.50
1 Tap Switch, 4-Point, Yaxley Type 44.	1.00
1 Cable Connector and Plug, Yaxley No. 660.	3.50

MATERIAL FOR THE METAL CABINET

7-$\frac{1}{2}''$ x $\frac{6}{32}''$ Oval-Head Nickel-Plated Machine Screws, with Hex Nuts (for Front Panel Mounting)	.14
$\frac{1}{2}$ Doz. $\frac{1}{2}''$ x $\frac{6}{32}''$ Round-Head Brass Machine Screws with Hex Nuts (for Parts Mounting)	.12
2-1″ x $\frac{6}{32}''$ Round-Head Brass Machine Screws with Hex Nuts (for Coil Mounting)	.04
1 Gross $\frac{1}{4}''$ x $\frac{6}{32}''$ Round-Head Nickel-Plated Machine Screws with Hex Nuts (for Cabinet Assembly)	1.50
36 Inches $\frac{1}{2}''$ x $\frac{1}{16}''$ Flat Brass Strip	.40
96 Inches $\frac{1}{2}''$ x $\frac{1}{16}''$ Angle Brass	1.00
1 Walnut Grained Aluminum Panel 7″ x 14″ x $\frac{3}{32}''$	1.25
1 Sheet, Aluminum Box Material 18″ wide x 48″ long x $\frac{3}{32}''$ thick	3.00
Total	$47.45



Radio Broadcast Photograph

THE ANTENNA STAGE COMPARTMENT

Is shown here with its associated apparatus. Note that only one wire connection is made to the filament switch. The frame of the switch is fastened directly to the panel which is at ground potential and, since the battery is connected to the minus A terminal of the connector plug, which is also grounded, the circuit is completed

Radio Broadcast Photograph

THE CORBETT TABLE CABINET

Houses the audio amplifier and power-supply unit, A battery, and trickle charger, presenting to view only the two-tube tuner unit and loud speaker

LETTERS FROM READERS

Contributions from Readers on Various Subjects of Radio Interest—An Open Forum for All

No Thistles in This Bouquet!

RADIO BROADCAST receives many letters from its readers—both of commendation and condemnation. Either are welcome. Mr. Goddard's credentials, we feel, qualify him to wax verbose should the cause arise, so we feel particularly complimented by his "straight from the shoulder" remarks in his letter of recent date:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

RADIO BROADCAST seems to cover every possible phase of the radio subject in a manner that shows splendid editorial work, and presents a great contrast to the many radio magazines with which the newsstands are flooded. Being in the printing game myself, I can also appreciate the really remarkable way in which the magazine is gotten up. Honestly, words fail me when I try to describe my feelings—and this is not applesauce, either.

I have been very busy for some weeks, and fear that I will have but little time in the near future, but you may rest assured that I shall keep an ear cocked for 2 GY (the experimental station of RADIO BROADCAST) on 7500 kc. (40 meters), and will surely be glad to report the signals. I hear you are using 250 watts now; that should pack a lusty clout out here on that wavelength!

Very truly yours,
H. J. GODDARD (9 EE),
Ellendale, North Dakota.

The Short-Wave Super-Heterodyne

RADIO BROADCAST is always glad to hear from any one who has been helped out by articles which have appeared in the magazine. The thought that the regenerative set (when used with short waves on c. w. work) is in reality a super-heterodyne, is one which may lead eventually to further study of the peculiar problems of the amateur:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

The article in the November RADIO BROADCAST by Mr. George J. Eltz, Jr., with its frank discussion of the disadvantages as well as the merits of the short-wave "super," has helped me to straighten out my ideas with regard to what is and what is not needed in a short-wave receiver.

The fact that the usual "ham" receiver has always been called "regenerative" has been misleading. When used for phone reception, of course, such a receiver is a regenerator, but, when used for c.w., the ordinary "ham" receiver is a super-heterodyne of the sort best adapted to present-day conditions. The first detector and oscillator are in the form of an autodyne, eliminating a tuning control so that we are able to add a control (regeneration control) for regulating the strength of the heterodyne. This increases the sensitivity of the receiver and decreases radiation.

The intermediate frequency happens to be so low that it is audible, which has three distinct advantages: The autodyne is more efficient because we can tune closer to the signal frequency. The necessity for a second detector and another heterodyne is removed because we can listen to the intermediate frequency itself. We get no long-wave QRM.

Audio amplification simply consists of further amplifying the intermediate frequency—already audible.

Is it a super-heterodyne? I believe it is.

Mr. Eltz's receiver is more sensitive and produces louder signals than the "ham" variety, but the latter could be made to give the same results if it were desirable!

Any signal too weak to operate the first detector is, of course, lost to either kind of receiver. A signal which operates the first detector, but is too weak to make an impression on the untuned, non-regenerative transformer of the "ham" receiver, may be picked up and amplified by Mr. Eltz's tuned, regenerative transformers.

Here is the point: Tuned, regenerative, audio frequency transformers can be used in our "ham" receivers, but we do not want to use them at present. There are hundreds of wobbly notes on the air at present on the 7500-kc. (40-meter) band which would not stand for a peaked transformer. When the great majority of amateur stations are using crystal control (or its equivalent), we can and shall use tuned regenerative audio stages. The result will be a receiver which is even more sensitive than Mr. Eltz's super-heterodyne.

To produce louder signals, more audio stages can be added, the limit being the noise level at the location in question. In my own case, any signal which is above the very high noise level is a good loud signal with only one stage of audio.

It might be better if the attention of the experimenters be devoted to more pressing problems such as non-radiating short-wave receivers, five-meter (60,000 kc.) work, steadier signals, etc.

Very truly yours,
JAMES T. McCORMICK (9 BHR),
Topeka, Kansas.

More About "Pirating"

IT IS a far cry from the pirates of olden days to the modern pirates who are providing chaos in the air by promiscuous broadcasting on whatever wavelength they may happen to choose. There was a certain amount of glamour attached to the old pirates, while the modern ones on the other hand remin done of the mischievious pranks of the small boy who destroys other peoples' pleasure with a total disregard for their feelings. The whole procedure is rather childish when you stop to think of it, and those stations who are causing annoyance are merely cooking up a dish which they will have to eat later, and without relish. Readers in various parts of the country continue to send in complaints regarding the matter. Heterodyning between stations is more than frequent, and is not confined to isolated communities. RADIO BROADCAST has always taken a rather firm stand on this question, and we are glad that our readers agree with us. Here are two letters which express unmistakably the feelings of the writers:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

I read all of the radio magazines more or less regularly and find some good features in all, but it seems to me that RADIO BROADCAST is far and away the superior in the field, both in the standard maintained by the advertising department (which is truly appreciated) and in the interest of the reading matter.

I should like to air my views about the switching of wavelengths by broadcasters without Secretary Hoover's permission. The average listener with a sensitive set has had enough interference between stations in the past without suffering any further increase.

Some contend that all should have equal rights in the broadcast field and make watchwords of "monopoly" and "censorship." My notion is that the pioneer developers of radio broadcasting, such as the Radio Corporation, Westinghouse, Western Electric, and others, have as much right to their wavelength as the man who discovers a gold field and gets first choice of claims there. These companies risked their money when the returns were uncertain, and they should be protected now that others are rushing in to obtain some of the benefits of their pioneering.

As to censorship, the second catchword, as long as stations, such as WEAF, WJZ, KDKA, WLW, WSAI, and certain others continue the type of program they have been giving, let there be that kind of censorship. Whenever the censorship fails to give the people what they want, you will hear from the people, rather than from other broadcast stations and reformers.

Very truly yours,
JAMES B. TANEY,
Salem, Virginia.

And here, is the other one:

Editor, RADIO BROADCAST,
Doubleday, Page & Company
Garden City, New York.

SIR:

If last night (October 30, 1926) was a criterion of the coming winter in radio, God help the poor radio fan. Talk about interference!

We have three stations in Boston, and our favorite, WEEI, was broadcasting the Balkite Hour, with Mr. Damrosch conducting. At 9:15 another station started up, possibly WLS, Chicago, and we had the joyous combination of Mr. Damrosch, a sweet heterodyne whistle, and a background of distorted but audible jazz. .

About the other stations: WNAC heterodynes beautifully with WSB. Broadcaster WBZA has three stations which heterodyne it, two in Chicago, and one somewhere else. There were eleven cases of heterodyning on the short-wave band below WPG, Atlantic City, not counting the locals.

Does the radio industry need laws to save itself? No one needs a radio receiver to listen to whistles, and if that is all we are to hear, the set might as well be in the ash heap.

Very truly yours,
HAROLD A. STURGES,
South Hamilton, Massachusetts.

The *Radio Broadcast* LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of RADIO BROADCAST *have until recently been answered either by letter or in "The Grid." The latter department has been discontinued, and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," appears this series of Laboratory Information Sheets. These sheets contain much the same type of information as formerly appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* RADIO BROADCAST *of much greater interest to our readers.*

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department. The first index appeared in November.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are requested to send their questions to the Technical Information Service of the Laboratory, using the coupon which appears on page 318 of this issue. Some of the former issues of RADIO BROADCAST, *in which appeared the first sets of Laboratory Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company at Garden City, New York.*

No. 57 RADIO BROADCAST Laboratory Information Sheet January, 1927

What is Resonance?

AN ELECTRICAL ANALYSIS

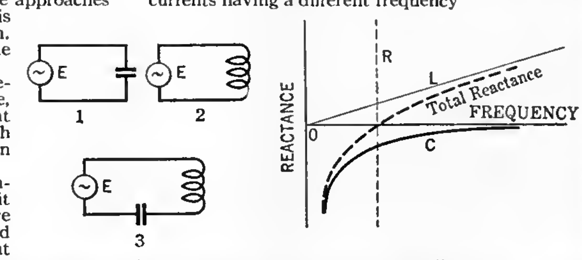
IT HAS frequently been said that, in order to receive any particular station, we must tune the various circuits of our receiver to resonance with the incoming frequency. We shall endeavor, in this sheet, to explain what is meant by resonance.

In the accompanying sketch, first refer to "A." Diagram No. 1 is a simple circuit consisting of some source of alternating voltage, marked E, in series with a condenser. The reactance or impedance offered by the condenser to the flow of current depends upon the frequency, and, if we plot a curve showing the change of reactance with frequency, we will get a curve similar to that marked C, in "B." As the frequency increases, the reactance of the condenser decreases, and the curve approaches the zero line. Capacitive reactance is usually considered negative, as shown, in order to indicate that it is opposite in effect to the inductive reactance.

If the condenser in the circuit is replaced by a coil of wire, or inductance, as shown in No. 2, "A," we find that the inductive reactance increases with an increase in frequency which is shown by the curve marked L on "B."

Now, if we connect both a condenser and an inductance in a circuit as shown in No. 3, "A," we will have a combination of the effects produced by both of them. Remembering that the effective resistances or impedances are opposite in sign, we may add the two curves together and the result will be a curve such as that marked "Total Reactance" in "B." At one point we notice that the line passes through zero, this point being indicated by the dotted line marked R. In other words, at this point, the total reactance in the circuit is zero, the reactance which is due to the condenser cancelling out the reactance due to the inductance.

When a circuit is tuned to resonance, the capacity and inductance are so proportioned that their effect in the circuit are nullified, and, as more current will flow in a circuit of least resistance or reactance, the combination will offer very little opposition to the currents having a frequency of R in the diagram but will offer considerable resistance to any other currents having a different frequency



No. 58 RADIO BROADCAST Laboratory Information Sheet January, 1927

The UX-171 and UX-210

A COMPARISON

BOTH of these tubes are suitable for use in the last stage of audio amplification, but under certain conditions one tube is to be preferred over the other.

By glancing at the table, it will be seen that the output resistance is lower for the 171 than the 210 for all values of plate voltage. The greatest transfer of energy occurs between a tube and a speaker when their impedances are matched. As most loud speakers have very little impedance at low frequencies, it is advantageous to use a tube such as the 171 which has a very low plate impedance. This compensates to some extent the low amplification factor of 3. From the figures given for the maximum undistorted output, it can be seen that, with 180 volts on the plate, the 171 will deliver to the load 700 milliwatts of power. This is about the same power as can be obtained from a 210 with about 300 volts on the plate. However, at 425 volts, the 210 is capable of delivering more than twice the undistorted power of a 171. It is quite evident then, that the 171 is somewhat to be preferred for ordinary signal strength such as is needed in the home, and that for unusual volume, such as concert work in large halls, the 210 would prove more satisfactory.

TUBE	GRID VOLTS	PLATE VOLTS	OUTPUT RESISTANCE	MAXIMUM UNDISTORTED OUTPUT (MILLIWATTS)	AMPLIFICATION FACTOR	PLATE CURRENT
UX-171	16.5	90	2500	130	3	10
	27	135	2200	330	3	16
	40	180	2000	700	3	20
UX-210	4.5	90	9200	18	7.5	3
	9	135	8000	65	7.5	4.5
	10.5	157.5	7400	90	7.5	6
	18	250	5600	340	7.5	12
	27	350	5100	925	7.6	18
	35	425	5000	1540	7.7	22

No. 59 RADIO BROADCAST Laboratory Information Sheet January, 1927

What are Harmonics?

THEIR ELECTRICAL CHARACTERISTICS

PRACTICALLY none of the sounds that we hear can be said to be pure, in the sense that they contain only one frequency. Several different persons could all sing the same note and yet the different voices would be easily distinguishable. A violin and a flute might play the same note, but they would sound entirely different.

The factor which causes this difference is the existence in practically all sounds of various harmonics, or overtones, about which something has been said in Laboratory Sheet No. 51. In the present Sheet, we will explain, from an electrical standpoint, what harmonics are.

Acoustically, the difference between a fundamental note and, say, its fifth harmonic is that the pitch of the harmonic is five times as high as the pitch of the fundamental. Electrically, the difference is that, for every time that the fundamental note goes through one cycle, the fifth harmonic goes through 5 cycles. This relation between a fundamental and any of its harmonics always is true, *i. e.*, while the fundamental passes through one cycle, a harmonic passes through a number of cycles, depending upon what harmonic it is; the second harmonic passes through two cycles, the third harmonic passes through three, the fourth through four, and so on.

A cycle comprises one complete alternation of the wave and, therefore, to produce one cycle the wave must start at zero, rise to a positive maximum, decrease to zero, rise to a negative maximum and again decrease to zero.

The sounds created by instruments are practically always very complicated and contain many harmonics. The violin, as an example, produces a very complex note containing a very prominent third harmonic, and many other harmonics as well, while some of the notes produced by a flute are perhaps the purest of any sounds that are generated by musical instruments.

Many amplifying systems are not capable of amplifying the low notes but fortunately a considerable decrease in amplitude in these low frequencies is hardly noticeable to the ear. It is also generally true that the harmonics of these low notes will have the same effect on the ear as the fundamental note. Consequently, if an organ sounded a chord which contained a 30-cycle note and only the second harmonic, 60 cycles, of this note was heard, it would give the same effect to the ear as the fundamental note of 30 cycles. This characteristic, combined with the fact that these low notes are very seldom used, makes it hardly worthwhile to go to any great expense to set up apparatus capable of giving exact amplification of these low frequencies.

No. 60 RADIO BROADCAST Laboratory Information Sheet January, 1927

Filter Circuit Data

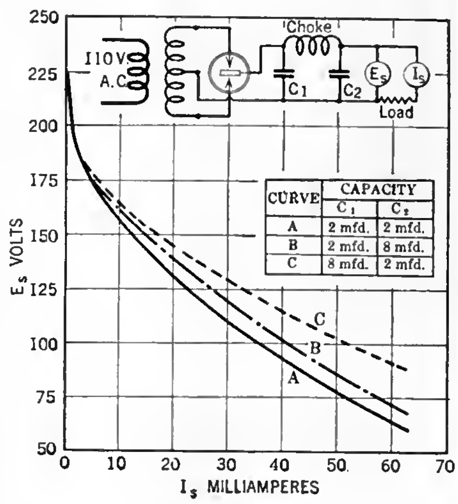
CONDENSER VALUES

SOME interesting data were given in the General Radio *Experimenter* of July, 1926, regarding the characteristics of filter circuits for use with B current-supply devices.

In the diagram, the condenser marked C_1 may be called a reservoir condenser as its function is to store up energy during the peak of the wave and feed it back into the circuit at the lower values of the wave. This condenser is especially valuable in keeping the voltage more nearly constant with varying loads. A small condenser at this point will cause the voltage to drop off very readily with increasing load.

The condenser marked C_2 is placed across the output, and is especially valuable in eliminating any ripple. The curves given on this sheet indicate the effect obtained with different values of condensers in the two positions. It should be noted that an increase in either one of these condensers improves the regulation (curve B and C both showing a decrease over A in voltage drop), due to increasing the size of the load. Curve C shows the best regulation where C_1 is the larger. This indicates that an increase in C_1 is more effective in improving the voltage regulation than C_2. An oscillograph would show that an increase in either condenser would tend to eliminate the ripple, but that less ripple would be obtained by increasing C_2 rather than C_1.

Both experiment and theory seem to indicate that, with a certain total capacity in the current, the best regulation and the least ripple are obtained by making both of the condensers of the same value.



The curves shown are for a single section filter using the Raytheon tube as a rectifier. A multi-section filter would, however, give the same type of curves.

No. 61 RADIO BROADCAST Laboratory Information Sheet January, 1927

The Intermediate Frequency Amplifier

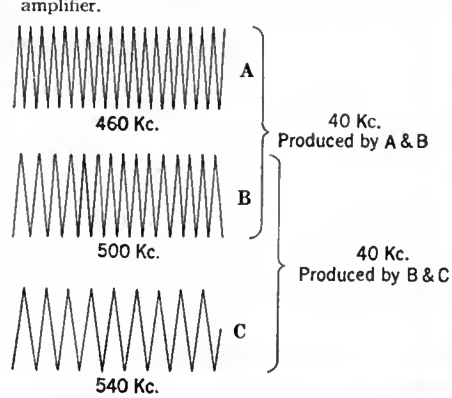
CHOOSING THE BEST FREQUENCY

THE best operating frequencies for intermediate-frequency amplifiers are 45, 55, 65, etc. rather than 40, 50, or 60. kc.

At the present time, broadcasting stations are supposed to be separated by a frequency of 10 kilocycles. Consequently, it is quite possible for any two stations to be separated, by, say, 40 kilocycles. If two stations, one strong and the other weak, are separated by this amount, it may be quite difficult to completely separate them by means of a single tuned circuit such as a loop. Therefore, both of these frequencies will be present in the loop circuit, and will beat with each other to produce a frequency equal to the difference between their respective frequencies. That is, a station on 500 kilocycles would heterodyne a station on 460 kilocycles to produce a 40-kilocycle note.

Should the intermediate-frequency amplifier happen to be tuned to this frequency, both stations will be heard in the output, even though the oscillator is removed from the circuit. If, on the other hand, the intermediate frequency amplifier is tuned to 45 kilocycles, only the heterodyne beat between the station wanted and the oscillator would be amplified.

We have endeavored to show this idea in the diagram where a 40-kc. intermediate amplifier is used: "A" is the interfering station, "B" is the station desired, and "C" is the wave produced by the oscillator. C is tuned to 540 kilocycles and produces a 40-kc. beat note or heterodyne with the desired signal B which is fed to the intermediate-frequency amplifier. However, at the same time, we will suppose that there is a powerful local station operating on 460 kilocycles (indicated at A), and the interaction between A and B also produces a 40-kilocycle beat note. The result is, that the station broadcasting on 460 kilocycles will also be heard through the amplifier. When stations whose frequencies are multiples of 10 heterodyne, they naturally produce a beat note which also is a multiple of 10. By designing the intermediate amplifier for a frequency which is not divisible by 10, it will, therefore, exclude beat notes of two heterodyning stations if such are divisible by 10. Hence the desirability of a 45-, 55-, or 65-kc. intermediate amplifier.



APPROVED BY 18 MONTHS OF PUBLIC USE

NO OTHER BATTERY IS LIKE IT

The Layerbilt patented construction revealed. Each layer is an electrical cell, making automatic contact with its neighbors, and filling all available space inside the battery case.

Eveready Layerbilt "B" Battery No. 486, the Heavy-Duty battery that should be specified for all loud-speaker sets.

★

Practical tests have shown this to be the most economical of "B" Batteries

In daily use in the home, Eveready Layerbilt "B" Battery No. 486 has fulfilled the promises made for it in laboratory tests. More than a year's study of the performance of this battery in the hands of the public has shown that it is the most satisfactory and most economical "B" battery ever developed. All loud-speaker sets require Heavy-Duty batteries—and the Layerbilt has proved itself absolutely the best of them all.

If you are now using the smaller, Light-Duty batteries, the Eveready Layerbilts will give you twice the service though they do not cost anything like twice as much. If you are already using Heavy-Duties, the Layerbilt, the longest lasting Heavy-Duty ever built, will run your set at least 25% longer, and again you will save money. Unless Eveready Layerbilts now are connected to your set, you spend more on "B" batteries than you should, and you can have no idea how good a "B" battery can be. The Layerbilt holds a surprise in store for you.

Eveready Layerbilt's unequaled service is due to its unique construction. All other dry cell "B" batteries are made of cylindrical cells, with many soldered connections, and a great deal of space is wasted between the cells. The Layerbilt is built up of layers of *flat* current-producing elements, that make connection with each other automatically, and that fill all available space inside the battery case. It is every inch a battery. In it you get more active materials than in any other battery and the Layerbilt construction makes those materials much more efficient current producers.

Those are the convincing reasons why the Eveready Layerbilt has proved itself the longest lasting, most economical and reliable "B" battery ever built.

Just remember this about "B" batteries—Heavy-Duty batteries are more economical than the smaller Light-Duty batteries on all loud-speaker sets, and the patented exclusive Eveready Layerbilt No. 486 is the most economical of all.

Manufactured and guaranteed by

NATIONAL CARBON CO., Inc.

New York San Francisco

Canadian National Carbon Co., Limited
Toronto, Ontario

Tuesday night is Eveready Hour Night—9 P. M., Eastern Standard Time, through the following stations:

WEAF–*New York*	WTAM–*Cleveland*
WJAR–*Providence*	WWJ–*Detroit*
WEEI–*Boston*	WGN–*Chicago*
WTAG–*Worcester*	WOC–*Davenport*
WFI–*Philadelphia*	WCCO { *Minneapolis* / *St. Paul*
WGR–*Buffalo*	
WCAE–*Pittsburgh*	KSD–*St. Louis*
WSAI–*Cincinnati*	WRC–*Washington*

No. 62 — Radio Broadcast Laboratory Information Sheet — January, 1927

Antenna Power Dissipation

DISTRIBUTION OF ENERGY

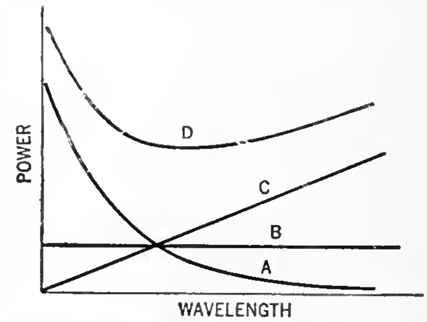
THE power supplied by an oscillator to a transmitting antenna, is dissipated in three ways: First, in the form of radiation; second, in the form of heat due to resistance of the wires in the circuit; third, in the form of heat due to dielectric absorption.

Only the first of these factors represents a useful dissipation. This radiation is the power which travels out from the antenna in the form of electromagnetic waves (as signals). Curve A in the accompanying drawing shows how the radiated power varies with the wavelength, it being proportional to the square of the antenna current, and inversely proportional to the square of the wavelength.

Curve B represents the power used up in the resistance of the wires. This is a straight line and does not vary with the wavelength. In actual practice, the eddy current loss and skin effect might be slightly greater at the lower wavelengths, but the variation is so small that it may be neglected.

Curve C illustrates the variation with wavelength of the power absorbed in the dielectric, and, since this absorption is proportional to wavelength, the curve is a straight line. This loss is due to trees, buildings, masts, or other objects in the vicinity of the antenna which absorb power.

Curve D represents the total power in the antenna, and is equal to the sum of the three separate curves. In taking curves such as this on an antenna, it is quite possible to obtain humps at certain wavelengths. This generally indicates the presence of some circuit in the vicinity of the antenna with a natural period of oscillation at that wavelength.



No. 63 — Radio Broadcast Laboratory Information Sheet — January, 1927

Line Power-Supply Devices

CALCULATION OF RESISTANCE VALUES

IN ORDER to obtain four output voltages from a line power-supply device we will place four resistances, R_1, R_2, R_3, R_4, in series across the total output of the device. One end of R_1 will connect to the negative B and one end of R_4 will connect to the maximum voltage terminal of the device.

The positive voltage tap, E, for the detector (22½ or 45 volts) will be taken off between R_1 and R_2. The voltage, E_2 (generally 90 volts), for an r.f. amplifier, will be taken off between R_2 and R_3. Voltage E_3, with a value of, say, 135 volts, will be obtained from a tap connected between R_3 and R_4. E_4 is the maximum voltage of the unit.

In order to calculate these resistance values, we must assume that a certain amount of current flows through the resistance R_1. An average value that can be assumed is 5 milliamperes, or 0.005 amperes. If we assume this current to flow through R_1, and that we desire 22½ volts for the detector, then $R_1 = 22.5 \div 0.005 = 4500$ ohms. If the voltage required is to be 45, then $R_1 = 45 \div .005 = 9000$ ohms.

The voltage across R_2 is $90 - 22\frac{1}{2} = 67\frac{1}{2}$, and as the detector plate current at 22½ volts is usually about 0.0005 amperes, this current, plus the 0.005 amperes loss current, flows in R_2, hence $R_2 = 67.5 \div 0.0055 = 12{,}300$ ohms approximately. In the case of 45 volts on the detector, the R_2 voltage would be 45 (90 — 45) but the detector plate current at 45 volts is now about 0.001 amperes, hence $R_2 = 45 \div 0.006 = 7500$ ohms.

To determine the current in R_3, we must know the plate current taken by all the tubes operating at 90 volts. Assuming there are two r.f. tubes (UV-201-A) only, the current taken by each when biased at 4.5 volts is 0.002, or 0.004 for both. The voltage across R_3 is $135 - 90 = 45$, and the current flowing in R_3 is $0.005 + 0.0005 + 0.004$ (for a detector plate voltage of 22½), therefore $R_4 = 45 \div 0.0095 = 4750$ ohms approximately. In the case of 45 volts on the detector plate, with 0.001 amperes flowing, we have $R_3 = 45 \div 0.01 = 4500$ ohms.

The current in R_4 is the sum of all the currents plus the current in the plate of the first audio tube (UV-201-A). The plate current in an UV-201-A at 135 volts with 9 volts negative bias is 0.0025 amperes and, in the case of 22½ volts detector, the total current in R_4 is $0.0005 + 0.005 + 0.004 + 0.0025$ or 0.012 total. The voltage across R_4 is $400 - 135 = 265$. Hence, $R_4 = 265 \div 0.012 = 22{,}000$ ohms approximately.

CASE 1.

1 UV-201-A Detector, 22½ volts.
2 UV-201-A R. F. 90 volts, Neg. bias 4½.
1 UV-201-A A. F. 135 volts, Neg. bias 9.
1 UX-210 A. F. 400 volts, Neg. bias 30.
$R_1 = 4500$, $R_2 = 12{,}300$, $R_3 = 4750$, $R_4 = 22{,}000$

CASE 2.

Same as above except 45-Volt Detector.
$R_1 = 9000$, $R_2 = 7500$, $R_3 = 4500$, $R_4 = 21{,}200$

No. 64 — Radio Broadcast Laboratory Information Sheet — January, 1927

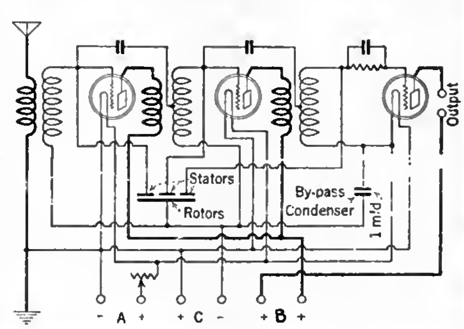
The Gang Condenser

CORRECT CONNECTIONS

SINCE the appearance on the market of gang condensers, that is, condensers having a common shaft and working in unison, many readers have requested information as to how they should be connected. The difficulty in connecting them usually arises from the fact that all of the rotor plates are connected together, thus making it impossible to get a positive return lead for the detector tube, while the radio frequency tubes of necessity must be negatively baised.

By looking at the diagram, it will be noticed that the filament return of the detector tube coil does not connect to the variable condenser but to the positive filament lead. A path for the radio frequency current is provided through the bypass condenser, as shown, to the tuning condenser. An alternative way of connecting is to allow the coil to be connected to the condenser, making the grid positive by connecting the grid leak directly between the grid of the tube and the positive filament. The grid condenser prevents the short circuiting of the batteries.

When a gang condenser is used, the coils must be carefully matched in order to minimize any inequalities between them. In spite of careful matching, there are bound to be some discrepancies, and it is frequently necessary to use a separate condenser in the antenna circuit, as outlined in Laboratory Sheet No. 33. Some gang condensers are provided with small condensers in parallel with the main condensers, which may be used to bring each circuit into exact resonance.

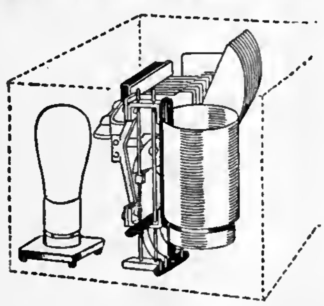


YOU CAN BUILD THE NEW SHIELDED HI-Q*

The Hammarlund-Roberts Board of Engineers

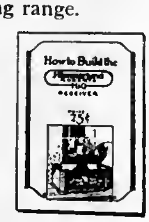
The Hammarlund-Roberts Hi-Q Receiver is the joint creation of ten leading engineers. A wealth of experience plus highest reputation for quality parts guarantee unexcelled performance.

Benjamin Electric Mfg. Co.	Martin-Copeland Co.
Carter Radio Company	Radiall Company (Amperite)
Durham Resistors	Samson Electric Co.
Eby Manufacturing Co.	Sangamo Electric Co.
Hammarlund Mfg. Company	Westinghouse Micarta



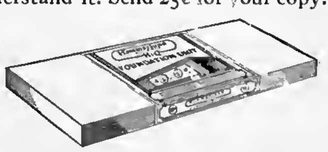
Automatic Variable Coupling

A wonderful new feature. Same control operates both tuning condenser and primary coil coupling. This gives maximum and equal amplification and selectivity over entire tuning range.



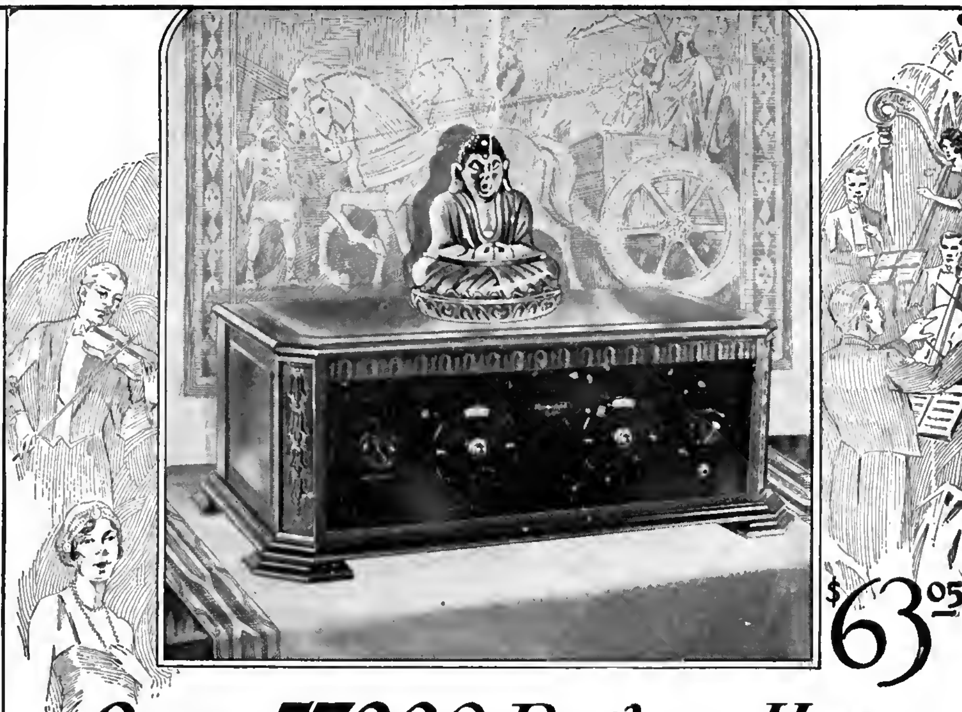
"How to Build It" Book

Written by the Hammarlund Roberts Board of Engineers in very simple A B C language. Every detail described, numbered and diagrammed so that you can easily understand it. Send 25¢ for your copy.



The Hi-Q Foundation Set

The Key to this wonderful receiver. Includes drilled and engraved panel, and sub panel and all the essentials required to start building. Price **$10.50.**



$63.05

Over 57,000 Built at Home

You Can Do It Too

LAST year 57,453 radio lovers had the fun of building the Hammarlund-Roberts Receiver at home—a wonderful tribute to the genius of America's ten leading engineers who designed this remarkable instrument.

The new Hi-Q Receiver is even more wonderful than our set of last year. A study of its modern features will disclose simple dual tuning, Complete Shielding, Automatic Variable Coupling, high detection efficiency, high power output and utter absence of oscillation.

An inspection of any home-built Hi-Q Receiver will prove that here for the first time 5 tubes equal 8. Actual test will prove a sensitivity equal to that of expensive "Supers." Reception is startling both in distance and power; volume is full and all signals have those rich, undistorted tones which fall like a caress on the most sensitive ear.

Save $50 to $100—Build it Yourself

When over 57,000 novices have built successful Hammarlund-Roberts Receivers, you can build one, too. Send 25c for the "How to Build It" Book or get a copy from your dealer. Follow the simple directions, solder a few connections and in a few hours you, too, will have the satisfaction of having built one of the world's finest receivers at half the price of factory-made sets not nearly so good.

Hammarlund ROBERTS Hi-Q* ★

*High ratio of reactance to resistance. High ratio—Great Selectivity—Long Signals

HAMMARLUND-ROBERTS, Inc., 1182-A Broadway, New York

"Now, I Have Found . . ."

A Department for the Exchange of Ideas and Suggestions of Value to the Radio Constructor and Operator

Contributions to this department are welcome and those used will be paid for at the usual rates, that is, from two to ten dollars each. Manuscripts intended for this department should not exceed about three hundred words in length, and should be typewritten. Little consideration can be given to manuscripts not typewritten. Envelopes should be addressed to this department, RADIO BROADCAST, *Garden City, New York.*

Filter System for Cone Speaker

I have been reading with much interest, the various ways of revamping Western Electric cone speakers. I have seen several articles in RADIO BROADCAST and quite a number of methods have been described in other magazines, but none have worked satisfactorily for me.

The Western Electric cone and RCA cone are somewhat alike, being made under the same patents and having the same mechanism. I borrowed an RCA impedance transformer, such as is used in a model 100 loud speaker, and put it in a Western Electric cone, and the results were wonderful.

The way to build this transformer is very simple and cheap. Make an iron core with haywire, the size of a lead pencil, and cut the core $2\frac{1}{2}$ inches long. Wind on this core a coil $\frac{7}{8}$ inches in diameter, using No. 30 silk enameled wire. Connect this coil in series with the speaker and put a Dubilier condenser, capacity 0.01 mfd., across the speaker terminals, and one condenser of the same capacity across the input to the speaker.

The diagram Fig. 1, shows clearly the method of wiring. This device, I have found, will match a Western Electric cone speaker perfectly, with an UX-120 tube, and give very good results with other tubes.

The device is used by the Radio Corporation in all Model 100 speakers, and if properly made, will reproduce low and high notes perfectly with plenty of volume.

W. C. GRASEL,
St. Louis, Missouri.

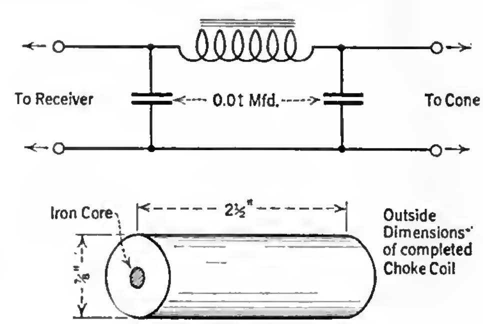


FIG. 1

Testing Fixed Condensers

The testing of small fixed condensers can best be accomplished by connecting an ordinary six-volt battery across them. If there is a "short" in the condenser, a good spark will be obtained whenever the connections are completed to the two terminals of the battery. The use of ear phones in series with a small battery for testing by the clicks heard is more or less deceptive unless the operator is thoroughly familiar with this type of testing. There is a distinct click, due to the discharge of the condenser, when there is no short present, which may easily be taken to indicate a short. In testing the larger sized fixed condensers, from 0.5 microfarad up, the best method for testing is to apply about 90 volts to the terminals. Then take the connections off and short the terminals with a screw driver or short piece of wire. A good strong spark indicates that the condenser is O. K. If the charge leaks off very rapidly after the battery voltage is removed, it indicates that there is a leak present whether it shows up or not. A shorted condenser will give no spark after the potential has been removed. A defective condenser may sometimes be repaired by connecting the terminals to a storage battery and allowing enough current to flow so that the short is burned out.

K. BLAINE,
Brooklyn, New York.

Plate Current Burns Out Tubes

Several users of Browning-Drake receivers have reported that they are unable to make the 199 tube in the radio frequency stage last more than a few days before burning out. In a test run on one of them, the writer found that four tubes lasted a total of nine days, although a careful check-up showed that the tube was getting proper filament voltage and that there was no leakage through the neutralizing condenser.

The trouble was found to lie not in the set, but in the diagram from which it was wired. This particular blue print (and a survey shows that many like it are in circulation) has the r.f. tube working on the same B voltage as the first audio tubes, which usually is 90 volts, or even more. Since the 199 is not biased with C battery, it is, therefore, being seriously overloaded.

Inspection of the burned-out tubes showed that in every case the filament parted right at its base. It then became apparent that the plate current, which is added to the filament current on the side of the filament to which the B negative is connected, overloaded the filament and caused the trouble. The addition of, say, 12 milliamperes to the filament circuit of a large tube, makes little difference. In the case of the 199, with a normal filament current of 60 milliamperes, it represents a 20 per cent. overload.

That this diagnosis is correct is attested by operation of the set in question for several months without trouble after the voltage on the radio frequency tube was lowered.

In existing sets, to save adding binding posts, it is advisable to connect the r.f. tube plate circuit to the detector B tap and then run this, feeding both detector and r.f. tube, at 40 to 50 volts. No drop in volume is experienced, changes are easily made, and neutralization is simple.

R. P. WORDEN,
Cleveland, Ohio.

Getting the Most from Your Milliammeter

A direct-current milliammeter is a very desirable instrument to have about the home laboratory. It may be used for checking resistance units, testing tubes, adjusting the grid bias of an amplifier, testing battery elim-

Which do you want Radio or Music?

WHEN you have read this advertisement you will realize that an important forward stride has been made in radio reproduction and you will be glad to have learned that, *no matter what kind, make or age of set you have,* you can now convert it in a few minutes time and at small expense into the *most perfect reproduction known to radio.* In test after test under all conditions, before laboratory experts, set manufacturers, broadcasting artists of national fame, musical critics, and in test by the radio public itself, the new Truphonic amplifying principle has definitely proved itself to be superior to all other methods of reproduction—barring none. And the Truphonic furthermore has the unique feature that it can be instantly attached to *any* set.

What the Truphonic is

The Truphonic is simply this: A compact instrument containing three stages of Truphonic coupling and an output unit to protect the loudspeaker from the powerful Truphonic output. A 6 foot battery cord contains all wires to the "A" and "B" batteries (including wires for "C" battery and additional "B" battery if power tube is used). A single wire with clip attached slips over the plate prong of the detector tube which is then reinserted in the socket of the set. It is as simple as ABC and can be attached by anyone in less than 5 minutes without any knowledge of radio.

Used in commercial sets

Although Truphonic amplification has been on the market only a short time it is now used in the sets of 22 radio manufacturers. Unfortunately it was not perfected in time for general use by manufacturers of large production this year. Next year the trend will be toward Truphonic amplification.

But if you want the most beautiful reproduction of music and speech in your home *right now,* get the Truphonic at your dealer's, attach it, and *know* that you have the finest reproduction obtainable—no matter how much you can afford to pay.

If your dealer has not stocked the Truphonic we will send you one C. O. D. on 5-day money back trial. No Truphonic sent unless you give your dealer's name and address.

ALDEN MANUFACTURING COMPANY
Dept. B-21 **Springfield, Mass.**

TRUPHONIC Power Amplifier

Reg. U. S. Pat. Off.

$20
Ready to Attach

★

★ Examined and approved by Radio Broadcast ★

inators, shooting trouble, and so on. Since the field of application of the milliammeter is so large, several different ranges are desirable. Manufacturers supply voltmeters with high and low ranges, but multi-range milliammeters are not available, and the demands upon one's purse usually preclude the luxury of several meters.

In electrical laboratories where large currents are often measured, ammeters of low current-carrying capacity are adapted to this purpose by means of an "external shunt." This is nothing more than a resistance unit of such a value as to bypass a known portion of the current around the meter. This practice may be conveniently adopted by the home experimenter in making external multipliers for his milliammeter. As an example, suppose a current estimated at about 50 milliamperes is about to be measured with a 0–10 mil. meter. If the meter resistance is 4 ohms, a shunt resistance of 1 ohm connected across its terminals will cause the current to divide inversely proportional to the resistances, 40 mils. going through the shunt, and 10 mils. going through the meter and registering on the scale as such. The meter with its shunt is then said to have a scale factor of 5, since the reading must be multiplied by 5 to obtain the value of the total current flowing.

Scale multipliers are easily made without the necessity of measuring either their own resistance or that of the milliammeter. Connect the meter in series with any high resistance unit and sufficient B battery voltage to give about a full scale deflection of the needle. A No. 10 Bradleyohm

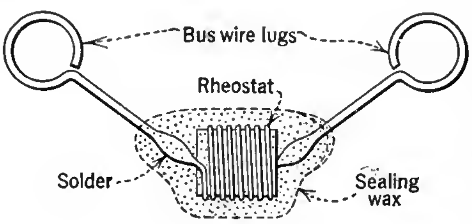


FIG. 2

is ideal for this purpose, as it may be adjusted to give exactly full-scale deflection. The resistance wire to be shunted across the meter may be obtained from an old rheostat, preferably of 30-ohm size. The "dime store" variety is satisfactory. After removing the winding from the frame, cut off about two dozen turns from the end, including the strip. When this wire is connected across the two terminals of the meter, less deflection of the needle will be noted. The length of the resistance wire should be gradually reduced until the needle shows the desired fraction of the original reading, as one-half, or one-fifth, etc. For these trials the ends of the wire should be well tinned as for soldering; if this is not done until last, the final reading will be spoiled. It is best to solder the terminal lugs in place just before the correct length is reached; further reduction may then be accurately accomplished by carefully tinning a small portion of the wire at a time.

This should be accurately done, as any error here will multiply as the scale factor increases. Factors of 10 or more are hardly practicable; in such cases it is better to take the meter with its shunt to a neighboring transmitting amateur, who will gladly check it against his high-range meter.

The unit may be made rigid by coating it with sealing wax, as shown in the diagram, Fig. 2. Place it in position on the meter terminals and, with the aid of a small alcohol blow torch, work the melted wax around it. The scale factor may then be marked on the wax. In using, the meter reading should be multiplied by this factor to obtain the value of the total measured current.

Homer S. Davis,
Memphis, Tennessee.

A Handy Reference Book

THOSE who have been subscribers to Radio Broadcast from the first issue have by this time acquired a rather large fund of useful information. It is a great aid to the experimenter if he has this information instantly available. The Reference Book described here, will eliminate the necessity of looking through perhaps a dozen volumes for some elusive article.

With a razor blade, cut the "Contents" page from each volume. Though Radio Broadcast

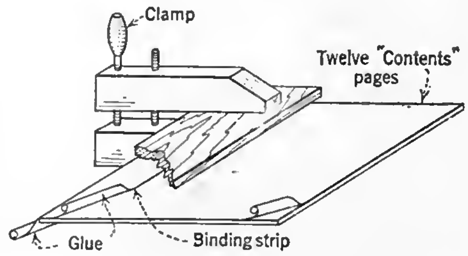


FIG. 3

has been issued in various sizes, it will be found that each "Contents" page can be cut to about seven by nine and one-half inches without destroying the table desired. All the sheets should be cut to this size. Take the sheets of the first twelve issues and lay the last of these on a table, face up. Apply glue to a strip one half inch wide up the left edge. Then lay the second last sheet on this, and apply glue as before. Do this with the ten remaining sheets. Then bind the folios with heavy paper, as shown in Fig. 3, and clamp the booklet in a vise till the glue hardens. Then remove it and drill two holes through the bound edge as shown in Fig. 4.

When folios for each year have been built up in this manner, place them one on top of the other and trim them with a razor blade to a uniform size. Make a cover of black oilcloth, faced with cardboard, and cut holes in it corresponding to those through the bound edges of the folios. (See Fig. 4.)

Assemble the book as shown, by means of

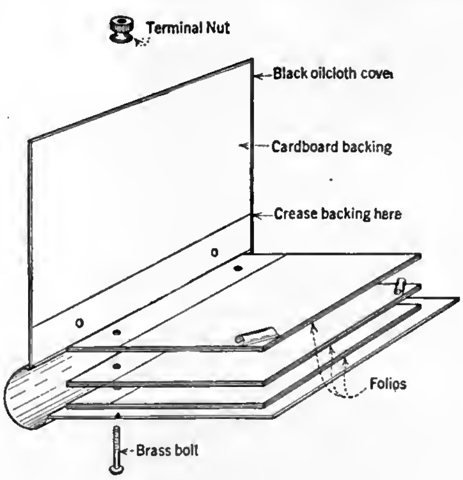
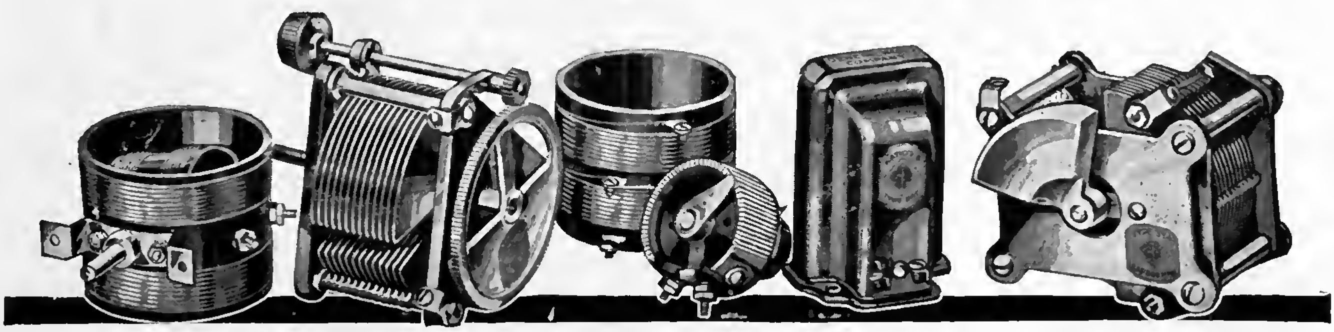


FIG. 4

brass bolts and battery terminals. This method of assembly permits the addition of folios from time to time, but eliminates the possibility of tearing the sheets from the book.

Ronald W. Klinck,
Vancouver, British Columbia.



B Supply Device Relay

UPON installing a B supply device in my home it was most convenient to place it in the basement where the wet B batteries had formerly been. This necessitated either going into the basement to turn the unit on and off or installing a switch for the 110-volt current near the set.

I went both of these alternatives one better

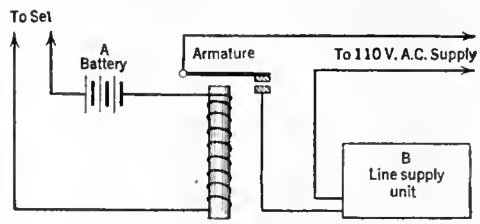


FIG. 5

by constructing from an old automobile reverse current generator relay an automatic switch for the supply unit. Now all I have to do is to pull the A-battery switch on the set and the B supply device cuts in with no further attention.

The sketch, Fig. 5, shows the schematic wiring. The core was stripped of both its original series and shunt windings and was rewound with No. 18 d.c.c. (the number of turns will be governed by the number of tubes and current consumed by the set). I used about 30 turns for a set pulling 2 amps. The armature was insulated from the frame with sheet mica. There is practically no arc at the points, and no condenser is needed.

H. N. Streit,
Boone, Iowa.

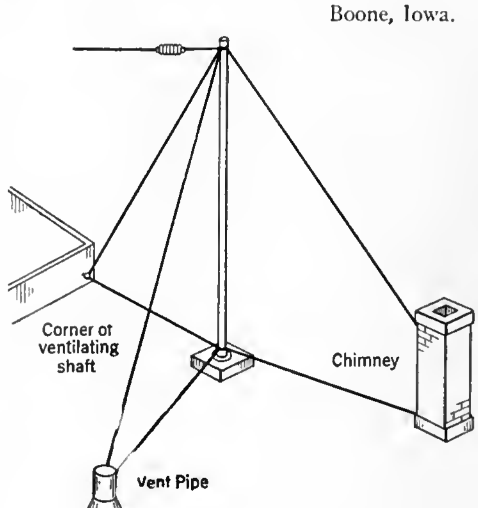


FIG. 6

Antenna Mast Installation

HAVING occasion recently to install a 15-foot antenna mast on the flat roof of an apartment building, I devised a method of securing the mast without having to fasten the lower end with screws. The roof was the usual combination of tar and gravel, and, as it was impossible to fasten the mast to a chimney or other projection from the surface of the roof, I finally decided to guy the mast both top and bottom. After getting the mast in position and securing the guy wires from the top, I simply ran additional guy wires from the lower end of the pole to such points as I could find, three in all, thereby securing both ends of the pole and making it impossible for it to work loose in a high wind. The sketch, Fig. 6, illustrates the method used. The pole (in this case 1 inch iron pipe was used) should be screwed to a wooden block about 8 inches or 10 inches square, so that its end will not wear a hole in the tar of the roof.

W. T. Mithoff,
Detroit, Michigan.

Keeping Radio Frequency Currents from the Audio Circuit

THE statement is often made that the primary of a good audio transformer has such a high impedance to radio frequency currents that they must use the bypass condenser or be blocked. It is the writer's experience, however, that a healthy radio frequency impulse can somehow get through such a rough passage and cause distortion.

The author has hit on the scheme, not of trying to choke off these impulses, but of balancing them out. From Fig. 7 it is apparent that there are present in the audio transformer intentional or parasitic capacities, Cp across the primary, Cs across the secondary, and Cc between the primary and secondary. The transformer is drawn in the usual fashion to call attention to the fact that one end of the primary is nearer the

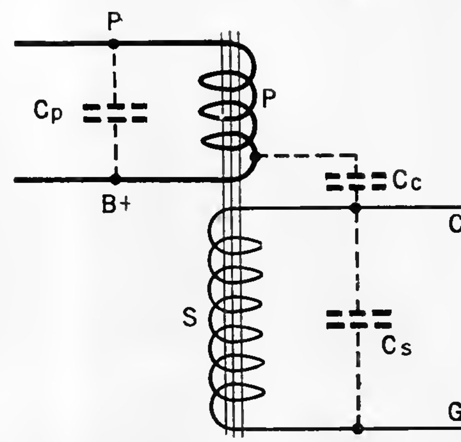


FIG. 7

filament end of the secondary than the grid end. In a good transformer, the secondary capacity is kept small but, compared with the inter-coil capacity, it is larger.

Fig. 8 shows how, by the addition of a plate-grid capacity Cn, a balanced or Wheatstone Bridge effect is obtained. The value of this condenser must be found by trial and is not very large. The author found one of 0.0002 mfd. was best with an Amertran De Luxe. Remember, if you have two condensers of say 0.0001 and 0.00025 mfd., that in series they have a value of 0.00007 mfd. and in parallel a value of 0.00035 mfd., so that two condensers make four values available for trial. Connect the end of a condenser to the grid of the first audio tube and listen with the wire to the other end of the condenser alternately on and off the "P" terminal of the first transformer. It will no doubt be noticed that quality is unmistakably improved.

H. D. Hatch,
Boston, Massachusetts.

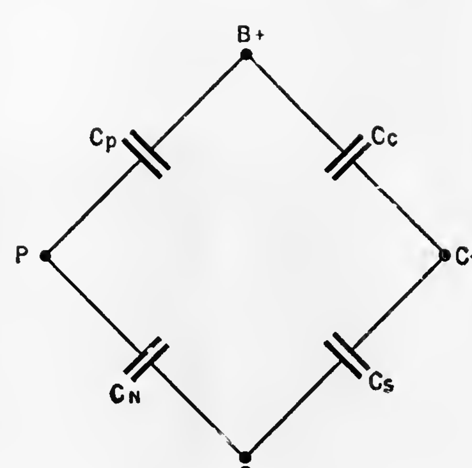


FIG. 8

THE BEST IN CURRENT RADIO PERIODICALS

The Fifteenth Installment of a Useful Classified Survey of Material Appearing in the Radio Press

By E. G. SHALKHAUSER

How This Survey Can Help You

HOW often have you looked for information contained in some article which you recall having read months ago—the description of the Browning-Drake receiver, or the measurement of losses in inductance coils, for example? After looking through probably several issues of a dozen different publications, you either give up or become interested in something altogether different.

When data is wanted on some particular subject, a systematic file of subjects and titles becomes a real radio encyclopedia. Instead of having merely the title of an article given, which often is misleading, a summary of the contents gives all the information. These surveys cover the radio field as gleaned from material in to-day's periodicals. They will always serve as a future reference-guide to all who are interested in the science of radio, whether engineer, manufacturer, dealer, experimenter, or listener.

To be of practical value and easily accessible, these surveys should either be pasted in a scrap book, or, better still, be pasted on individual cards and filed according to numbers, or alphabetically. In the matter of classification of articles, the Bureau of Standards circular No. 138 has been followed. This may be obtained from the Government Printing Office, Washington, District of Columbia, for ten cents. In addition, each abstract has certain key-words placed at the upper right, which may be used for the purpose of filing articles alphabetically.

With this series of surveys we hope to aid our readers and help them through many difficulties which they no doubt have often experienced. The writer is prepared to give information and references to articles previously surveyed upon receipt of a stamped and self-addressed envelope.

Following is the series of headings, made up according to the Dewey Decimal System used in the Bureau of Standards circular No. 138:

R000 RADIO COMMUNICATION IN GENERAL.
Under this heading will appear all subject matter pertaining to laws, regulations, history, publications, etc., which deal with radio in a general way.

R100 PRINCIPLES UNDERLYING RADIO COMMUNICATION.
Here will be given the phenomena of radio waves, their underlying theory of propagation, the principle of antenna and counterpoise, design and characteristics of vacuum tubes and their behavior in circuits, types of circuits, transmitting and receiving apparatus and their principles of operation.

R200 RADIO MEASUREMENTS AND STANDARDIZATION METHODS.
The various known methods which have been used in measuring frequency, wavelength, resonance, capacity, inductance, resistance current, voltage, dielectric constants, and properties of materials, will be mentioned here.

R300 RADIO APPARATUS AND EQUIPMENT.
A description of various types of antennas and their properties, the use of the electron tube in various types of receiving and transmitting sets, other methods of transmission of signals, various detecting devices used in reception, instruments and parts of circuits, come under this heading.

R400 RADIO COMMUNICATION SYSTEMS.
The spark, modulated wave and continuous wave systems in transmission, beat and other methods of reception, wired wireless, automatic printing, the buzzerphone and Fullerphone, will be given here.

R500 APPLICATIONS OF RADIO—
To aviation, navigation, commerce, military, private and broadcasting, and the specific information under their headings, are referred to here.

R600 RADIO STATIONS.
The operation, equipment, and management of radio installations, both transmitting and receiving, the testing, the rules and regulations concerning stations, the reports and bulletins issued, will follow under this heading.

R700 RADIO MANUFACTURING.
Data relative to costs and contracts of radio equipment from raw material to finished product including factories, tools, equipment, management, sales and advertising, follow here.

R800 NON-RADIO SUBJECTS.
The matter of patents in general; the mathematics and physics, including chemistry, geology and geography; meters of various kinds; all information not strictly pertaining to radio but correlated to this subject, will be found under this heading.

R900 MISCELLANEOUS MATERIAL.

A Key to Recent Radio Articles

R800 (539). MOLECULAR PHYSICS. ATOMS.
Popular Radio. Oct., 1926. Pp. 517–519.
"Will Science Succeed in Releasing the Power of the Atom?" T. F. Wall.
Evidence concerning the nature of magnetism, based on some very startling experimental phenomena, leads the writer to believe that an actual disturbance of the electronic structure has been obtained by the application of intense magnetic fields. Some of this evidence is brought out in the two curves presented, which show the relation of B to H for steel before and after having undergone an intense magnetizing process.

R534. AGRICULTURE, APPLICATIONS OF RADIO TO. FARMERS AND RADIO.
Popular Radio. Oct., 1926. Pp. 525-ff.
"Sets That Earn Incomes," H. R. Kibler.
It is shown how the introduction of the radio receiver into rural communities has changed the habits and methods of farmers in many ways. They now market by radio, farm by radio, are entertained by radio, and conduct their business by radio. In the charts shown, which are the results of a nation-wide survey conducted by the National Farm Radio Council, many outstanding disclosures concerning the effects of radio on farm life and community are made.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, *LC-27.*
Popular Radio. Oct., 1926. Pp. 511-ff.
"How to Build the New LC-27 Receiver," L. M. Cockaday.
A new 5-tube receiver, called the LC-27, is outlined. It is claimed to have all the ideal characteristics looked for in a modern set. These include splendid quality of reproduction, simple tuning control, selectivity, shielding, and non-regeneration. Blue prints, photographs, a list of parts, and constructional details, are presented.

R113.1. FADING. FADING.
Popular Radio. Oct., 1926. Pp. 531-ff.
"Why Signals Fade," Charles C. Bidwell.
In the writer's opinion, the under surface of the Heaviside Layer is not a smooth surface. Through the recent studies of Breit, Hurlburt, and others in America, and of Appleton, Smith-Rose, and others in England, it has been shown that this lower surface is corrugated, or billowed, like waves on the sea, or like an irregular cloud layer in the sky. The author shows in this article how his experiments point to the same conclusions arrived at by the other scientists. Charts are presented indicating the variations of signal strength from stations KDKA and WGY at various longer periods of time.

See that Screw

A screw-driver adjusts an X-L in crowded places

★ **X-L VARIO DENSER**

RESULTS in easier tuning, more distance, volume and clarity—greater stability. Indorsed by leading authorities.

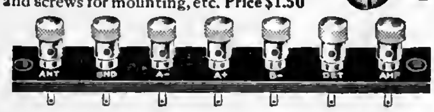
Model "N" A slight turn obtains correct tube oscillation on all tuned radio frequency circuits. Neutrodyne, Roberts two tube Browning-Drake, McMurdo Silver's Knockout, etc. capacity range 1.8 to 20 micro-micro farads. **Price $1.00**

Model "G" With grid clips obtains the proper grid capacity on Cockaday circuits, filter and intermediate frequency tuning in heterodyne and positive grid bias in all sets. Capacity range.

Model G-1—.00002 to .0001 MFD
Model G-5—.0001 to .0005 MFD
Model G-10—.0003 to .001 MFD
Price $1.50

X-L Push Post. Push it down with your thumb, insert wire, remove pressure and wire is firmly held. Releases Instantly. **Price 15c.**

Push Post Panel permanently marked in white on black rubber. In box including soldering lugs, raising bushings and screws for mounting, etc. **Price $1.50**



X-L Radio Laboratories 2424 Lincoln Ave. CHICAGO, ILL.

Yale GROUND HOG

• The Perfect Ground • **DOUBLES** POWER AND DISTANCE

Marvelous newly-invented ground gives incredibly improved reception. Doubles power and distance users say. Reduces leakage. Stops jangling even in mid-summer. Results never before equalled. Satisfaction guaranteed or money back at once. Approved by Highest Radio authorities after exhaustive tests. Proven absolutely essential to clear, powerful distance reception. Draws and holds moisture indefinitely. Highly sensitive to radio energy. **SEND NO MONEY**—To introduce, we offer to those who act at once, regular $5.00 size for only $2.00. Send name today and pay $2.00 plus 17c postage on delivery. Or send only $2.00 with order and save postage.

FREE—Full description of Ground Hog and details of amazing special offer on request—write today. ★

Yale Specialty Supply Co.
133 W. 5th St. Kansas City

Order your copy of *Radio Broadcast* from your news dealer or radio store. Make sure that he reserves a copy for you each month. If your favorite radio store does not stock the magazine write us giving name of radio dealer and address.

AMSCO
METALOID

GRID GATE
& RESISTOR

There's no thunder in these *Metaloids*—no crackle or noise of any kind. *They're Quiet!*

The resistance element is colloidal and smooth — not crystalline, ragged and noisy.

Adopted by leading set makers. *They're perfect!*

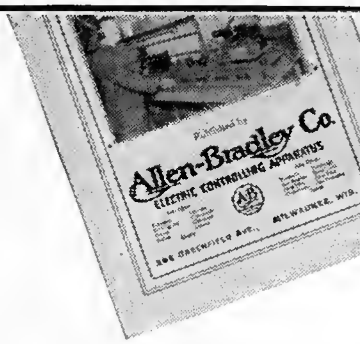
Ask your dealer or write for leaflet

AMSCO PRODUCTS, INC.
Broome and Lafayette Streets
New York City

★ AMSCO

SEND FOR THIS RADIO FOLDER

Contains seven hookups for B-Eliminators published in a prominent radio magazine.



Well-known B-Eliminator Manufacturers who use Bradleyohms

Acme, All-American, American Bosch, Brown & Green, DeWitt-LaFrance, Farrand, Forest Unitron, Grigsby-Grunow-Hinds (Majestic), Kellogg, Philadelphia Storage Battery (Philco), Precision, Radio Receptor; R. A. Rothermel, London; Spartana, Valley, Willard, Wilson.

When You Build a B-Eliminator

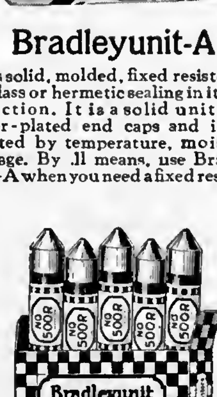
Use Bradleyohm-E for the Variable Resistors and Bradleyunit-A for the Fixed Resistors

Bradleyohm-E

For B-eliminator service requiring wide voltage control, Bradleyohm-E is essential. It is an oversize Bradleyohm with sufficient capacity to handle all normal B-eliminator requirements. Be sure to ask for Bradleyohm-E in the checkered carton. Your dealer can get them for you.

Bradleyunit-A

This solid, molded, fixed resistor has no glass or hermetic sealing in its construction. It is a solid unit with silver-plated end caps and is not affected by temperature, moisture and age. By all means, use Bradleyunit-A when you need a fixed resistor.



ALWAYS insist that Bradleyohm-E and Bradleyunit-A are included with your B-Eliminator kit, if you want to be assured of perfect voltage control. The leading manufacturers of B-Eliminators have long since adopted these Allen-Bradley variable and fixed resistors as standard equipment for their B-Eliminators. In fact, Bradleyohm-E is used almost as universally as the Raytheon tube, itself.

You cannot afford to risk the use of inferior substitutes for the scientifically treated discs used in Bradleyohm-E. This remarkable variable resistor handles the strenuous requirements of B-Eliminator service without the slightest strain. Ask your dealer for Allen-Bradley Perfect Radio Devices, today.

★

MAIL THE HANDY COUPON

Allen-Bradley Company
278 Greenfield Avenue
Milwaukee, Wisconsin

Please send me, FREE, your radio folder with seven B-Eliminator hook-ups.

Name ....

Address ....

R343. Electron-Tube Receiving Sets. Receivers·
Popular Radio. Oct., 1926. Pp. 528-ff. *Bosch, Grebe,*
"Inside Information on New Radio *Freed-Eisemann.*
Receivers," S. G. Taylor.

The new Bosch "Amborola," the latest Grebe "Synchrophase," and the new Freed-Eisemann "800" receivers are discussed in detail, with data being given on care, operation, and installation.

R550. Broadcasting. Broadcasting,
Radio Broadcast. Nov., 1926. Pp. 62-ff. *Technical*
"The Technical and Scientific Aspects of *Aspects of.*
Broadcasting," R. Bown.

An article reprinted from the new *Encyclopædia Britannica* explains the art of broadcast transmission and reception under the following titles.

1. Transmitting Systems.
2. Receiving Systems.
3. Forms of Antennas.
4. Tuning Circuits:
   (a) Regenerative Sets,
   (b) R. F. Amplifiers,
   (c) Super-Heterodynes.
5. Loud Speakers.
6. Power Supply.
7. Interference.
8. Fading.
9. Interconnection of Broadcasting Stations.

R329. Special Types of Antennas. Antennas,
QST. Oct., 1926. Pp. 16. *Hertz.*
"The Length of the Hertz Antenna," G. Wm. Lang.

In operating a Hertzian antenna the matter of length is usually a guess with most of the folks who put them up. In a table presented, nine different forms of antennas are listed, with measurements concerning wire length, fundamental wavelength, etc.

R114. Strays. Aurora,
QST. Oct., 1926. Pp. 23–24. Effects.
"Aurora and Its Effects Upon Radio Signals," W. M. Sutton.

It is the writer's opinion, borne out by actual experience, that the Aurora Borealis has a decided effect on radio signals of certain frequencies. The Aurora tends to lower the Heaviside Layer, thus reducing the skip-distance and often making nearby stations, which are often inaudible, easily heard. It is stated that strong Aurora kills signals on all waves from 35 meters (8566 kc.) up to 500 meters (600 kc.), that moderate Aurora materially changes the skipped distance of 40-meter (7496 kc.) signals, and that slight Aurora changes the skipped distance a little on the 40-meter band and causes fading on medium-distance broadcast stations, but distant-station signals remain constant.

R343. Electron-Tube Receiving Sets. Receivers,
QST. Oct., 1926 Pp. 34–35. *Short-Wave.*
"Short-Wave Tuner Kits," J. M. Clayton.

Three short-wave tuner kits, the Gross receiver, the REL tuner, and the Silver-Marshall, are shown. These are described and the method of construction pictured.

R344.3 and 343. Transmitter and "Transceiver,"
Receiver. *Portable.*
QST. Oct., 1926. Pp. 36-ff.
"A Portable 'Transceiver,'" F. A. Gunther.

The portable transmitter-receiver here analyzed and shown in diagram form, uses three UX-199 tubes for receiving and one UX-210 tube for transmitting. A dynamotor is used to supply the plate input energy.

R070. Education; Training. Education,
Radio. Oct., 1926. Pp. 16-ff. *Engineering.*
"Dollars from Radio Inventions," V. G. Mathison.

In the writer's opinion, a thorough knowledge of the fundamental laws of electricity, magnetism and chemistry are essential in order that one succeed as a radio research engineer or inventor. Most of the research in radio is being carried on behind closed doors at corporation laboratories, and are for monetary purposes solely. This biases the genius of the inventor, who does not receive due reward for his invention. The opportunities, however, are present, providing the "mental equipment" is first obtained.

R343.5. Super-Heterodyne Sets. Super-Heterodyne.
Radio. Oct., 1926. Pp. 19-ff.
"An Improved, Shielded Super-Heterodyne," H. W. Armstrong.

An improvement, through the addition of one stage of tuned r.f. amplification and one stage of power tube a.f. amplification, to the 50 to 600 meter (5,996-500 kc.) super-heterodyne, found in the August, 1925, *Radio*, is described. With separate shielding, plug-in coil arrangement, and loop reception, the best possible results are said to be obtainable.

R230. Inductance, Measurement of. Inductance.
Radio. Oct., 1926. P. 22.

A Kulmann inductance chart, showing how a single-layer solenoid of a given number of turns and size wire on a coil of given diameter will yield a definite inductance value, is pictured and explained.

R134. Detector Action. Detection.
Radio. Oct., 1926. Pp. 32–34.
"The Siamese Twins of Radio: Detection and Distortion," R. B. Thorpe.

The principle of detection involves "distortion," for without distortion there would be no detection, the proof being evident from an analysis of the equation of the detector action in a radio circuit. A simple mathematical discussion of these principles found in detector action is presented, as also is the effect that good and poor modulated energy from the transmitter would have when passing through the detector tube

R470. Wired Radio. Wired Radio.
Radio News. Oct., 1926. Pp. 324-ff.
"Wired Radio and Its Applications," M. L. Muhleman.

The principle of "wired radio" consists in transmitting over the same two wires several radio frequency currents without any intermingling of these currents. The system, as tried in the East, from the transmitting as well as the receiving end, has shown that the problem can be carried out successfully. Several difficulties have been encountered. One of these is to efficiently couple the carrier current lines and power lines used for transmission. Another, the effect of variations in the line itself due to the great difference in current consumption during the 24 hours. In the case of telephone and telegraph lines, these difficulties are not encountered to such a degree.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER
RADIO BROADCAST. Nov., 1926. Pp. 35-42. *R. B. Lab.*
"Constructing the R. B. 'Lab.' Receiver," J. B. Brennan.

A four-tube receiver, employing the Rice method of neutralization, is described. The volume is said to be sufficient to operate a loud speaker. The entire panel layout, and the method of assembly, are so planned as to give the shortest possible leads. The latest parts are incorporated throughout.

R210. FREQUENCY; WAVELENGTH. FREQUENCY,
Popular Radio. Oct., 1926. Pp. 534-ff. WAVELENGTH.
"Wavelengths to Frequencies," J. O. Perrine.

The writer discusses at some length the advisability of using the term *frequency* instead of *wavelength* when speaking of the ether vibrations and the oscillations in radio circuits. It is brought out that, in using frequency, an equal division is always obtainable, which is not the case when speaking of wavelength. Charts for converting from frequency to wavelength, or vice versa, are given.

R800(347.7). PATENT PRACTICE. PATENTS,
RADIO BROADCAST. Nov., 1926. Pp. 19-22. *Radio.*
"The Radio Patent Structure and What It Means," F. Strother.

It is stated that the radio industry at present is tied up with over 2400 patents, interlocking and meshing in a way which only extended patent litigation can untangle. Materials, ideas, methods, combinations of ideas and methods, are all subjects of patents. Of all of these probably the vacuum tube is in the greatest difficulty. Also the neutralization patents are a bone of contention at present. The belief is prevalent that, with the rapid advance of the art, the control of a basic idea does not rest in the basic patent, but rests in the patent upon some more recent refinement of the basic patent, or upon some new method of manufacturing the device.

R090. HISTORY. HISTORY,
RADIO BROADCAST. Nov., 1926. Pp. 28-31. *Radio,*
"Looking Back Over Thirty Years of Radio," G. Marconi.

Senatore Marconi gives a résumé of the history of wireless from the time of his early pioneering and experimenting in the commercial wireless field, to the present day when short-wave low-power beam transmitters are replacing those of longer waves and higher power. His discoveries in 1895 led to the erection of larger and larger stations which finally transmitted with enough power to consistently reach across the Atlantic Ocean. The importance of the discoveries of Fleming, DeForest, Langmuir, Armstrong, and others, have brought radio to its present high standing.

R351. SIMPLE OSCILLATOR TRANSMITTERS. TRANSMITTERS,
RADIO BROADCAST. *B Battery.*
Nov., 1926. Pp. 32-34.
"High Efficiency B-Battery Transmitters," K. Henney.

This article supplements the one appearing in the April issue of RADIO BROADCAST for 1926 (pp. 678 ff.) and shows some of the transmitters which have been built by readers of RADIO BROADCAST. Each set is described, with comments on construction and operation. In tuning the set, a variety of curves are presented which aid greatly in determining what to look for when desiring maximum results.

R343.5. HETERODYNE RECEIVERS. SUPER-HETERODYNE,
RADIO BROADCAST. Nov., 1926. Pp. 54-56. *Short-*
"A short-Wave Super-Heterodyne Receiver," *Wave*
G. J. Eltz, Jr.

A short-wave receiver is described, which does not use the common regenerative method of reception, but the super-heterodyne principle. Since c.w. is supposed to be received with this set, the problem of distortion is not considered of paramount importance. An intermediate frequency of 22 kilocycles is used. The action of the receiver, which is a five-tube set, is summarized as follows:

1. Approximate tuning to the incoming frequency by the first detector tube (which is also an oscillator) and the creation of a 22-kilocycle note.
2. Amplification of the 22-kilocycle note.
3. Detection of the beat note with: (a) Straight detector for telephone; (b) Oscillating detector for c.w.
4. Amplification at audio frequency.
5. One-dial control for the entire action.

A description of the entire set is given with comments on construction and operation.

R550. BROADCASTING. BROADCASTING,
RADIO BROADCAST. Nov., 1926. *Regulation of.*
Pp. 57-59.
"A New Plan to Regulate Radio Broadcasting," C. Dreher.

A solution of the problem of broadcast-wave allotments is suggested. The opinion is expressed that competition for the much-desired licenses be the method used in rationing them out. The question of merit, when a license to broadcast is desired, shall be decided by a check-up on program, power, and quality of transmission.

In summary, the points to be considered are as follows:

1. Establishment of a suitable commission with power to rate broadcasting stations as to public service value or capacity, and facilities for determining the same.
2. Allocation of wavelengths on a population basis and with due regard for technical limitations.
3. Evaluation of hours of each day as to relative importance for broadcasting.
4. Distribution of available time and wavelengths to applying stations according to individual ratings and values assigned to hours, exchange of hours to be permitted, subject to ratification by the commission.
5. Modification as necessary to secure flexibility and aptimum service to listeners.
6. Provision for judicial review of major decisions.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER,
QST. Oct., 1923. Pp. 9-15. *All-Wave.*
"Covering All Wavelengths," John M. Clayton.

In an attempt to do away with a multitude of receivers to cover all the radio frequencies from the 15= to the 20,000-kc. band, Mr. Clayton has designed a receiver using plug-in coils in the Weagant circuit, with two stages of audio amplification. In order to take care of the variable capacity at this wide range of frequencies, a double condenser is used. The complete layout and data concerning the plug-in coils are given.

R800(621.313.73). MERCURY VAPOR RECTIFIERS. MERCURY-ARC RECTIFIERS.
Radio. Oct., 1926. Pp. 40-41.
"An Amateur's Mercury Arc Rectifier," Don C. Wallace.

In order to supply plate current to the larger tubes used for transmitting purposes, a mercury arc rectifier can be used. A suitable one is sold by the General Electric Company. It supplies voltages anywhere from 500 to 5000 with practically no internal drop. The circuit arrangement and the layout and construction of parts necessary for such a transmitter are described.

R343. ELECTRON-TUBE RECEIVING SET. RECEIVER, *"Equamatic."*
Radio. Oct., 1926. Pp. 29-ff.
"The 'Equamatic' Tuned R. F. Receiver," G. M. Best.

Of the various methods used in tuned radio frequency sets to overcome the tendency to oscillate at the higher frequencies and still have a high efficiency, the "Equamatic" system is said to bring about a stable condition more uniform than any other. The principle involved consists in automatically varying the coupling between primary and secondary coils through direct connection with the condenser shaft. The method of constructing and operating a receiver employing the "Equamatic" system is outlined.

R344.5. ALTERNATING CURRENT SUPPLY. ELIMINATORS, *B Battery*.
Radio News. Oct., 1926. Pp. 322-ff.
"B Battery Eliminators," M. L. Muhleman.

The various forms of B battery eliminators now on the market are presented and discussed. Their circuit diagrams, and the principle upon which they operate, is brought out in detail for every instrument shown.

R387. SHIELDS. SHIELDING.
Radio News. Oct., 1926. Pp. 336-337.
"A Perfect Static Shield," V. G. Mathison.

The use of solid metal shielding is considered to be out of the question when looking for amplification of weak signals in receivers, according to the author. Too much energy is lost. In this article, the use of copper rods or copper wires is substituted for the solid shields, with the result that no energy is absorbed from the set, but the set is totally shielded nevertheless. Coils may also be shielded by this method with considerable success.

R132. AMPLIFYING ACTION. AMPLIFICATION, *Radio Frequency*.
Radio News. Oct., 1926. Pp. 342-ff.
"Radio-Frequency Amplification," E. T. Flewelling.

Attention is called to some common errors frequently made in the construction and the connections of tuned radio-frequency amplifier sets. Parts must be balanced and wires so placed that they do not cause disturbances in neighboring parts. Every measurement from stage to stage should be made with precision in order to be able to tell what to expect of a set before it is assembled.

R375. DETECTORS AND RECTIFIERS. RECTIFIER, *Raytheon BH*.
Radio News. Oct., 1926. Pp. 343-ff.
"A New Rectifier for A, B, C, Power Units."

A new Raytheon tube, capable of delivering enough current and voltage to replace A, B, and C batteries in a set equipped with 199 tubes and a power amplifier, has been developed. A circuit diagram showing how this new tube may be used for the above-mentioned purposes is presented, and discussed at some length. Variations from 10 to 85 milliamperes are possible, the tube having a very good regulation over this range.

R342. AMPLIFIERS. AMPLIFIERS, *Audio Frequency*.
Radio News. Oct., 1926. Pp. 358-ff.
"A New Amplifier and B Supply Unit," A. H. Lynch and R. R. Mayo.

The requirements for good audio output are said to rest with the following:

1. An r. f. amplifier which does not cut off side bands.
2. An r. f. amplifier which does not produce excessive gain and bring in local disturbances.
3. An r. f amplifier which does not overload the detector.
4. A straight frequency-line characteristic for the audio amplifier whether under- or over-loaded.
5. A loud speaker with good reproducing qualities.

An audio frequency amplifier, operated from the lamp socket, and giving exceptional reproduction, is described, and the method of construction outlined. It is a resistance-coupled instrument with a B line power-supply device.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVERS, *Loewe Tube*
Radio News. Oct., 1926. Pp. 362-363.
"A Five-In-Two Receiver," C. J. Fitch.

The writer presents a receiving set built around the new multiple tubes made by Loewe of Germany. The internal construction and arrangement of these new tubes, and the apparatus necessary to assemble a neat and compact receiver, are points discussed and presented.

R210. FREQUENCY MEASUREMENT. FREQUENCY MEASUREMENT.
Bureau of Standards. Letter Circular LC-171.
"Methods and Apparatus for Measurement of the Frequencies of Distant Radio Transmitting Stations."

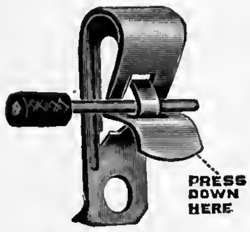
It is the purpose of this circular to outline several methods of measuring frequencies and to describe the apparatus needed for this purpose. A schedule of standard frequency transmissions from WWV and 6 XBM, is printed, the range of frequencies covered being from 125 to 6000 kilocycles. The zero beat method and the resonance click method may be used, the former being the more accurate, as stated. Both methods are discussed at some length.

In constructing a frequency meter, of fundamental importance is said to be its mechanical ruggedness. The condenser should meet with certain requirements, its range being covered through small variations. It should be shielded and have a low r. f. resistance. As for the resonance indicator, it may consist of several devices, the thermo-galvanometer being preferred. The testing of this frequency meter is accomplished most satisfactorily with a low-power generator described here. In an accompanying table (No. 1) are given the coil sizes of various frequency ranges. A 5-watt generator for setting up the r.f. currents is outlined, with diagrams of hook-ups appended. The method of procedure in making all the measurements is explained in great detail.

Fahnestock Clips

RADIO'S GREATEST CONVENIENCE

Used by Manufacturers of Standard Sets and Parts—and by Manufacturers of High Grade Wet and Dry Batteries.



★

ALL GENUINE FAHNESTOCK CLIPS

bear our imprint on the thumb piece of the clip.

WORLD'S LARGEST MAKER OF CLIP TERMINALS

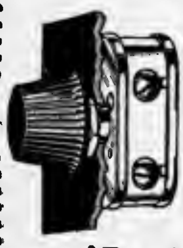
48 different sizes and styles to meet all requirements.

Send for Catalog and Samples

FAHNESTOCK ELECT. CO.
L. I. City New York

Bradleystat

PERFECT FILAMENT CONTROL



Provides complete noiseless filament control for all radio tubes without change of connections. Metal parts are nickel plated. One hole mounting. Self contained switch opens battery circuit when desired.

Allen-Bradley Co.
★ Electric Controlling Apparatus
278 Greenfield Avenue Milwaukee, Wis.

Make Your Own Three Foot Cone Speaker In Less Than An Hour

WORLD'S FINEST LOUD SPEAKER
~~ GENUINE ~~
"ENSCO" 3FT CONE KIT

ONLY $10 — Can be Assembled in Less Than an - HOUR -

The Original Three Foot Cone Speaker - KIT - ONLY $10

NO DISTORTION — THE SOLUTION OF THE LOUD-SPEAKER PROBLEM *The Choice of Leading Engineers* — PERFECT FIDELITY

Complete parts furnished in kit form. We guarantee this speaker the equal of any manufactured cone speaker at any price.

With this THREE FOOT CONE SPEAKER you hear *all* the tones. It brings out the true depth and beauty of orchestral and instrumental music. Can be operated softly for living room music or full volume for dancing, and without trace of distortion.

Kit includes famous "ENSCO" cone unit, the only direct-drive, distortionless unit for large cones; Alhambra Fonotex for big cone, with brass apex, two Sepia Prints showing cabinet or simple stand construction. All necessary instructions.

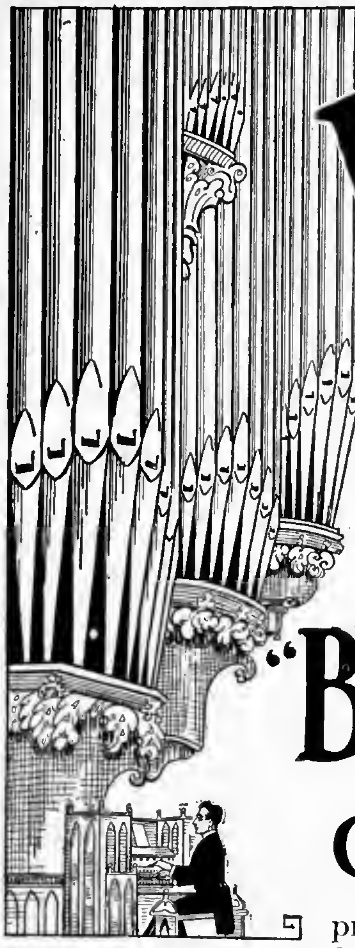
Buy this wonderful speaker under our absolute guarantee. *Your money back* if you are not convinced that it is the finest reproducing medium obtainable at any price. It works on any set, with ordinary Tubes or with Power Output.

SEND NO MONEY!

Write your name plainly as indicated below, then mail and complete kit will be forwarded to you. Just pay postman $10.00 upon delivery.

Name...
Address...

ENGINEERS' SERVICE CO.
25 Church St. Desk X New York City



Power for the deep tones PLUS a "B" Eliminator

COMPLETE realism in radio reproduction requires that the deep bass tones as well as the high notes be prominently brought out. Only a UX 210 (or CX 310) tube, using up to 400 volts in your last audio stage, has sufficient power to do this. To use this tube directly in your set, rewiring would be required to take care of the increased voltage. Now by merely attaching a POWERIZER and eliminating your present last tube, you can not only use this real power tube without rewiring, but eliminate "B" batteries as well.

POWERIZER operates from the lamp socket, using two power tubes—one the 210 or Super-Amplifier giving such marvelous tone that it has come to be known as the "Tonifier", the other a UX 216 (or CX 316) rectifying tube, making the POWERIZER a heavy duty super "B" eliminator

You cannot KNOW what really perfect tone quality is until you hear POWERIZER. POWERIZER can be attached to any set in a few minutes with no technical knowledge whatever. Ask the nearest POWERIZER dealer to demonstrate it to you today.

Our new descriptive leaflet, "New Tone for Old", will gladly be sent upon request. Write for it.

POWERIZER

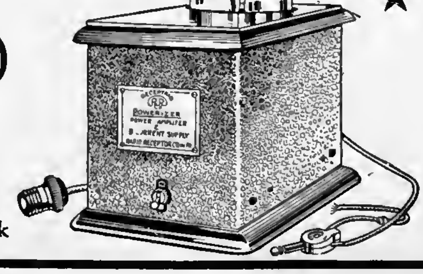
REG.

TESTED and APPROVED by ALL Leading Laboratories

Power Amplifier and "B" Eliminator combined—at cost of good "B" Eliminator alone.

$49.50

★



RADIO RECEPTOR CO.
106 Seventh Avenue New York

THE "RADIO BROADCAST" INFORMATION SERVICE

How to Write for Technical Information—The Scope of This Service

AS WAS announced in the June RADIO BROADCAST, all questions which were formerly sent to "The Grid" will now be handled by the Technical Information Service, RADIO BROADCAST Laboratory. That service is maintained under the following rules:

1. All questions from subscribers to RADIO BROADCAST will be answered free of charge.
2. Non-subscribers to RADIO BROADCAST will be charged a fee of One Dollar for the Laboratory Technical Service.
3. All questions will be answered by mail and none will be published in RADIO BROADCAST.

The Technical Information Service of the Laboratory feels that it is important to define the scope of its service to readers. Although the Service is of very general help to our readers, there are certain demands which can not be met.

The Technical Information Service:

1. Cannot make comparisons between various kinds of receivers or manufactured apparatus.
2. Wiring diagrams of manufactured receivers cannot be supplied. This information can be secured from the various manufacturers.
3. Complete information cannot be given about sets described in other publications, but in all cases (wherever possible), inquirers will be referred to a source of information where the data can be obtained. In this connection, the monthly department in RADIO BROADCAST "The Best in Current Radio Publications" should be of great help, and should be consulted. That department records the most important constructional, technical, and general radio articles which appear.
4. Special receivers or circuits cannot be designed by the Technical Service.
5. Those who ask questions which cannot be answered in the scope of a letter will be referred, if possible, to sources where the information can be obtained.

TECHNICAL INFORMATION INQUIRY BLANK

Technical Service,
RADIO BROADCAST Laboratory,
Garden City, New York

GENTLEMEN:

Please give me fullest information on the attached questions. I enclose a stamped addressed envelope.

☐ I am a subscriber to RADIO BROADCAST, and therefore will receive this information free of charge.

☐ I am not a subscriber and enclose $1 to cover cost of the answer.

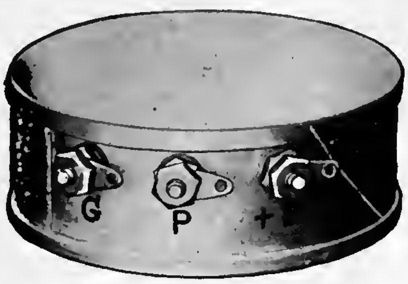
Name......................................

Address......................................

R. B. J.

$625 In Prizes

A BOOKLET recently received from the advertising department of the Benjamin Electric Manufacturing Company, of 120–128 S. Sangamon Street, Chicago, Illinois, announces a series of prizes for radio fans who enter a competition which closes on January 31st, 1927. The prizes, totalling $625, are offered for new and original circuits, ideas for improvements and modifications of circuits, the best description of a home-made radio set, and for trade names and slogans for Benjamin products.



Shielded Tuned Radio Transformer, No. 30

SICKLES

Diamond-Weave Coils

THE new Sickles Shielded Tuned Radio Transformer prevents both outside and local interference. It is remarkably compact, sharp tuning, sturdy.

Sickles Diamond-weave coils have established an enviable reputation for low distributed capacity, low dielectric losses, and large range of frequency with small variable capacity.

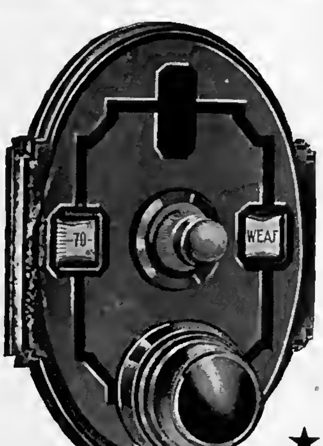
The ideal coil for the Naald Localized Control Tuning Unit and for the Truphonic Catacomb Assembly.

There are Sickles Diamond Weave Coils for all Leading Circuits.

The F. W. Sickles Co.
132 Union Street ★
SPRINGFIELD, MASS.

COIL PRICES

No. 30	Shielded Transformer....	$2.00 each
No. 24	Browning-Drake..........	7.50 Set
No. 18A	Roberts Circuit..........	8.00 "
No. 25	Aristocrat Circuit.........	8.00 "



★

ACCURATUNE

Illuminated Dial

Its simplicity and efficiency has overwhelmed the real radio fans.

Its positive friction grip insures absolute smooth action.

Graduated from 0 to 100 or reverse.

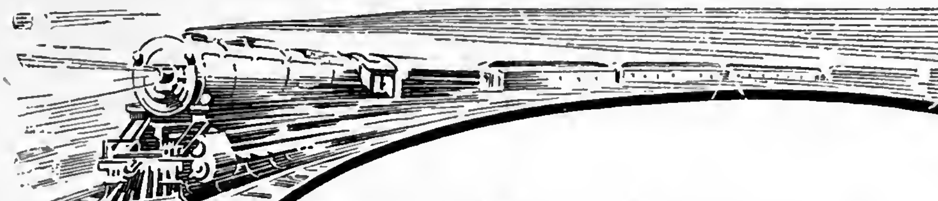
Sold in three ways.

Recording Dial.................. $2.00
(Ratio 10 to 1)
With Micrometer control 2.75
(Coarse ratio and 200 to 1)
Illuminated extra................ .50

Sent direct if your Dealer cannot supply you

MYDAR RADIO COMPANY
3 Campbell St. Newark, N. J.

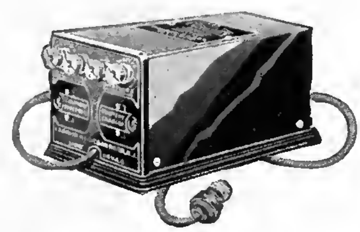
"Pioneer Mfrs. of Micrometer Dials"




After Having Served America's Leading Railways for Over 20 Years it is gratifying to know that now, Radios in over 2,000,000 Homes are Protected by BRACH LIGHTNING ARRESTERS

★

BRACH CONTROLIT



Gives the SET SWITCH Control of Trickle Charger and "B" Substitute—AUTOMATICALLY.

No need, now, to operate three switches every time you turn on or off your set. The Brach CONTROLIT makes this unnecessary by eliminating all extra switches and placing complete control of your power plant and set in the set switch. At the same time it makes any Radio a light socket power-operated set.

Anyone can install a CONTROLIT—no extra wiring or altering is necessary.

PRICE $6 in U. S. A.

Brach Radio Products

20 years in the lead

L. S. BRACH MFG. CO.
Newark, N. J., U. S. A. Toronto, Canada

How the Radio Trade-mark is Protected

ORDINARILY it is considered legitimate for any person or firm to adopt and use a well-known and popular trade-mark, provided its use is confined to goods or merchandise of an entirely different class from those sold by the original user. With such protection the public is not likely to purchase the goods of the later user of the trade-mark, believing them to be the product of the former user. For example, if "Eata" is recognized as a trade-mark for bread there is nothing to prevent its use by another firm as a trade-mark for automobiles or other products not of the same or kindred class of goods. This is true, because no one is likely to be deceived into purchasing an automobile thinking it is made in a bread-maker's factory, and therefore, no harm usually can come to the original user of the mark "Eata."

A recent higher United States Court trade name case that is particularly interesting from the viewpoint of the restricted use of a trade-mark adopted for use on a somewhat different class of merchandise is that of "Rolls-Royce" for radio tubes.

The Rolls-Royce Company of America, manufacturers of high-priced automobiles and aeroplane engines, instituted legal proceedings against Howard Wall, doing business under the name of the Rolls-Royce Tube Company, to prevent the use of the name "Rolls-Royce" in carrying on his regular business.

In this specific case, irrespective of the remarks in the foregoing paragraphs, the court restrained the use of the name "Rolls-Royce" as a trade-mark for radio tubes, and also as a part of the name of the company that was selling them. It appeared that the Rolls-Royce Tube Company had met with considerable success in selling Rolls-Royce radio tubes by mail. The tubes were simply marked "Rolls-Royce" without other indications to show where or by whom they were manufactured. Also, in advertising the tubes, the words "Rolls-Royce" were used alone in quotation marks with the statement following "Like Their Name, Significant of Quality." The advertisement directed correspondence to be sent to "Dept. A. of the Rolls-Royce Tube Company," thus giving the suggestion that the business comprised this and other departments.

The court decided that, inasmuch as the tubes bore only the name Rolls-Royce, with nothing else to indicate their origin, and as electricity is a vital element in automobiles, purchasers of the tubes might suppose the original Rolls-Royce Company had extended its high-grade products to include radio tubes. If the Rolls-Royce radio tubes proved unsatisfactory, it would tend to destroy, in the minds of the purchasers, the excellence of the product for which the words "Rolls-Royce" heretofore stood.

The court further said, in effect, that it is quite possible the use of the name "Rolls-Royce" might lead uninformed persons to believe the original Rolls-Royce Company stands financially behind the Rolls-Royce Tube Company, which impression, in the event that the radio tube business was not carried on successfully, might cause the name "Rolls-Royce" to suffer accordingly.

The use of the words "Rolls-Royce" in connection with radio tubes was, therefore, enjoined.

LEO. T. PARKER.

In Your Set

Tube life and efficiency, tone clarity and accurate tuning—all depend on filament control.

AMPERITE, the only self-adjusting filament control, regulates the tube current that governs these vital points. Eliminates hand-rheostats, simplifies set-wiring.

Accepted as standard equipment by every leading engineer, AMPERITE is specified in all popular construction sets.

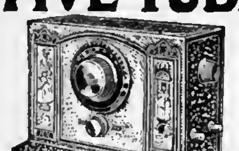
FREE—Write for "*The Radiall Book*," containing the latest popular hook-ups and construction data, to Dept. R. B.-1.

Radiall Company ★
50 FRANKLIN ST., NEW YORK

AMPERITE
REG. U.S. PAT. OFF.

The "SELF-ADJUSTING" Rheostat

FIVE TUBE RADIO



$25.00

AGENTS WANTED BIG COMMISSION

Demonstrating agent wanted; every county. Exclusive to right man. Sell what public wants—five tube, long distance, loud speaker radio with single dial control. Price within reach of all, $25.00 retail; liberal discount to agents. Sell in spare time—evenings. No selling or radio experience necessary. Territory going fast. 100 page Radio Book FREE. Write today—don't delay.
C. P. FISCHER, 122 W. Austin Ave., Chicago

HOME BUILT B SUPPLY
In the February *Radio Broadcast* appears the first of a series of articles by James Millen describing in great detail many different types of B supplies and amplifiers combined. On the News-stands. January 15th.

Build Your Own

3 ft. Cone

YOU must have a good 36 inch cone speaker to really enjoy your radio. *Build it yourself!* You can easily—in one evening—and save 4/5 the retail cost.

With this DOUBLE CONE speaker, exactly like highest price factory-made, and PENN C. S. Unit the low bass notes are clear and musical; the high treble notes are rich and mellow. Every instrument in an entire symphony orchestra is distinct and resonant.

Tone quality depends on the unit. The PENN is made especially for 3 ft. cone speaker; operates with any set; adjustable to audio output of set with which it is used.

Penn
CONE SPEAKER
UNIT

has full 16 oz. cyanide hardened magnet fully magnetized and completely udalyted to prevent rust. Ask your dealer for PENN C. S. Unit. Price, $9.50.

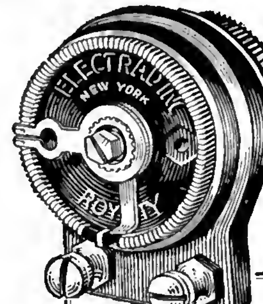
Complete parts only $14.15; include unit; 2 sheets Alhambra Fonotex, pr. Back Rings, Unit Mountings and spc. Ambroid Cement. We'll supply you if your dealer can't or won't. Add $1 for packing and shipping.

Pamphlet, "*How to Build a Giant 3 ft. Cone Speaker*" *mailed for 10c*, coin or stamps. Send for it today.

PENN RADIO SALES CO.
104 Fifth Ave., Suite 2103, New York City
Exclusive Sales Agents for G. R. Penn Mfg. Co., New York

ELECTRAD

New Model!



Say "ROYALTY" When in Need of Variable High Resistance!

Dissipates Three Watts

Licensed by Technidyne Corporation under U. S. Patent 1593685, July 27, 1926

From these 11 types you can select the range of resistance exactly adapted to your set. Note these important features of superiority:

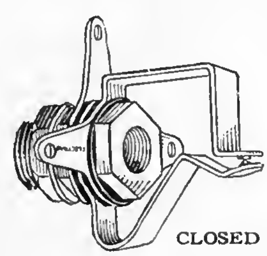
1—Resistance element is not exposed to any mechanical operation.
2—Electrical contact is made positive by metallic arm on wirewound strip.
3—The same resistance is always obtained at the same point.
4—Resistance value is under control in process of manufacture and does not change in use.
5—Entire range of resistance is covered with less than a single turn of the knob.
6—There is no mechanical binding, and shaft is turned smoothly over entire range.

Ask your dealer for the genuine ELECTRAD Royalty High Resistances and insure satisfactory results.

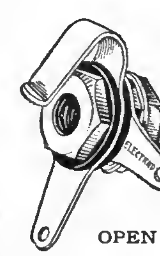
A Range for Every Purpose

Type A—1/10 to 7 megohms.
Type B—1500 to 100,000 ohms.
Type C—500 to 50,000 ohms.
Type D—10,000 to 700,000 ohms (Detector control for B Eliminator)
Type E—Compensator, 500,000 ohms. Potentiometer.
Type F—0 to 2,000 ohms.
Type G—0 to 10,000 ohms.
Type H—0 to 25,000 ohms.
Type J—0 to 200,000 ohms.
Type K—0 to 5,000 ohms.
Type L—0 to 500,000 ohms.
Type E—$2.00—All other types $1.50.

ELECTRAD CERTIFIED JACKS



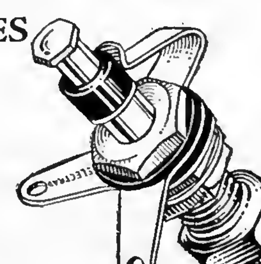
CLOSED



OPEN

You have never seen the equal of the new Electrad Certified Single Circuit Jacks both open and closed. Requires less than 1″ behind panel. Positive acting spring of phosphor bronze. Sterling silver contact points. Insulation of hard rubber. Tinned soldering lugs, so placed that good connections can easily be made. Any good radio store has these jacks or can easily get them for you. Certified and guaranteed electrically and mechanically. U. S. Prices, Open 25c., Closed 35c. Canada Prices, Open 35c., Closed 50c.

ELECTRAD CERTIFIED SWITCHES
—Hear Them Click



No doubt whether you are on or off when you equip your set with the Electrad Certified Switch. You hear it click. Requires less than 1″ behind panel. Solid brass construction. Tinned soldering lugs so placed to make easy connections. Neatly designed. Genuine Bakelite knobs. Adds to the appearance of your set. Certified and guaranteed electrically and mechanically. Price U. S. 40c. Canada 60c.

★

For perfect control of tone and volume use the Electrad 500,000 ohm compensator. For free hook-up write 428 Broadway, New York City.

ELECTRAD
Inc.

Manufacturers' Booklets Available

A Varied List of Books Pertaining to Radio and Allied Subjects Which May Be Obtained Free by Using the Accompanying Coupon

As an additional service to Radio Broadcast *readers, we print below a list of booklets on radio subjects issued by various manufacturers. Already, a regular feature of this magazine is an analysis of the best material in current radio publications, and a series of Laboratory Data Sheets, both of which present concise and accurate information in such a form as to be readily used. The publications listed below cover a wide range of subjects, and offer interesting reading to the radio enthusiast. The manufacturers issuing these publications have made great effort to collect interesting and accurate information.* Radio Broadcast *hopes, by listing these publications regularly, to keep its readers in touch with what the manufacturers are doing. Every publication listed below is supplied free. In ordering, the coupon printed on page 324 may be used. Order by number only.*—The Editor.

Parts

1. Hook-Ups—Problems of filament supply, voltage, regulation, and effect on various circuits. Radiall Company.
2. Hard Rubber Panels—Characteristics and properties of hard rubber as used in radio, with suggestions on how to "work" it. B. F. Goodrich Rubber Company.
3. Audio Transformers—A booklet giving data on input and output transformers. Pacent Electric Company.
4. Resistance-Coupled Amplifiers—A general discussion of resistance coupling with curves and circuit diagrams. Cole Radio Manufacturing Company.
5. Carborundum in Radio—A book giving pertinent data on the crystal as used for detection, with hook-ups, and a section giving information on the use of resistors. The Carborundum Company.
6. B-Eliminator Construction—Complete constructional data on how to build. American Electric Company
7. Transformer and Choke-Coupled Amplification—Circuit diagrams and discussion. All-American Radio Corporation.
8. Resistance Units—A data sheet of resistance units and their application. Ward-Leonard Electric Company.
9. Volume Control—A leaflet showing circuits for distortionless control of volume. Central Radio Laboratories.
10. Variable Resistances—As used in various circuits. Central Radio Laboratories.
11. Resistance Coupling—Resistors and their application to audio amplification with circuit diagrams. DeJur Products Company.
12. Distortion and What Causes It—Hook-ups of resistance-coupled amplifiers with standard circuits. Allen-Bradley Company.
13. Materials for Screw Machine Products—Comparative costs of steel and brass with data and actual examples of how to specify. Bridgeport Brass Company.
14. Ordering the Right Kind of Sheet Brass—How to specify the proper grades for various purposes. Bridgeport Brass Company.
15. B-Eliminator and Power Amplifer—Instructions for assembly and operation using Raytheon tube. General Radio Company

15a. B-Eliminator and Power Amplifier—Instructions for assembly and operation using an R. C. A. rectifier. General Radio Company.

16. Variable Condensers—An ambitious description of the functions and characteristics of variable condensers with curves and specifications for their application to complete receivers. Allen D. Cardwell Manufacturing Company.
17. Bakelite—A description of various uses of bakelite in radio, its manufacture, and its properties. Bakelite Corporation.
18. Brass Rods—Details of manufacture together with tests and specifications. Bridgeport Brass Company.
19. Power Supply—A discussion on power supply with particular reference to lamp-socket operation. Theory and constructional data for building power supply devices. Acme Apparatus Company.
20. Audio Amplification—A booklet containing data on audio amplification together with hints to the constructor; also some general radio information. All-American Radio Corporation.
21. High-Frequency Driver and Short-Wave Wavemeter—Costructional data and application. Burgess Battery Company.

Accessories

22. A Primer of Electricity—Fundamentals of electricity with special reference to the application of dry cells to radio and other uses. Constructional data on buzzers, automatic switches, alarms, etc. National Carbon Company.
23. Automatic Relay Connections—A data sheet showing how a relay may be used to control A and B circuits. Yaxley Manufacturing Company.
24. Detector Tubes—A brief outline of tube operation. C. E. Manufacturing Company.
25. Electrolytic Rectifier—Technical data on a new type of rectifier with operating curves. Kodel Radio Corporation.
26. Dry Cells for Transmitters—Actual tests given, well illustrated with curves showing exactly what may be expected of this type of B power. Burgess Battery Company.
27. Dry-Cell Battery Capacities for Radio Transmitters—Characteristic curves and data on discharge tests. Burgess Battery Company.
28. B Battery Life—Battery life curves with general curves on tube characteristics. Burgess Battery Company.
29. How to Make Your Set Work Better—A non-technical discussion of general radio subjects with hints on how reception may be bettered. United Radio and Electric Corporation.
30. Tube Characteristics—A data sheet giving constants of tubes. C. E. Manufacturing Company.
31. Functions of the Loud Speaker—A short, non-technical general article on loud speakers. Amplion Corporation of America.
32. Meters for Radio—A catalogue of meters used in radio with connecting diagrams. Burton-Rogers Company.
33. Switchboard and Portable Meters—A booklet giving dimensions, specifications, and shunts used with various meters. Burton-Rogers Company.
34. Cost of B Batteries—An interesting discussion of the relative merits of various sources of B supply. Hartford Battery Manufacturing Company.
35. Storage Battery Operation—An illustrated booklet on the care and operation of

the storage battery. GENERAL LEAD BATTERIES COMPANY.

36. CHARGING A AND B BATTERIES—Various ways of connecting up batteries for charging purposes. WESTINGHOUSE UNION BATTERY COMPANY.

37. CHOOSING THE RIGHT RADIO BATTERY—Advice on what dry cell battery to use; their application to radio, with wiring diagrams. NATIONAL CARBON COMPANY.

MISCELLANEOUS

38. LOG SHEET—A list of broadcasting stations with columns for marking down dial settings. U. S. L. RADIO, INCORPORATED.

39. BEHIND THE SCENES IN A BROADCASTING STATION—Operation in general, and specific facts about WKRC. KODEL RADIO CORPORATION.

40. STATIC—A brief discussion of the disturbances which may cause trouble in a receiver. SUN MANUFACTURING COMPANY.

41. BABY RADIO TRANSMITTER OF 9XH-9EK—Description and circuit diagrams of dry-cell operated transmitter. BURGESS BATTERY COMPANY.

42. ARCTIC RADIO EQUIPMENT—Description and circuit details of short-wave receiver and transmitter used in Arctic exploration. BURGESS BATTERY COMPANY.

43. SHORT-WAVE RECEIVER OF 9XH-9EK—Complete directions for assembly and operation of the receiver. BURGESS BATTERY COMPANY.

44. ALUMINUM FOR RADIO—A booklet containing much radio information with hook-ups of basic circuits, with inductance-capacity tables and other pertinent data. ALUMINUM COMPANY OF AMERICA.

45. SHIELDING—A discussion on the application of shielding in radio circuits with special data on aluminum shields. ALUMINUM COMPANY OF AMERICA.

46. AUDIO FREQUENCY CHOKES—A pamphlet showing positions in the circuit where audio frequency chokes may be used. SAMSON ELECTRIC COMPANY.

47. RADIO FREQUENCY CHOKES—Circuit diagrams illustrating the use of chokes to keep out radio frequency currents from definite points. SAMSON ELECTRIC COMPANY.

48. TRANSFORMER AND IMPEDANCE DATA—Tables giving the mechanical and electrical characteristics of transformers and impedances, together with a short description of their use in the circuit. SAMSON ELECTRIC COMPANY.

USE THIS COUPON

RADIO BROADCAST SERVICE DEPARTMENT
RADIO BROADCAST, *Garden City, New York.*
Please send me (at no expense) the following booklets indicated by numbers in the published list

. . . .

. . . .

. . . .

. . . .

Name . . . .

Address . . . .
(Number) *(Street)*

. . . .
(City) *(State)*

ORDER BY NUMBER ONLY
This coupon must accompany every order.
RB 127

Book Reviews

Physics for the Radio Man

PRACTICAL PHYSICS. *By Black and Davis. Published by the Macmillan Co. Revised edition, 1925. 572 pages, including supplementary pamphlet, 1926, on "Radio Broadcasting." 580 illustrations. Price, $1.68.*

THE original meaning of "physics" was "the study of natural philosophy, the science of the principles operative in inorganic nature." The lever, the arch, the windlass, the pulley, and the flow of liquids were the foundations of a branch of human knowledge which to-day has acquired endless ramifications. To-day we cannot think of physics either as "natural philosophy" or as a thing so abstract as "the principles operative in inorganic nature." It is a study of principles, the operation of which surrounds us at every moment.

The authors of "Practical Physics" have been diligent in bringing home to their readers the practical application of physics in the things of daily life. They have not contented themselves with statements of laws, formulas, and principles. There is hardly a page which does not illustrate some familiar device in general use as examples of the principles expounded in the text. For example, by turning only a few pages, we found clear-cut diagrams of a vacuum cleaner, phonograph, door check, carbon transmitter, automobile speedometer, dry cell and voltmeter, water tap, lawn sprinkler, electric iron, and a steam radiator vent. By this means, its writers have made their comprehensive volume interesting reading, a quality usually lacking in reference books and school texts.

The problem of writing a physics text book is largely one of elimination. To attain conciseness without undue length, yet completeness sufficient to be useful, ease of reference, and questions and problems for study purposes, in a mere 572 pages, is indeed no small problem. Good arrangement has contributed liberally in making the attainment of these objectives possible. Every section is numbered and headed in bold face for easy reference; questions and problems are distributed in convenient grouping, not only at the end of each of the twenty-four chapters but at each logical point throughout the text, permitting of easy assignment for study; at the end of each chapter is a summary expounding crisply the laws, principles, and conclusions of the entire chapter.

To the radio enthusiast, ease of reference is of great importance, for he consults a physics book solely to refresh his mind on some particular fact or principle. He finds a knowledge of many branches of physics enters into his radio problems. A vernier dial is not a radio device nearly so much as it is a mechanical contrivance; the physics of sound contributes its share to attaining good tonal quality; a knowledge of electrical engineering is essential when the storage battery, power-supply device, fuses, chargers, power transformers, and numerous other parts of radio equipment are being considered. A textbook on physics is indeed no intruder in the radio enthusiast's library.

In fact, more often than not, the radio devotee is quite unfamiliar with the principles outlined in Chapter XIII, dealing with Magnetism; XIV, Static Electricity; XV, Electric Currents (*i. e.*, units, resistance, its application to series and parallel circuits, battery connections, and numerous practical points in constant use about the radio laboratory); XVI, Effects of Electric Current (describing relations of electricity and magnetism, bells, telegraphs, meters, fuses, circuit breakers, lamps, storage batteries, arcs, etc.);

Sheet Copper for Shielding

Shielding

Prevents aerial radiation and feedback.

Insulates against interference from adjoining circuits.

Improves efficiency, selectivity and tone quality.

USE SHEET COPPER because it combines low resistance with easy working qualities.

COPPER & BRASS
RESEARCH ASSOCIATION
25 Broadway — New York

RAYTHEON

For Reliable Reception

★

American RADIO Now— 50% DISCOUNT ON RADIO!

AMERICAN AUTO & RADIO MFG. Co

BIG NEW 1927 CATALOG-FREE

Dealers, Agents, Set Builders—get our big 1927 Catalog—225 nationally advertised lines. Lowest prices in America! Largest, most complete stock. Radio's latest developments. It's FREE—send for your copy now.
AMERICAN AUTO & RADIO MFG. CO., Inc.
36 McGee Street, Kansas City, Mo.

Stop It!

$15
Complete with tube

Last quarter—eight minutes to play—score tied—your favorite has the ball on opponent's twenty yard line—first down—ten yards to go—looks like a touchdown —

Broadcasting coming in fine—play by play—and then,—it fades away. Tubes are not lit—"A" Battery is out—rundown.

This cannot happen to those who use the

FRESHMAN AUTOMATIC CHARGER

This device keeps the "A" Battery fully charged at all times

An absolute necessity—fool proof and dependable in every respect. Equipped with a Tungar Rectifying Tube which supplies a steady charging current to the "A" Battery when the set in not in use. When the radio is in operation the charger is disconnected by means of an automatic relay.

NO LIQUIDS USED "B" ELIMINATOR CONNECTION

Sold by Authorized Freshman Dealers Only ★

Write for our new 48-page book illustrating and describing the entire line of Freshman Masterpiece Receivers and other apparatus

CHAS. FRESHMAN CO., Inc.
Freshman Bldg., NEW YORK—2626 W. Washington Bldg., Chicago

XVII, Induced Currents (with generators, commutators, series, shunt and compound windings, starting resistances, induction coils, telephones, featured in the text); Chapter XVIII, Alternating Currents; Chapter XIX, Sound (wave motion, musical tone, pitch, timbre); Chapter XXIII, Electric Waves (oscillatory discharge, vacuum tube detectors); and Chapter XXIV, Radio Broadcasting.

Favorable as our comment is as to the value of this book to the radio enthusiast, we warn him that it is not a radio book. Just as the authors have confined themselves to basic principles in every branch of mechanics, optics, and acoustics, so also have they dealt with our beloved subject of radio. For example, we challenge you to understand the functioning of a vacuum tube clearly from a reading of the author's description. Everything there is true. But the student may ask after reading it, "What is the B battery for?" Perhaps the diligent reader may remember a statement, earlier in the book, that "electric current flows downhill from plus to minus in outside circuit." That would only confuse him, however, because the explanation says "the filament, when glowing, emits electrons" and they flow "from the filament to the plate." In the next chapter, it says that the B battery always keeps the plate positive. It would not be impossible to conclude from these statements that the B battery opposes the flow of electrons from the filament to the plate. The real error does not lie in the text; it is the fact that plus and minus signs were arbitrarily placed on dry cells long before anything was known about flow of electrons through vacuums. Early investigators simply got the signs the wrong way around.

Nevertheless, these are minor points which do not detract seriously from the value of this comprehensive textbook of physics.

EDGAR H. FELIX.

Announcers' Biographies

THE AMERICAN ANNOUNCER AND RADIO LOG: *Published by the American Announcer, Buffalo, New York, 76 pages, 112 portraits. Price $2.50.*

ACCORDING to the publisher, it is intended that the purpose of *The American Announcer and Radio Log* be to bring the various fine broadcasting stations of the country nearer to the hearts and homes of the listener. The book is a fairly complete compilation of the biographies of some of the leading station announcers in the country. While perhaps all of the announcers can never be listed, the publishers are fully aware of the fact, but have made provision for the insertion of new pages when these are warranted.

A photograph of each announcer is given, together with a brief sketch of his life and history before he became an announcer. To those who are interested in tracing back the influence which made their favorite announcers take up the profession, this information would be of particular interest. The station call letters, the owner, the power, and wavelength of the station are also given. With the physical dimensions, color of eyes, and hair, any ardent announcer-worshipper can certainly get a pretty good idea of his favorate idol.

The latter pages of this book offer a list of stations, accurate at the time of publication with room for additions as the need may arise. The log gives the call letters, the owner, the location, the wavelength, the power, and three columns for marking down the dial settings. To supplement this list, the stations are regrouped according to their locality, and ready reference maps are provided for locating the stations. Cuban and Canadian stations are also listed.

The Extra Straw

Like the camel driver, the radio set builder loads the panel or sub-panel with condensers, coils, tubes, sockets, transformers, and fuses until scarcely a square inch of space remains.

When all the holes are drilled, the sub-panel looks more like the family sieve than the actual backbone of the radio set. With such construction, only the strongest of materials will carry the weight without sagging or warping.

Micarta panels have withstood the test of years and are used by the leading radio manufacturers. Their high insulating qualities allow the most compact construction.

With Micarta you get a deep, permanent finish in black, mahogany, walnut grain, or walnut burl. You benefit by constant research in papers, dyes, and molding methods.

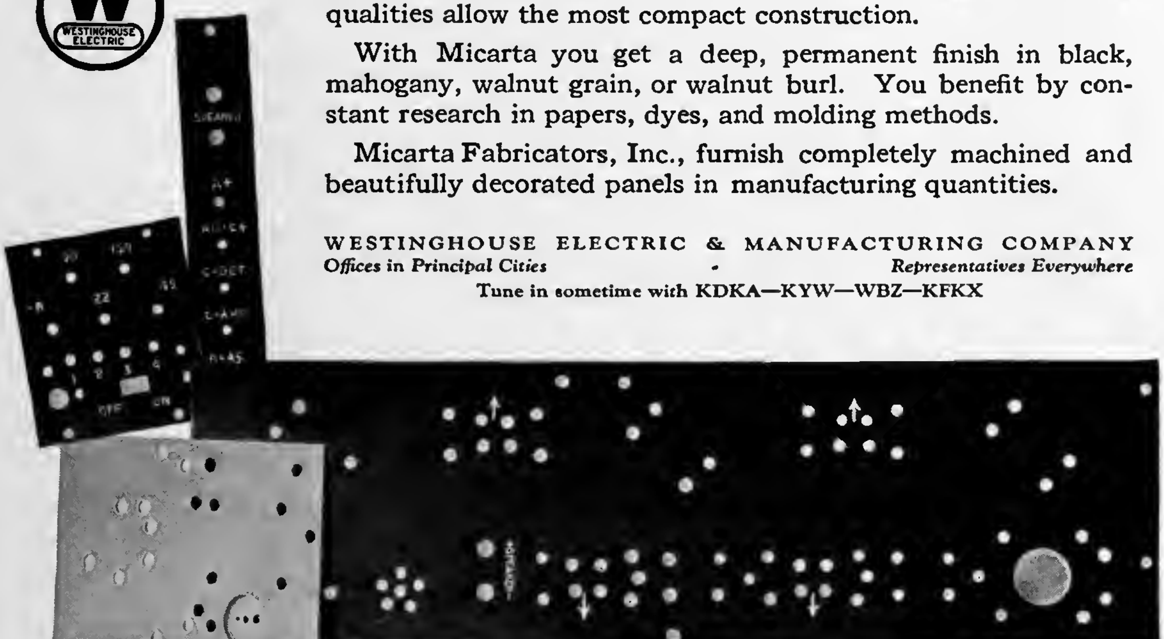
Micarta Fabricators, Inc., furnish completely machined and beautifully decorated panels in manufacturing quantities.

There's Westinghouse Micarta tubing for better wire insulation, Westinghouse instruments for better reception, and the Westinghouse Rectigon for better battery charging—at home.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

Offices in Principal Cities • *Representatives Everywhere*

Tune in sometime with KDKA—KYW—WBZ—KFKX



Westinghouse

MICARTA FABRICATORS, Inc.
OF NEW YORK
309 Canal Street
New York City

MICARTA
REG. U.S. PAT. OFF.

MICARTA FABRICATORS, Inc.
OF ILLINOIS
500 South Peoria Street
Chicago, Ill.

RADIO BROADCAST

FEBRUARY, 1927

WILLIS K. WING, Editor

KEITH HENNEY, Director of the Laboratory

JOHN B. BRENNAN, Technical Editor

EDGAR H. FELIX, Contributing Editor

Vol. X, No. 4

CONTENTS

BEHIND EDITORIAL SCENES

IF WE can judge from the correspondence which has been coming into the office recently, radio folk are at present most interested in what steps are to be taken to clear the air and unravel the present serious broadcast tangle. Almost every letter we receive—and our mail man always has a full load—has something strong to say about the present situation and expresses the hope that something many be done. No one can forecast what will happen in Washington where the legislators meditate suitable legislation, but every reader who wants "something to be done" should write his opinions with a plea for action to his Congressman. The people are the Government and letters to our Washington representatives are the best way to make one's feeling felt. It may be that legislation will be passed even before this magazine reaches the hands of the reader, but at present, that happy event seems but distantly possible. The leading editorial in "The March of Radio," dealing with proposals for widening the broadcast band, is worthy of very careful reading.

THE questionnaire in the "Listeners' Point of View" in the January magazine has provoked a large number of extremely interesting replies and it is reprinted on page 376 of this issue for the benefit of those who did not fill out that printed in the January number. It is not possible to acknowledge and thank every reader who sent us the filled out questionnaire, but we greatly appreciate the fine interest and cooperation of the many who went to considerable trouble to reply. The January listing of many excellent booklets published by various radio concerns has attracted wide interest. An extraordinarily large number of readers have returned the coupon requesting some of the booklets, which are sent without charge. A more complete list is published in this number.

QUOTATIONS from Senatore Marconi's description of his new beams system, contained in Mr. Humphrey's leading article, are printed in detail for the first time in this country. Much of the description, too, has not heretofore been released in the United States.

THE second of David Grimes's excellent descriptions of his improvements on his Inverse Duplex System appears in this issue and his third article appears in the March RADIO BROADCAST. Experiments have been taking place in the Laboratory to improve the four-tube R. B. "Lab" receiver. The changes described in the article beginning on page 368 are not extensive but they are important. This model is one of the finest receivers we have ever used and we welcome correspondence from readers detailing their experience with this set. Edgar Felix's article on page 372, "Looking for Trouble?" should offer great help to the "average radio fan" who is called upon to "shoot trouble" in his own outfit or those of his friends. The information there can also be applied with great profit by radio dealers and others who are called upon to put an ailing set in order.

IN MARCH, the second of James Millen's constructional articles on B-power supply units appears, as does a constructional article on the Grimes receiver, a constructional article on adding power supply to the Hammarlund-Roberts "Hi-Q," and many other articles of wide interest.

—WILLIS K. WING.

Doubleday, Page & Co.
MAGAZINES
COUNTRY LIFE
WORLD'S WORK
GARDEN & HOME BUILDER
RADIO BROADCAST
SHORT STORIES
EDUCATIONAL REVIEW
LE PETIT JOURNAL
EL ECO
FRONTIER STORIES
WEST

Doubleday, Page & Co.
BOOK SHOPS
(Books of all Publishers)
NEW YORK: LORD & TAYLOR; PENNSYLVANIA TERMINAL (2 Shops); GRAND CENTRAL TERMINAL; 38 WALL ST. and 526 LEXINGTON AVE.; 848 MADISON AVE. and 166 WEST 32ND ST.
ST. LOUIS: 223 N. 8TH ST. and 4914 MARYLAND AVE.
KANSAS CITY: 920 GRAND AVE. and 206 W. 47TH ST.
CLEVELAND: HIGBEE CO.
SPRINGFIELD, MASS.: MEEKINS, PACKARD & WHEAT

Doubleday, Page & Co.
OFFICES
GARDEN CITY, N. Y.
NEW YORK: 285 MADISON AVE.
BOSTON: PARK SQUARE BUILDING
CHICAGO: PEOPLES GAS BUILDING
SANTA BARBARA, CAL.
LONDON: WM. HEINEMANN LTD.
TORONTO: OXFORD UNIVERSITY PRESS

Doubleday, Page & Co.
OFFICERS
F. N. DOUBLEDAY, *President*
A. W. PAGE, *Vice-President*
NELSON DOUBLEDAY, *Vice-President*
RUSSELL DOUBLEDAY, *Secretary*
S. A. EVERITT, *Treasurer*
JOHN J. HESSIAN, *Asst. Treasurer*

DOUBLEDAY, PAGE & COMPANY, Garden City, New York

TERMS: $4.00 a year; single copies 35 cents.

RADIO NOW AIDS THE MARINER

The navigator who peers through thick fog, looking for the beams of a lighthouse no longer has to depend on his sight alone, for the important lights along the coasts have been equipped with automatic radio transmitters which send out predetermined signals, each individual to the location, enabling a ship operator with direction finding equipment to determine his position accurately by radio. This view shows the San Pedro Breakwater Light, just outside the Los Angeles harbor.

RADIO BROADCAST

VOLUME X | NUMBER 4

FEBRUARY, 1927

Linking Continents with Twenty Kilowatts

How Britain Is Linking Up with Her Colonies by Means of the Short-Wave Beam System—New Stations Can Handle Five Times as Much Traffic as Long-Wave Stations and Expense Is Lowered—A Description of a Typical Beam Station and the Principles Involved—What Marconi Thinks of the "Ham's" Share in Short-Wave Development

By KENNETH B. HUMPHREY

"I HAVE always felt," said Senatore Guglielmo Marconi in the "James Forrest" lecture given before the Institute of Civil Engineers in London recently, "that wireless waves are far too valuable to be continuously scattered and broadcast equally in all directions instead of being concentrated as much as possible on the station with which one desires to communicate."

"Ten years ago," he continued, "during the War, I began to consider the possible alternative which might be offered by an exploration of the capabilities for point to point communication of those electric waves which had never yet been used for practical radio telegraphy. I mean waves only a few meters in length, and I was particularly attracted to this line of research because I was well aware that with these waves, and with these waves only, it would be possible to project most of the radiation in a narrow beam in any desired direction, instead of allowing it all to spread in every direction.

"There is no doubt that, generally speaking, radio engineers of four or five years ago thought they knew much more about the subject than we think we know to-day. Laws and formulas were announced and accepted showing which wavelengths were best adapted for various distances, and indicating what amount of power would be necessary in order to be able to communicate any given distance. Unfortunately, it soon became apparent that the logical application of these laws and formulas brought us to the necessity of employing, for long-distance transmission, such enormous and expensive antenna systems, and such large amounts of power as to make the method so costly in capital expenditure and operation, that only a very small margin of profit would remain when the system was worked in competition with modern cables and land lines."

A SHORT-WAVE WAVEMETER
This particular instrument is utilized to keep check on the Bodmin short-wave beam station

As long ago as 1913 efforts were made to design long-wave stations which could be used for long-distance communication. It was not until 1923, however, that the British Government finally decided definitely to proceed with a plan of linking up the Dominions with the mother country by means of wireless telegraph stations. The Dominions had been asking for such a service for many years, and when the decision was finally reached by the British Government, the Dominion governments immediately made arrangements for the construction of corresponding stations in their own territories to complete the service. Even while negotiations were under way to provide long-wave stations, Senatore Marconi became convinced, as a result of his experiments, that a new system could be developed which would prove to be better both from a standpoint of effectiveness and cost.

Some courage was necessary to propose a system which might easily revolutionize the whole art of long-distance communication. This too, it must be remembered, at a period when larger and larger long-wave stations were being erected in America and at other points, such as the Lafayette station at Bordeaux, France, the station at Nauen, Germany, and others. But in spite of the opinion against him, Senatore Marconi was able to convince the British Government and the Dominions that the beam system of short-wave telegraphy was entirely practical. The early predictions of Marconi have been justified, and the Government has officially accepted the first link in the chain between England and Canada after a rigid seven days' test.

To get some definite conception of what the inauguration of the new beam system will mean, consider the great long-wave stations which have recently been completed, and which may eventually have to give way to the new competitor. Commercial long-distance radio communication has been accomplished previously by stations employing frequencies from 37.48 up to 9.99 kilocycles (8000 to 30,000 meters), and using several hundreds of kilowatts in power at the transmitting station.

One of the latest and largest of these long-wave stations in the United States is located at Rocky Point, Long Island, and is operated by the Radio Corporation of America. Twelve antennas are used to communicate with various points in the world. Each antenna is supported on twelve 440-foot steel towers, and the length of each antenna is in the neighborhood of three miles. From 200 to 400 kilowatts of power are used, and transmission is carried on at two frequencies, 17.15 and 18.22 kilocycles (17,500 and 16,465 meters).

The British Post Office wireless station at Rugby (England) has an antenna 800 feet high supported on 12 masts, and uses about 500 kilowatts of power. The frequency used in transmission is 21.3 kilocycles (14,080 meters).

Buenos Aires, in the Argentine, has an antenna about 680 feet high supported on ten towers, and uses about 800 kilowatts of power. The station normally works on a frequency of from 18.7 to 24.9 kilocycles (16,000 to 12,000 meters). Many other similar stations are operating in Germany, France, Italy, and other countries.

Contrast the above stations with the modern short-wave beam station having five masts 277 feet in height and using a power of only 20 kilowatts, and a transmitting frequency of 11,500 kilocycles (26.09 meters).

Senatore Marconi said that the *average* speed obtained by the long-wave stations was 20 words a minute for a daily average of 18 hours. The beam stations, during the official tests, averaged at least 100 words a minute for 18 hours a day.

The average 20-word speed of the long-wave stations referred to above, is considerably less than maximum speed, which is said to be 100 words a minute. The maximum workable speed for ordinary telegraphic work on the new "Permalloy" cables is said to be about 500 words a minute. During the tests of the new beam station, a speed of 250 words a minute was maintained for several hours at a time without difficulty.

ADVANTAGES OF THE BEAM SYSTEM

THERE are several distinct advantages in using the short-wave beam system over the long-wave system for point to point communication over long distances:

1. The cost of equipment is less.
2. It is more economical to operate and maintain.
3. The speed is greater.

AT THE BODMIN BEAM STATION

The antenna system for the transmission of directional signals to Canada is here shown. There are five masts, providing four spans of horizontal supporting wires from which the vertical antenna and reflector wires are dropped. Canada, looking at this picture, is "way over" to the right, hence the reflector wires are at the left. The antenna coupling boxes, one for each pair of antenna wires, are shown in the picture, as also is a part of the copper-tubing feeder system

Concentrating the radio waves in a beam instead of allowing them to wander to every point on the earth makes it possible to use only 20 kilowatts of power instead of 200 kw. or more (as in long-wave telegraphy). In spite of using less power at the transmitting station, more power is received at the receiving station, and that is the goal that all radio engineers strive for.

Economical operation and maintenance costs are in direct proportion to the amount of power used and the size of the antenna, both of which are less in beam transmission than for long-wave stations giving the same kind of service.

Another advantage is that the speed in signalling is increased, due to the utilization of short waves. The larger antenna takes an appreciable time to charge and discharge while the smaller antenna takes much less time.

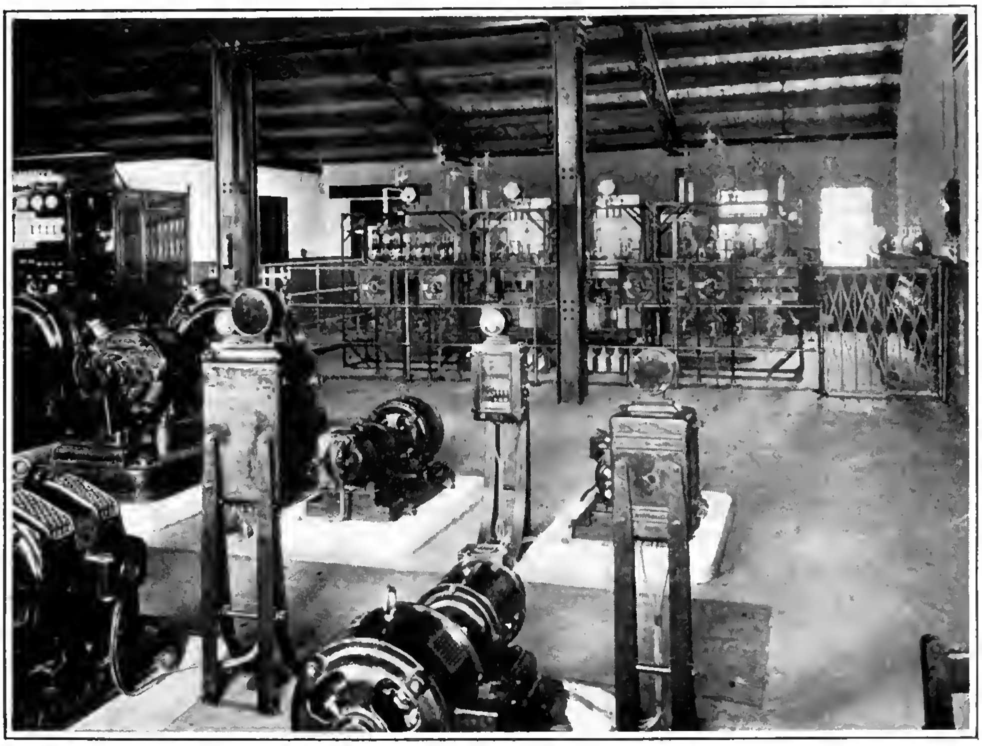
Short waves alone, however, would not accomplish the desired result as far as speed is concerned. It is by the use of reflectors at both sending and receiving ends that the signal is stepped up about a hundred times over that which would be possible with ordinary non-directional sending and receiving. The wave is projected out in a narrow beam and is caught at the receiving station by a similar reflector, and concentrated on the receiving antenna.

It may be calculated, that, to obtain a signal strength of a hundred times that of another signal, the power required would be ten thousand times as large. Considering the ordinary method of signalling without reflectors, the power applied would have to be 20,000 kilowatts instead of the 20 kilowatts actually used in the beam system!

Atmospherics, which have always limited high speed radio sending, do not exist as a serious factor in the new system. Fading is reported to be considerably less in the directional system than in the non-directional system. True, there is still some fading, but because of the increased signal strength, the margin of reliability is increased. During the test week there were only two bad periods where fading was enough to hamper the service. These were during the appearance of very large sun spots, and during an intense display of the aurora borealis in Canada. No interference was experienced on the long waves, but the cables and land lines were seriously affected. It was also noticed that, by changing the wavelength slightly, a path could be found which was practically free from interference.

In the first beam experiments carried out in Italy and in England, the reflectors consisted of a number of vertical wires parallel to the antenna and spaced around it on a parabolic curve of which the transmitting or receiving antenna constituted the focal line, but in the more modern stations an arrangement devised and patented by Mr. C. S. Franklin has been more advantageously employed.

In this arrangement, the antenna and the reflector wires are disposed so as to constitute grids parallel to each other, the antenna wires being energized simultaneously from the transmitter at a number of feeding-points, through a special feeding-



THE MACHINERY HALL IN THE BODMIN STATION
Built by the Marconi Company for the British General Post Office. In the background may be seen the rectifying panels for the Canadian and South African transmitters

system, so as to insure that the phase of the oscillations in all the wires is the same. It has been proved by calculations, and confirmed by experiments, that the directional effect of such an arrangement is a function of its dimensions relative to the wavelengths utilized.

A similar system of antennas and reflecting wires is used at the receiving stations.

THE BEAM ANTENNA SYSTEM

IN A typical short-wave beam station, the Bodmin station, for example, there are five steel lattice masts, each 277 feet high, erected in a straight line at right angles to a line passing through both sending and receiving station. These five masts provide four spans of wire (one between each pair of masts) the sole purpose of which is to support the vertical antenna and reflecting wires. Except as supports, the horizontal spans serve no useful purpose in the actual transmission. At each station there are two distinct transmitters for each point it is intended to communicate with, operating on different frequencies. but whether the second one is to be used as a standby or as a supplementary channel has not as yet been definitely decided. Of the two transmitters, one operates on 11,500 kc. (26.09 meters), while the second will operate on a slightly higher frequency.

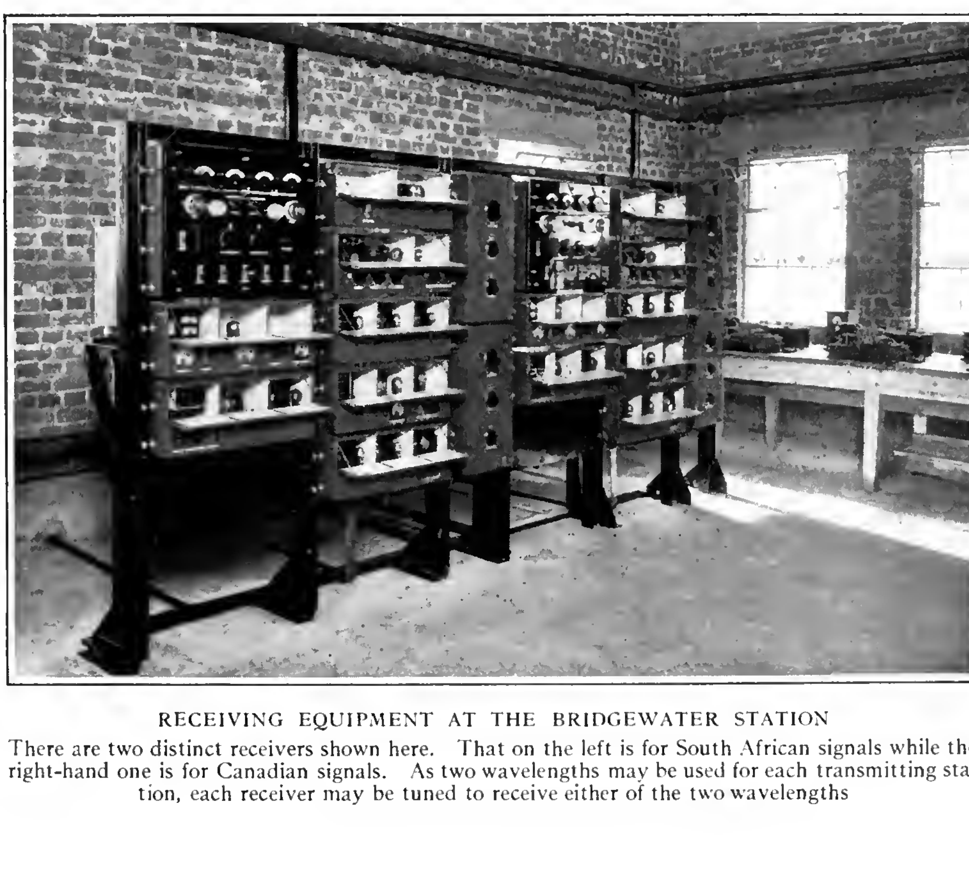
Cross-arms at the top of the masts extend for forty-five feet on either side of the vertical, forming a support for the horizontal sustaining wires. For the 11,500-kc. band, there are thirty-two vertical antenna wires, grouped in fours, in a parallel row with which are the reflector wires. There are twice as many reflector wires as antenna wires. The horizontal wire spans between the first second and third masts (two spans) support the antenna-reflector system for the 11,500-kc. transmitter.

Each of the reflector wires is divided into five complete sections by means of insulators. The reflector wires are placed on that side of the actual antenna wires which is remote from the distant receiving station. Counterweights are attached to the lower ends of both antenna and reflector wires, the object of these being to keep an equal tension on each wire irrespective of changes in wind pressure.

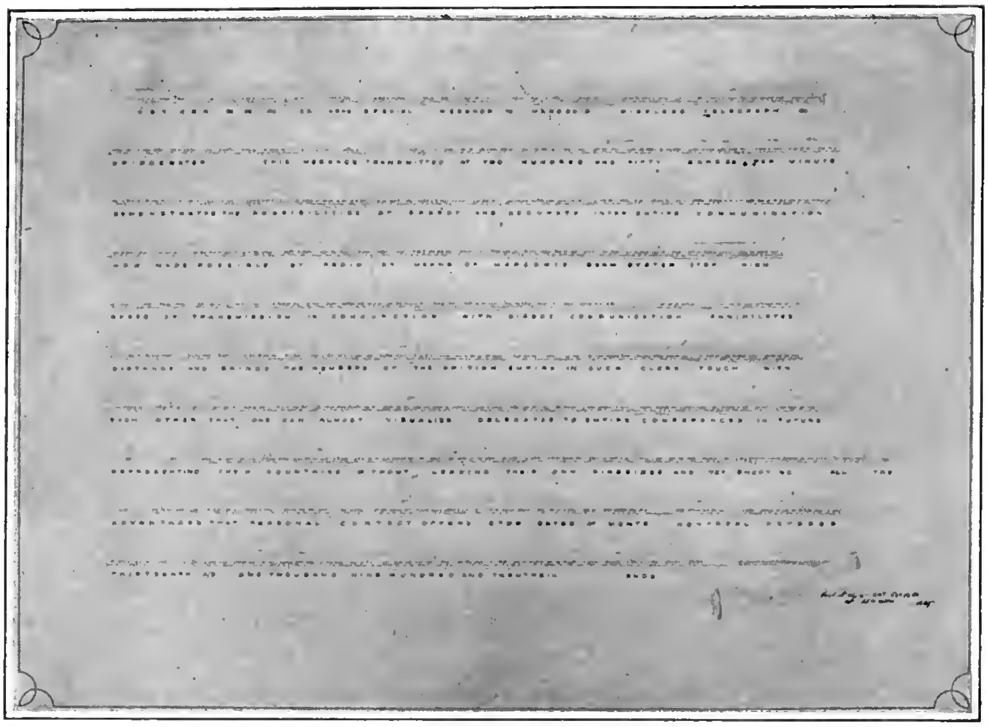
The system of wires which constitutes the connecting link between the transmitter and the antenna is known as the "feeder system." This system consists of two concentric copper tubes, air insulated from each other to avoid loss. The outer tube is grounded and carried on metal standards a short distance above the ground, while the inner tube carries the current to the antenna. In order to insure an equal amount of current for each of the separate antenna wires, the feeder system is arranged so that the distance which the current has to travel through the feeders is exactly the same for each individual wire in the entire antenna system. In order to prevent the presence of reflected waves in the feeder system, which would cause trouble, equalization may be obtained by means of coupling transformers located at each junction box. A check against any reflected wave in the feeder system is provided by three high-frequency thermo-ammeters wired at three different points 32 feet apart. Actually the three meters are located at one point for ease in reading. With no reflected waves in the system, the meters will all register alike.

Each antenna coupling box is grounded by means of metal plates three feet square, arranged in a circle of 50 feet in diameter. This is for the short-wave antenna. For the long-wave antenna the diameter of the circle is 100 feet. Each transmitter is grounded near the building with a galvanized iron plate six feet by three feet connected to a copper tray placed under the transmitter proper by means of heavy copper bars. All masts and guy wires are grounded, as is the support for the feeder system.

The transmitting apparatus follows closely that used in standard practice.

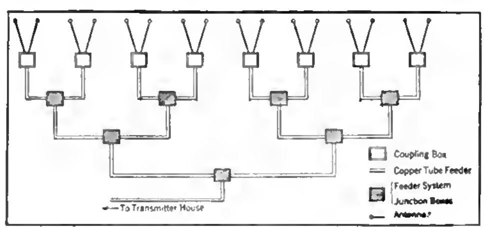


RECEIVING EQUIPMENT AT THE BRIDGEWATER STATION
There are two distinct receivers shown here. That on the left is for South African signals while the right-hand one is for Canadian signals. As two wavelengths may be used for each transmitting station, each receiver may be tuned to receive either of the two wavelengths



A MESSAGE SENT AT 250 WORDS PER MINUTE

This is an actual record of a message received at a speed of 250 words per minute during official tests of the beam wireless circuit between England and Canada



THE FEEDER SYSTEM

This may be studied in conjunction with the pictures on page 352 and at the foot of this page. The antenna wires are taken in pairs to the coupling boxes and thence to the copper-tubing feeder system. The distance from the transmitter to each antenna wire is the same

Many parts, however, had to be designed especially for the work in hand. Vacuum tubes are used throughout for generating the high frequency current. The main power oscillators are cooled by means of oil and are designed particularly to reduce tube capacity and resistance losses. A master oscillator tube is provided which determines the frequency or wavelength at which the main transmitter tubes will oscillate. The voltage used on the tubes has an approximate range of from 8000 to 10,000 volts, which is supplied by special rectifier tubes.

The method used in keying, or interrupting the circuit in order to transmit the dots and dashes of the signals, is of interest. When a signal is being sent, the high frequency current is allowed to go out into the antenna, while, when no signal is being sent, the power is absorbed by an equivalent load made up of resistances placed in a small house near the transmitter. This makes it possible to keep the load on the transmitting tubes the same at all times.

The absorption system is controlled by means of vacuum tubes the grids of which are thrown positive or negative by the keying relay through other amplifying tubes.

By using vacuum tubes in place of mechanical relays it is possible to speed up the system to a remarkable degree. Only one small mechanical relay is used to tie up the land line with the transmitter.

Everyone who has followed radio to any extent in the last few years knows something about the super-heterodyne system of receiving signals. The English engineers use this idea in a new way. It will be remembered that the super-heterodyne changes over the incoming signal from a short wavelength (high frequency) to a longer wavelength (low frequency) in order that it may be more easily amplified. It is again detected and operates an audio amplifier.

This system is extended for use in the receivers at the beam stations by using two heterodying systems, or what is practically the equivalent of two super-heterodynes in series. The signal is collected on the antenna, which, being of the reflector type gives a signal of considerable strength, and is fed to the first detector through a very loosely coupled tuned unit. The loose coupling is resorted to in order to cut out interference and reduce the pickup of static and other noises. This first detector is coupled with an oscillator which changes the short wave of 26 meters (11,538 kc.) over to a wavelength of about 1600 meters (187 kc.). The signal then goes through a three-stage amplifier at this frequency and is again detected. At this point another heterodyne oscillator is provided and the wavelength changed from 1600 meters to 10,000 meters (30 kc.). Again it is amplified through three stages and again detected. This second heterodyne may be tuned to an audible note so that the operator may listen-in and tune the signals as received through the first part of the receiver. The output of the receiver operates a high-speed relay which in turn operates the recording mechanism. Each stage of amplification is of the push-pull type in order to provide distortionless amplification throughout. The output works through a bridge system which insures

THE FEEDER AND COUNTERWEIGHT SYSTEMS

The copper tubing which constitutes the line between the transmitter and the antenna system, together with one of the junction boxes, is shown in this picture. To the left may be seen one of the antenna coupling boxes to which two of the antenna down leads are taken. The weird wooden structures, which in windy weather are apt to cultivate bobbing propensities, and which may be seen dotted about the field, are the automatic counterweights which provide a certain amount of slack to the antennas when necessary that the signal strength is practically the same no matter what the strength of the incoming signal.

MARCONI PRAISES "HAMS'" EFFORTS

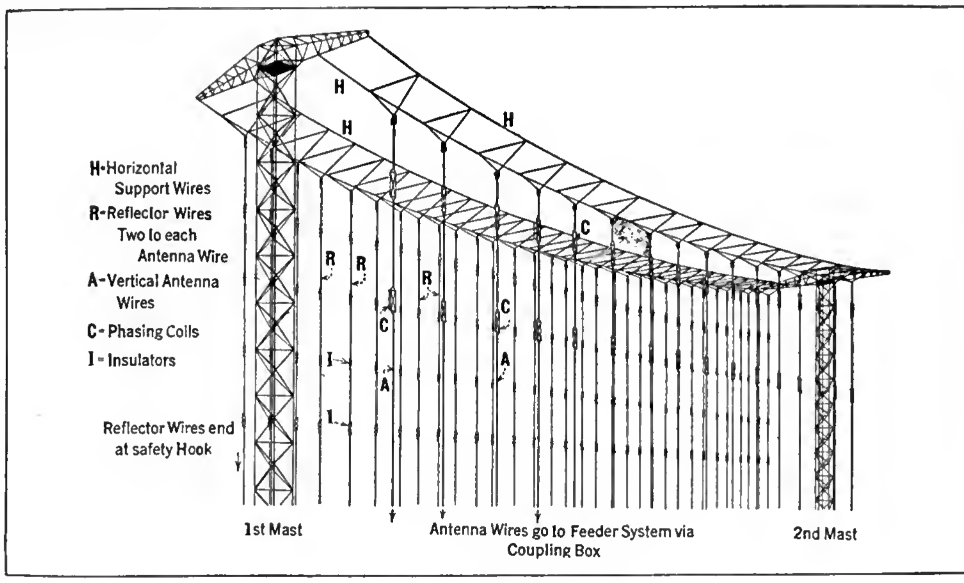
IN THE course of his address on the beam system, Senatore Marconi made some interesting remarks relative to the value of the amateurs' share in short-wave development. "The results obtained by amateurs in the field of short-wave endeavor do great credit to them," he said, "especially if we consider that most amateurs possess only limited facilities for experimental work. It should not be forgotten that amateurs were the first to carry out two-way communication with New Zealand for brief periods. Their observations have often been of value in helping us to arrive at a somewhat better understanding of the very complex phenomena involved, but I think it is sometimes dangerous to attach too much importance to all their observations, especially when they concern what I might term 'negative results.' Only the other day I read a statement by an eminent authority that, according to amateurs' observations, the daylight range of a 100-meter (2998-kc.) wave did not exceed 200 miles, and for a 50-meter (5996-kc.) wave 100 miles. I have carried out tests on a 100-meter wavelength for months on end and have never found its daylight range to be below 1000 miles. With a 47-meter (6379-kc.) wave, which is close to 50 meters, we have never observed any skip distance commencing at 100 miles or at anything like so short a distance. It may well be that some of the observers were not particularly skilled, or were using insensitive receivers or that their stations happened to be situated near buildings or structures which unfavorably affected receiving. I therefore think it would be unfortunate if, in consequence of some reports, the theory of skip-distances should become unduly generalized and extended.

"I have found that, for reliable observations and deductions in regard to the behavior of transmissions over varying distances, there is nothing so good as a receiving station installed on a suitable ship."

LOCATION OF THE BEAM STATIONS

THE beam transmitting station in Canada is situated at Drummondville, 30 miles east of Montreal, and the receiving station at Yamachiche, 25 miles north of Drummondville. These stations are linked up by land line to the central office of the Canadian Marconi Company in Montreal in the same way that the English stations are linked to the General Post Office, in London. Beam stations are also being erected in Canada for direct communication with Australia, and corresponding beam stations are being built at Melbourne.

The sites occupied by the beam stations at Bodmin and Bridgwater in England, for communication with Canada, are also utilized for the stations to be used for communication with South Africa. These South African stations are practically complete. Similar stations are being built in England at Tetney, near Grimsby, and at Winthorpe, near Skegness, for communication with Australia and India—the Grimsby stations being transmitting stations and the Skegness stations receiving stations. Corresponding stations are being built in the Dominions near Cape Town, Melbourne, and Bombay. All these stations are in an advanced state of construction, and are expected to be opened within the next few months. This will complete the present Imperial Scheme; but outside of this scheme, the Marconi Company is already engaged on a considerable development of commercial telegraph services on the beam principle. The Company holds a license from the Post Office to conduct wireless telegraph services with certain continental countries and with all other foreign countries outside Europe. In addition to the wireless stations the Company has been operating on these services for some years, it has a beam station nearly completed at Dorchester for communication with North and South America. A corresponding station is also in process of erection at Rio de Janeiro.



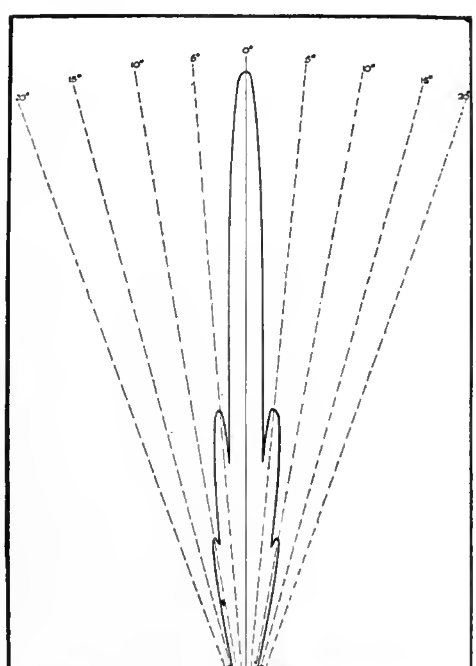
THE BEAM ANTENNA SYSTEM

Showing the position of the antenna and reflector wires in relation to each other. The relative location of the insulators, phasing coils, supporting wires, and towers are also shown. There are sixteen antenna wires and thirty-two reflector wires to each span

Another important development in which beam stations are included—and these are already under construction—is the Portuguese scheme for linking up Portgual and its colonies. Some time ago the Marconi Company obtained a concession from the Portuguese Government for the establishment of wireless telegraph stations in Portugal and its colonies for the purpose of linking them together and establishing wireless communication with other parts of the world. These stations are now being built in Lisbon, in the Cape Verde Islands, in the Azores, and in East and West Africa. When they are completed, wireless services will be established with England, with the principal continental countries, and with South America.

The beam system is not by any means limited to wireless *telegraphy,* according to Senatore Marconi. He feels confident that it can be utilized for placing wireless *telephony* on a much more practical basis than it is on at present, besides helping the systems of picture and facsimile transmission, not to speak of television.

Even for broadcasting he believes it will result in enabling programs and speeches to be transmitted to large portions of the United States, Canada, South Africa, and Australia with much greater strength and accuracy than it is possible to obtain by means of the existing broadcasting systems.



A POLAR CURVE OF A RADIO BEAM

Showing how the radio wave travels out from the station in a beam instead of being broadcast in all directions

THE MARCH OF RADIO

News and Interpretation of Current Radio Events

Why Short Waves Should Not Be Opened to Broadcasting

VARIOUS proposals are being brought forward to accommodate the excess broadcasters who insist on infesting the ether with their unnecessary emanations. These are offered principally by pacifists seeking to mollify rejected wavelength-seekers, rather than by those who have the good of broadcasting and the development of radio at heart.

The most tempting and, to the uninformed, the most logical course is to open the higher frequencies, below our present broadcasting wavelengths, to accommodate a host of additional broadcasters. The amateurs have been able defenders of this wavelength territory and, in this respect, they have been highly useful conservers of wavelength space. Were there any real need for additional broadcasters, it is doubtful whether the amateurs and others assigned to short-wave bands, could retain possession of the extensive frequency territory which they now occupy.

The broadcast listener is the principal sufferer if the wavelength territory is extended. To him it means that his present day radio receiver will no longer give him the entire range of programs. To accommodate an enlarged band, receiving sets must be equipped with tapped inductances and switches making them so complicated and inefficient that only the technically inclined enjoy their use.

In Great Britain, where broadcasting stations have been spread over a wide range of frequencies, receiving sets are either incapable of tuning to all of them or the listener must fuss with a comprehensive lay-out of plug-in coils. Tuning to stations requires reference to a number of charts. Neutralizing such receivers over the entire range is out of the question without a considerable sacrifice in amplification. So discouraging is the tuning process under these conditions that British manufacturers have found it profitable to market receiving sets to disgusted non-technically inclined listeners, adjusted to the wavelength of only one particular station. If stations of any account begin radiating programs on the higher frequencies, the broadcast listener will have excellent reason to complain, Either he must deny himself the pleasure of listening to them or substitute for his simple receiver one of annoying complexity.

The broadcasting station operating on these higher frequencies will not find itself pleasantly situated either. Short-wave programs are subject to a surprising amount of fading which, varying at different hours of the day and night, will cause him no end of complaint. Heterodyning, by reason of the vagaries of short waves, is not limited to the usual ranges by power, because a short-wave, low power station, hard to pick up at a distance of 25 miles, may be a powerful source of interference at distances of 1000 to 5000 miles.

More important than the consideration of the listener and the broadcaster is the importance of conserving radio frequencies for essential services. The higher frequencies are best adapted to point-to-point communication because little power carries great distances The higher frequencies alone are adapted to beam transmission and high-speed automatic communication. The transmission of photographs and motion pictures, the coming of which is as certain as commercial aviation, will be seriously handicapped if the numerous Podunk Radio Companies of Four Corners, seeking wavelengths, have their way.

When one examines the list of applicants desiring to broadcast and realizes the remoteness of any chance that they will contribute to the good of broadcasting, one hopes that a way will be found to disregard their clamorings utterly. Recently, we saw an item in an Iowa newspaper which announced that no less than eight

The illustration forming the heading shows the lonely post of Clifford York, fire ranger, atop a 6400-foot mountain in the California National Forest. A radio receiver helps while away the hours of this ranger's lonely watch new members had joined a local radio club and, encouraged by this substantial increase of membership and evidence of interest, they decided at once to proceed with the erection of a broadcasting station. Moving picture theatres, hotels, radio stores, automobile agencies and ambitious amateurs comprise a large part of the wavelength seekers. Municipalities and religious organizations which ought to know better, have hardly been in the minority when it comes to vandalistic wave-length-jumping and ruination of reception. The character of the applicants for space on the ether is exposed by the ruthlessness with which the meagre allotment of six exclusive wavelengths to our Canadian neighbors was usurped. There is no greater disgrace in the annals of broadcasting than this wanton and ungentlemanly action on the part of stations which have deliberately ruined broadcast reception in Canada. A total of 57 American stations have seized Canadian wavelengths, including WHT, WNAC, WHAP, KSO, WJAZ, WWAE, KFCW, KWDH, KSBA, KTLD, KMMJ, KGDT, KFKB, and KFXF.

There are ample broadcasting facilities for all, if sympathetic interests will combine in the operation of stations, but, if each must use his own station, the future needs of commercial aviation, of short-wave rebroadcasting links, of high speed point-to-point communication, of emergency railroad service and a score of other useful services are menaced by this insistent rabble of the ether.

Why should we accommodate more stations? Simply as a sop to those who must be excluded from the present broadcasting band if there is to be an end to radio chaos. It is an economic waste. If those who apply for stations do not have prospect of an appreciable following, they certainly should not be licensed. If they do, it reduces the audience of existing broadcasting stations. That means less value to their microphones and, in consequence, less attractiveness to better artists and features—in other words, lowered program values. It is hard to see who gains by the insane mania which some people seem to possess to stir up the ether through their own private microphone.

Conserving of radio frequencies is a problem calling for the same foresight as the conservation of forests and the judicious planning of our public highways and railroad grants. Divesting one established on a frequency thoughtlessly assigned today, will be as difficult a generation from now as it would be for the government to regain former public lands, occupied for twenty years by thriving farms, villages, and cities. Many rail at the lack of foresight of our fathers because of their failure to plan cities, highways and railroads while rights of way were purchasable at low figures. Today we cut up the only remaining airplane landing fields near large cities into real estate developments and we give away broadcast radio frequencies for which there will ultimately be a crying need to promote the safety of aërial travelers and to extend worldwide communication.

Gentlemen, have mercy on your grandchildren!

A GERMAN POLICE MOTORCYCLE, RADIO EQUIPPED

A complete outfit is installed in the armored car at the left, so that the unit may be at all times in communication with headquarters. If any shooting starts, things must be a bit difficult for the unprotected driver

Failures in the Broadcasting Tax System

THOSE who dislike commercial broadcasting in principle always suggest, if they have any constructive idea, the establishment of a taxation system to support broadcasting. The experience of South Africa, as described in *Broadcaster and Wireless Retailer*, a leading British trade publication, is enlightening. In the prosperous South African province, two stations have been given a monopoly, one at Johannesburg and one at Durban, the former now showing a deficit of over \$25,000 and the latter about \$35,000. The magazine complains that there are 20,000 "pirates" in Johannesburg who do not pay their broadcasting fee and incidentally points out that the cost of collecting the \$50,000 revenue from listeners was more than \$2500. The annual license fee is about \$10.50.

In Great Britain, there are 2,105,000 licensees, but whether listeners are wholly satisfied with their much vaunted broadcasting system is indicated by another item in the same publication:

> The British Broadcasting Company carries on remarkably, but many promises and long overdue improvements, such as high power stations and alternative programs, are held up, among other reasons, because of lack of funds.
>
> In view of the fact that of the £2,227,000 received by the Post Office in license fees for the three years ending March 31, 1926, only £1,166,000 has been handed over to the B. B. C., the Wireless Retailers' Association has instituted a campaign to recover the bulk of the balance for the purpose for which it was subscribed.

After outlining the activities of the Wireless Retailers' Association in stimulating the Postmaster General, the article continues: "The Wireless Retailers' Association's activities are far from finished in this connection and dealers throughout the country will undoubtedly do all they can in this endeavor to secure better broadcasting."

A well known New Yorker, a zealous radio follower, is quoted anonymously in the *Times* as follows: "What makes British radio rather dull for an American is the heavy official way in which they run it. Parliament is constantly talking about and laying down rules for it. Every set owner pays a license fee and the really huge sum thus raised does not appear to go back into broadcasting. The general impression one gains is that the government is everything, individual initiative nothing—in radio."

The Useless Newspaper Radio Program

EXTENDING still further their policy of disregarding the interests of their radio readers, newspapers are now publishing the radio programs in a manner which makes them totally useless. By leaving out the specific names of commercial features and substituting some asinine generality such as "musical feature" or "entertainers" they have destroyed the news value of the only part of their radio sections which commands general interest. This is done on the ground that commercial features should not be given free publicity, but its only effect has been to make the ambiguous program listings a waste of space.

Perhaps the astute newspaper publishers will discover that their news columns give free publicity on a much larger scale than do the radio programs. Headlines will read, "Famous automobile manufacturer reduces prices," instead of "Ford prices drop," and all news will studiously avoid mentioning the names of persons and companies engaged in profitable pursuits. Reader interest will of course be greatly enhanced because these readers fall for puzzles so enthusiastically!

Why not cut out the radio programs altogether? Nobody would miss the present-day conundrums anyway.

The Courts Aid in the Radio Tangle

VARIOUS court decisions, recently granted and about to be granted uphold the priority rights to wavelengths. Chicago, where every conceivable broadcasting shortsightedness has been permitted, on an extensive scale, is also in consequence, the most fruitful source of experience and precedents. WJAZ, which precipitated the present broadcasting tangle almost singlehanded, by upsetting the Department of Commerce's regulatory power and which also was the first to disregard the gentleman's agreement with Canada, is a Chicago station. WGN, a Chicago station, won the first court decision against WGES, establishing legally the priority to an established wavelength. Although won in a court of limited jurisdiction, it establishes a most acceptable precedent. When this decision was announced, WHN retained John F. Hylan, who, it may be remembered, was once mayor of New York, to hail WRNY into court for planting a steady whistle on its programs. By the time this appears in print, there will probably be many other broadcasting suits under way.

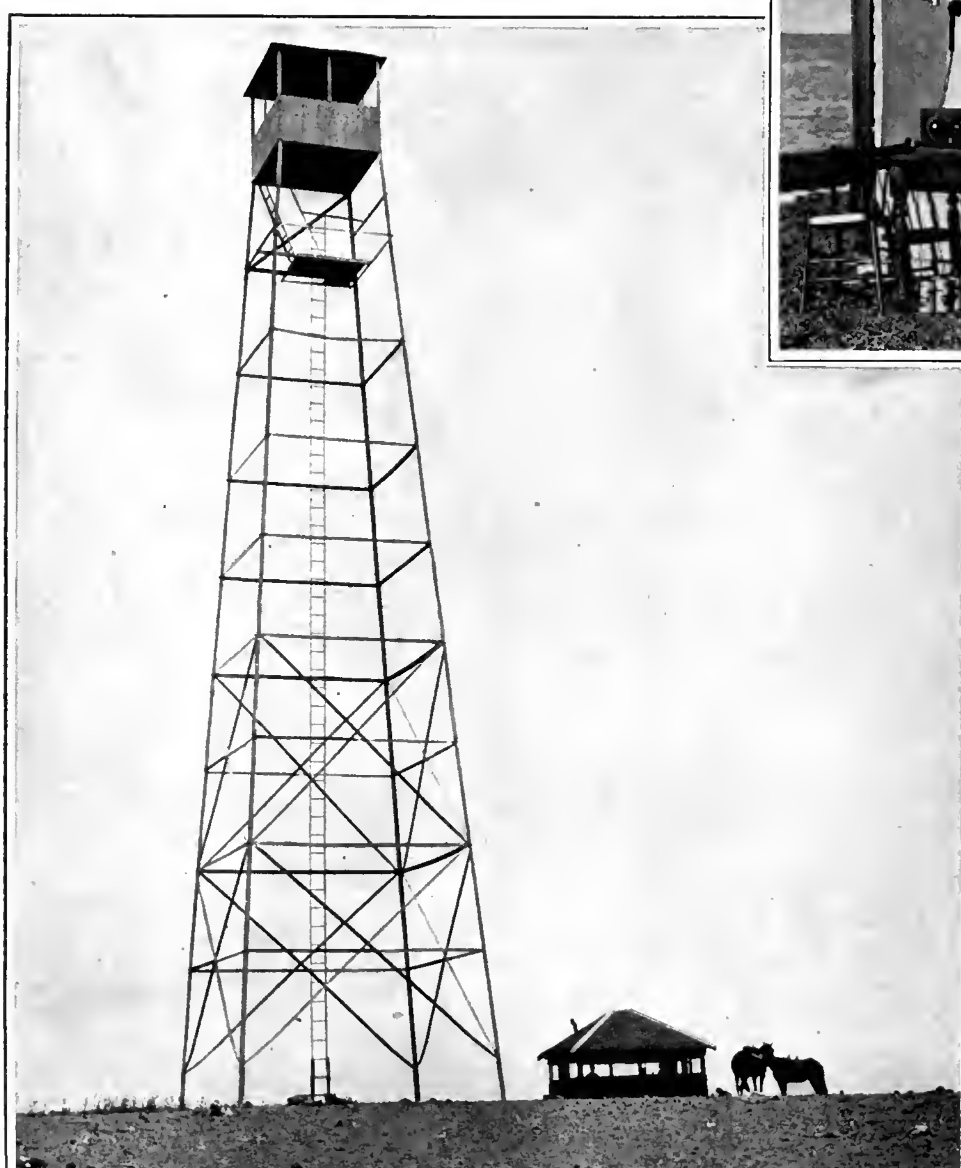
Chicago has the doubtful distinction of having the largest number of broadcasting stations of any area, as any long distance fan will testify who almost invariably finds as many Chicago stations operating at a late hour as in the rest of the country put together. A manifestation of intelligence in Chicago broadcasting circles is both a surprise and a relief. The merger of WEBH and WJJD in the presentation of programs under the direction of the Chicago *Herald and Examiner* may lead to the elimination of one of these two duplicate equipments, a move which will be distinctive in that it is one in the right direction.

Constructive Work by the Bureau of Standards

IN HIS annual report to the Secretary of Commerce, George K. Burgess, Director of the Bureau of Standards, briefly summarizes the comprehensive activities of the Bureau. In the field of radio, marked progress was made in frequency standards and in the development of instruments for holding broadcasting stations exactly on their assigned frequencies. We wonder if the Bureau is not too late in this discovery. In the broad sense, holding to assigned frequencies has gone quite out of fashion. Several contributions were made to the knowledge of the vagaries of radio wave propagation and the subject is being studied with the coöperation of twenty scattered laboratories. Direction finders of various types were developed for the Coast Guard, the Navy and the Signal Corps and several studies were made into the frequency range of accurate direction finding. The Bureau is frequently asked to test radio apparatus for manufacturers, but its staff and funds do not permit of such investigation. It

CANADIAN MOUNTED POLICE STATION, POND'S INLET

This station, in northern Baffinland, is one of the "farthest north" radio stations. The call letters are C-5 AO, 7596 kc. (40 meters), and the outfit is operated by Constable Tinsbury, R.C.M.P. The sending set was designed by Robert Foster, former operator aboard the Canadian C. G. S. *Arctic* and the receiver was presented by George C. Wendt of Montreal. Pond's Inlet is five degrees above the Arctic Circle and enjoys four months of perpetual darkness. Those who hear this station should report the fact to Mr. Wendt, P. O. Box 390, Montreal, P. Q.



THE LOOKOUT TOWER ON SHEET IRON MOUNTAIN, CALIFORNIA

The life of a forest preserve lookout is lonely by the very nature of things and this post of Clifford York in the California National Forest, Glenn County, California, is at least isolated. During June to October, the season of greatest fire hazard, York is on watch ten and a half hours a day and his radio receiver does much to break the monotony. Note the glassed-in cabin below would be a valuable service to the industry if a comparison test of the performance of radio equipment could be made by a government body for a fee covering the cost.

How They Solve Interference Problems Abroad

EUROPE has improved its broadcasting conditions by adopting a uniform plan of frequency assignment with the result that long distance hunting has been attacked with renewed interest. Although there were less than thirty broadcasting stations operating in Great Britain, the conferees had the foresight to reduce the number of stations in order to give Europe interference-free reception. At once there was increased demand for sensitive receivers and also for better and easier means of identifying distant stations. A correspondent of *Wireless World* suggests that every station should be identified by a number transmitted in Morse. This suggests the basis for a most intriguing proposal. Supposing all our broadcasting stations were required to transmit license numbers beginning with Number 1 at the high frequency end and ending with 610 or 950, whatever the number is by the time this gets into print. It would be a wonderful game to begin with Number 1 and work all the way to the top of the scale.

Bringing Classical Music to the People

"THE day of the concert stage is passing rapidly," says Madame Fritz Kreisler, urging musical artists to forego the concert stage in favor of soloist work at one of the prominent movie palaces. "People are no longer willing to sit through long programs. They want their music in tabloid form."

Radio has contributed a valuable demonstration of the possibility of popularizing classical music by abandoning the hackneyed, impersonal and formal concert hall style of presentation. A worthy ambition, if commercial broadcasting continues to develop, will be fame as a radio star, involving as it does a technique as specialized as that necessary for successful concert or opera performance and a service infinitely more exclusive.

Radio Fills Empty Church Pews

IN VIEW of the complaints of some of the clergy against the inroads of radio, it is illuminating to have confirmed by a questionnaire, circulated by the Sears Roebuck Agricultural Foundation, that the broadcasting of services by twenty-seven churches has increased their attendance, while it decreased attendance of only two. One rector wrote, "Since we have been broadcasting our service, our attendance has grown so rapidly that it is a problem to know how to take care of the crowds." Another wrote that forty persons had recently joined his church as a result of broadcasting, while a third stated that the gallery pews in his church had been opened up, and dusted for the first time in twenty years, as a result of the increased attendance attributed to broadcasting.

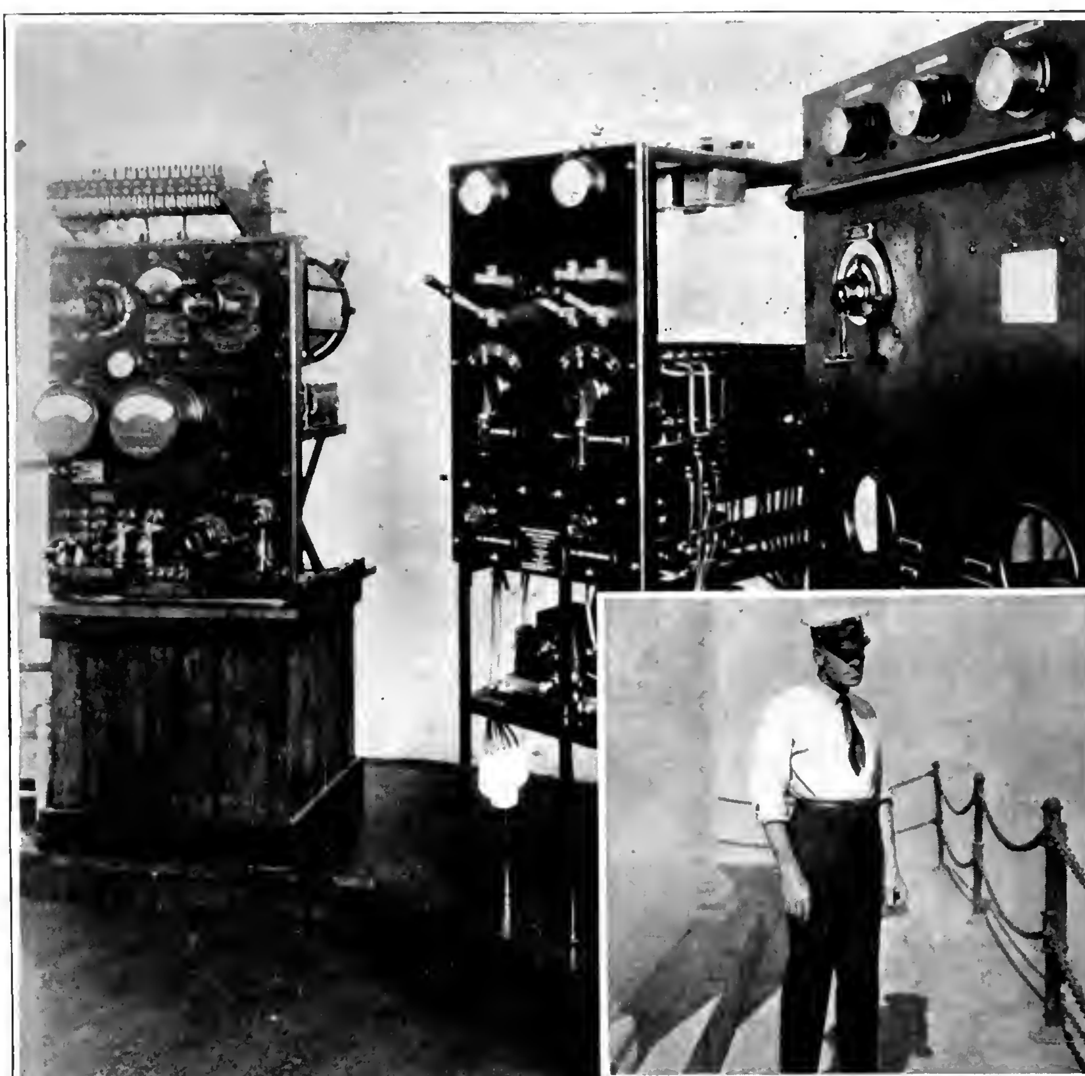
How the Cable Companies Look On Radio

WHILE Marconi announces reduced costs in trans-oceanic communication by reason of short wave beam transmitters and the British Post Office and the A. T. & T. discuss charges for transatlantic telephony, Newcomb Carlton, President of the Western Union Telegraph Company, indulges in some belittling: "Every few months, an improvement in radio is announced. Each one is revolutionary and each is good for at least a column in any newspaper. Static, of course, was overcome several years ago and has been overcome regularly ever since. However, after allowing for all improvements, including the beam transfer method, I think it would be safe to say that, in respect to international communication, the radio retains a position on the left hind leg."

Twelve days later, substantial reductions in cable rates were announced.

Bureaucratic Meddling with Broadcasting

THE State Athletic Commission of New York State has taken upon itself the privilege of assigning radio announcers to local ring battles. Having heard a few of those in the favor of the Commission assigned to the task of announcing, one gathers that the qualifications of articulation and familiarity with the English language are not considered



THE RADIO EQUIPMENT OF A LIGHTHOUSE

Automatic radio fog signals are sent out from many lighthouses. The large view shows the transmitting and automatic control apparatus in use at the San Pedro breakwater light, located just outside the breakwater that forms the outer harbor of Los Angeles. Radio beacon signals are sent out on 299.8 kc. (1000 meters). The insert shows one of the light keepers of paramount importance. Why not select experienced radio announcers who, by training and experience, have learned the art of "getting over" by radio?

Why the Poor Engineer is Poor

THE Board of Investigation and Coördination of the Society for the Promotion of Engineering Education, which has been investigating for three years, urges that a program of sweeping changes be put into effect in all the engineering colleges of the country associated with it. "The development of greater social insight and a large sense of social responsibility should be a definite objective of the engineering profession if it is to gain recognition for more than its technical proficiency," the report declares, and continues: "At the same time, it has need to prove its proficiency in dealing with problems of economy as related to the technical problems of engineering. The ability of the engineer to extend his influence . . . . appears to hinge primarily on his attainment of greater competency and greater recognition on the economical and social side of his work."

The unimaginative style of writing of most engineers and their failure to translate their work and achievement in such terms that the public can understand and appreciate it is often mentioned as a primary reason for their small remuneration as measured by their service to the public. Many people assert that they can recognize an engineer when they see one by his introspective and concentrated manner. Development of greater appreciation of his social significance not only means greater recognition to the engineer but better adaptability of his work to commercial and human needs. When chief engineers, engineers, and sales managers get together, there is generally a battle. "Make it cheap enough to sell," says the sales manager. "Make it to today's latest specifications," says the never-satisfied engineer. Better appreciation of sales problems and the economics of industry would make better engineers.

RALPH P. WORDEN

Cleveland

Radio Editor, the Cleveland *News*. Especially written for RADIO BROADCAST:

"The increasing use of 'mixers,' by means of which the control operator in a broadcasting station can emphasize or subdue various sections of a large orchestra, places on the operator's shoulders a great responsibility. The orchestra may be directed by Damrosch or Stokowski, yet if the operator is anything short of a Damrosch or a Stokowski in his own field it is possible for him to prevent the artistry of the leader from reaching the radio audience. This is said, not in criticism of the leading stations, whose broadcasts have been above reproach at all times, but in explanation of the fact that large orchestras or bands 'on the road' often do not sound as well over various radio stations as they do when featured at the country's leading broadcast studios."

The Month In Radio

E. F. BEMIS, Electrical Division, Department of Commerce, announced the leadership of the United States in the export of radio apparatus. Its 1925 shipments were valued at $9,903,857, being nearly three and a half millions greater than that of Great Britain. British sales to Europe constituted more than 41 per cent. of the total British radio exports, while American volume is built up largely in Canada and Latin America.

ANOTHER Department of Commerce statement announces a 60.4 per cent. decline in phonograph output in two years, the number of manufacturing establishments dropping from 111 to 68. The principal phonograph companies have gone into the radio business.

AN APPEAL, seeking to upset the rejection of Claims 11, 12 and 13 of R. A. Heising's Patent 1603282 was unsuccessful in a recent Patent Office hearing, and the rejection of these claims was affirmed. An interference in connection with patent 789124, issued to one Ehret, was cited.

IN A decision rendered in a federal court in Pennsylvania, DeForest patent 1507016 and 1507017, for oscillating audion and feedback circuits were held prior in invention to the claims in Armstrong's 1113149 and Claims 1, 2, 3, 5, 8, 9, 12 and 14 to 18 of the latter were held invalid. The suit was between the DeForest and Westinghouse companies. This decision is subject to further appeal to higher courts.

M. C. HOPKINS, whose patents 1275127 and 1275129 have already been battled over with the Western Electric Company through the Lektophone Corporation, has appealed the decision of the Circuit Court of Appeals of September 20, 1926. His company has done likewise in a suit involving the same patents with the Brandes Products Corporation.

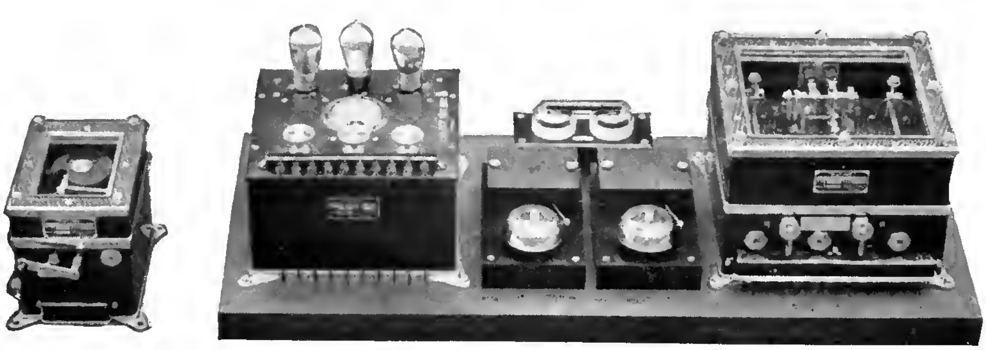
AN AVERAGE of 500 letters a day is being received by the Radio Service of the Department of Agriculture which is broadcasting special programs for the farmer through numerous stations. Considering the antipathy which the farmer has toward letter communication, this is indeed a reassuring indication of the remarkable success of these programs

GERMAN radio fans are petitioning the president of the Reichstag to permit the broadcasting of all debates of that body. Gluttons for punishment, these Germans.

TWELVE minutes after the referee's decision in Philadelphia that Gene Tunney was the new World's Heavyweight Boxing Champion, the presses of the *Rand Daily Mail* in Johannesburg were printing papers containing the news. 2XAF, WGY's short-wave little sister, bridged the distance between the two continents. London newspapers published summaries of the announcer's description of the fight as heard by short-wave listeners.

AN EXAMPLE of the value of radio compass bearings is given in an announcement from the Communication Division of the Office of Naval Operations of the Department of the Navy. Two merchant vessels, proceeding in a fog, in the vicinity of Hog Island Light, did not make use of the radio compass group located at the entrance to Chesapeake Bay. One of the vessels grounded and then requested bearings. She was promptly told that she was on the edge of a shoal. The other ship overheard and escaped. Better late than never, but too late is futile.

A DIRECT radio link between Nauen, Germany, and Rio de Janeiro, Brazil, has been established with a rate of 2.75 reichmarks per word.

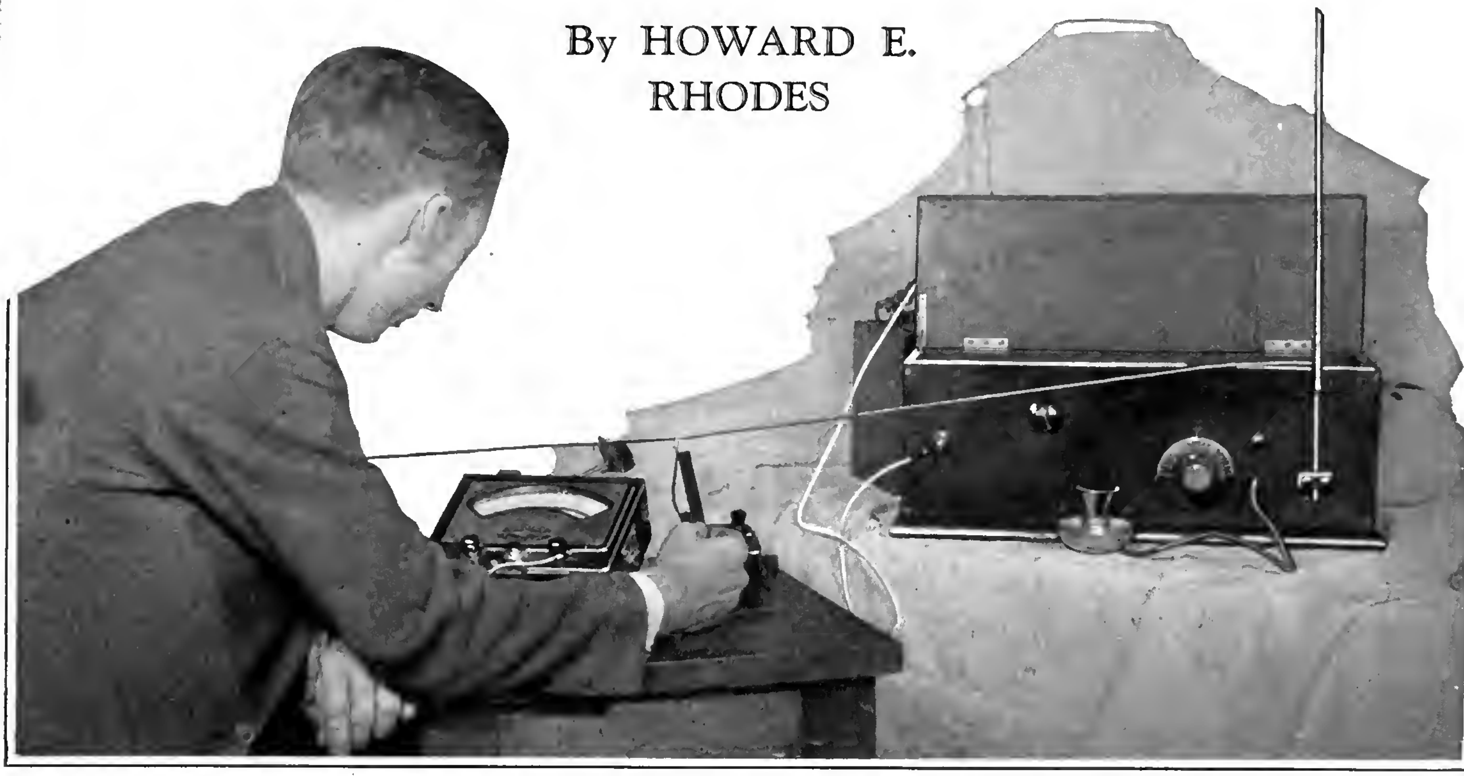


A WIRELESS ALARM FOR SHIPS

This device, supplied by Marconi's Wireless Telegraph Company, Ltd., is designed to respond to a series of three four-second dashes, which is suggested be preparatory to the sending of distress calls. Ships thus equipped would not have to maintain a constant watch for distress calls. On the left is the four-second dash sender, which is connected to the main transmitter of the ship. The mechanism is wound up by the handle. Next is the tube receiver, and on the right, the selector unit for interpreting the signals and putting the alarm bell in circuit

Some Experiments on One Meter

By HOWARD E. RHODES



RADIO BROADCAST Photograph

FIG. 1

A special method, perhaps used for the first time by Mr. Hallberg, several years ago, for measuring short wavelengths with a single wire. Two points on the Lecher wire are found where a maximum deflection on the indicating meter is obtained. The distance between these two points is equal to half of the wavelength. The microphone is on the table near the transmitter. The antenna on the transmitter is evident, projecting upward at the right of the picture

Being a Report of the Radiophone Experiments of J. H. Hallberg on One Meter—A Description of a Transmitter and Receiver Used for Work on the 300,000 kc. Band—A Special Form of Lecher Wire Is Used for Measuring the Wave-length—Plenty of Scope for Experiment Is Offered the Interested Amateur

A CONSIDERABLE amount of work has been done during the last one or two years on short waves, between one and five meters (300,000 and 60,000 kc.), and the special purpose of this article is to report on some work of this nature which has been done by Mr. J. H. Hallberg, and which should form a worth while addition to the information available at present. Mr. Hallberg has experimented with short-wave telephony for the last few years, having originally become interested in it through research work which he has done, relative to the measurement of very short wavelengths, and which made necessary the development and calibration of $\frac{3}{4}$- to 10-meter oscillators and detectors. Most of the work done by other experimenters on ultra short waves was with pure un-modulated c. w., so that these experiments with modulation throw some light on the possibility of using telephony on very short wavelengths. Many experiments of the nature described here can be easily duplicated by readers of this magazine.

It is necessary for those who experiment along these lines to possess an amateur station and operators' license, information on which can be secured from U. S. Radio Inspectors. Those who have concerned themselves with short-wave work, will find sufficient material about their laboratories to make the transmitter and receiver described in this article. It is the cheapness and ease with which these short-wave experiments can be done that counts in part for the interest which they should create.

MR. J. H. HALLBERG

Whose interesting experiments with 1-meter radiophony are described in this article

The transmission experiments outlined here, were made on the sixth floor of a twelve-story steel apartment house, not the best place, by any means, to experiment on wavelengths between 1 and 5 meters. Steel girders, conduits, pipes, fixtures, metal grill work, etc., absorbed the greater part of the power, which, for most of the tests, was only about four watts. With this low power and with so many objects capable of absorption located in the vicinity of the transmitter, it was to be expected that the range would not be very great. With a single-tube receiver (no audio amplification) the voice, music, or the tick of a clock placed close to the microphone on the transmitter, could be heard about one-half mile away. This is not at all bad when it is realized that the per cent. modulation must have been quite low. Beyond about a half a mile the modulation could be heard but was quite weak. If the detector was made to oscillate, signals were increased in strength considerably but at the same time there was much distortion. Sometimes it would be found that the signals could not be heard in one location but that moving the receiver a few feet away would bring them in with good strength. Very likely the signals could have been heard further than half a mile away in certain locations with

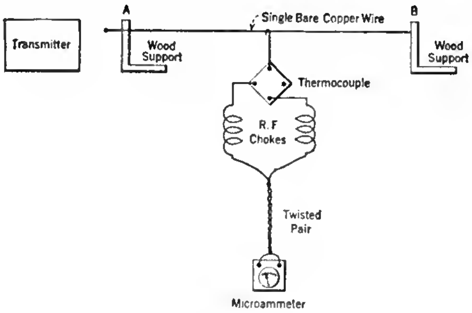
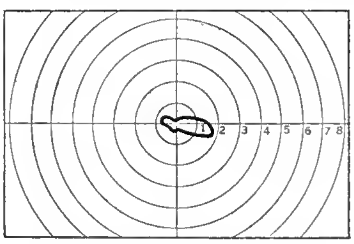


FIG. 2

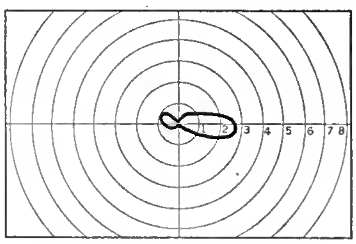
A diagrammatical sketch showing how the instruments are arranged. The technique of measuring is explained in the article. The lead connecting from the Lecher wire to the thermocouple should be as short as practical, not over 1" long. The twisted leads may be several feet long so as to permit the microammeter to be placed on a table below the Lecher wire. The r.f. chokes are of the same construction as those used in the transmitter and receiver

mA. This gives an input power of 1.3 watts. With this power the signals could be picked up and were sometimes as loud and clear as with a 210 tube, but were not very dependable. For more consistent results a 210 tube was used with 6 volts on the filament and 220 volts on the plate. The plate current varied between about 18 and 30 milliamperes, which corresponds to input powers of 4.4 and 6.5 watts respectively. Some experiments were tried with a plate voltage of 400 and 7.5 volts on the filament but there was no improvement in reception. The fact that results were practically the same with either 400 or 200 volts on the plate of the 210 tube seems to indicate that with 200 volts there is plenty of power available and that the problem lies in suitably utilizing it and preventing any great amount of absorption by surrounding objects. The problem of absorption is one that causes a great deal of trouble when the work must be confined to an apartment or small laboratory. As mentioned above, it is very much better to conduct the experiments in the open.

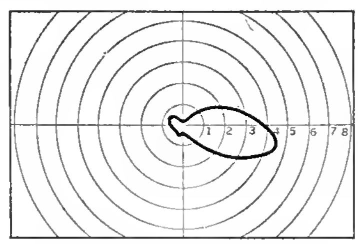
Lecher wires. It is not necessary to use two wires, and in this work on very short wavelengths Mr. Hallberg has found that the single wire gives better results and that the readings are much more accurate than can be obtained using two wires. After some experimenting, apparatus was set up as illustrated in Fig. 1. Fig. 2 is a diagram of the set-up. The single No. 18 bare copper wire was tightly strung up between the two supports, A and B, the end of the wire at A being brought within about two inches of the oscillator inductance. The end of the wire could have been formed into an open loop to afford more pick-up but it was not found necessary to do this. One terminal for the heater of the thermocouple is hooked over the wire and the other end of the thermocouple is left open. The microammeter is connected to the output terminals of the thermocouple by a pair of twisted leads. In determining the wavelength the hooked wire is slid along the Lecher wire until a maximum deflection is obtained. This point is marked on the wire. The instrument is then slid further



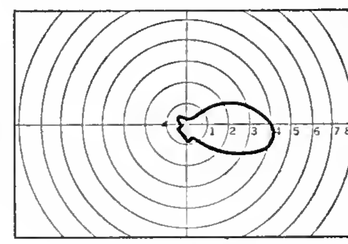
A - 14 reflector wires, 4'8" long, spacing 1'. Wavelength 3 meters. Back loop mainly due to reflection from moist stone wall.



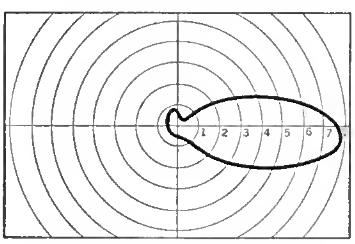
B - 14 reflector wires, 4'4" long, spacing 1'. Wavelength 3 meters. Back loop mainly due to reflection from moist stone wall



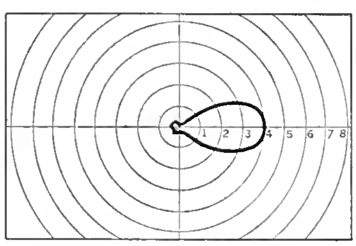
C - 14 reflector wires, 4'6" long, spacing 1' Wavelength 3 meters. Back loop smaller since reflector further from wall.



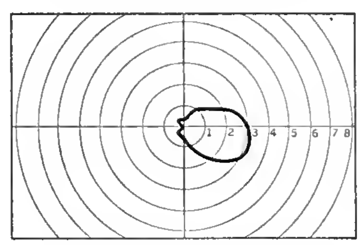
D - 14 reflector wires, 4'7" long, spacing 1'. Wavelength 2.94 meters.



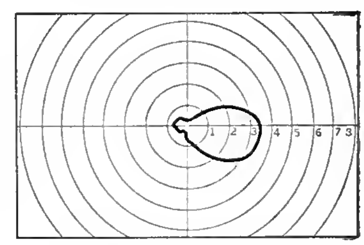
E - 14 reflector wires, 4'7" long, spacing 1'. Wavelength 3 meters. (Compare with C and D.)



F 8 reflector wires, 4'7" long, spacing 2' Wavelength 2.96 meters. (Compare with C, D and E.)



G - 3 reflector wires, 4'9.5" long, spacing ½ wavelength. Wavelength 3 meters.



H - 5 reflector wires, 4'9.5" long, spacing ¼ wavelength. Wavelength 3 meters.

FIG. 3

Eight valuable polar curves reprinted from *QST*, showing the energy distribution from a transmitter when using different reflectors. The reflector wires were in all cases arranged in the form of a parabola, energy being fed to the antenna, located at the focus, by means of an r.f. transmission line

reference to the transmitter, but the experiments were not carried any further. The best place to do experiments of this nature would be in the open country where there are not so many objects capable of energy absorption in the vicinity of the transmitter. The results mentioned above were obtained when a 210 type tube, with a plate voltage of about 220, was being used as an oscillator. The receiver was a portable affair with self-contained batteries. Some care is necessary in selecting the tube for the receiver to be sure to obtain one with a sufficiently low inter-electrode capacity. In the experiments which Mr. Hallberg made, he found the Magnavox tube especially suitable because its grid-plate capacity was in general very much lower than that of the other tubes with which he experimented. A small antenna is used on the transmitter and the construction of this antenna will be described in detail further on in the article. No counterpoise is used on the transmitter. The receiver uses neither antenna nor ground, although they may be used if desired.

Various types of tubes were used in the transmitter with various plate voltages. With a 201-A best results were obtained using a plate voltage of 130 and a plate current of about 10

In ultra short-wave work of this sort it is almost essential that the receiver and transmitter be calibrated together since very slight changes in inductance or capacity will make it impossible to tune the two sets to the same frequency. In one test we had tuned-in the signal at about 50 on the condenser dial of the receiver, but, on shortening the grid inductance ⅛th of an inch it was not possible to pick up the signals. In measuring the wavelength, Mr. Hallberg used a special form of Lecher wire which is very interesting. Perhaps all of our readers are not familiar with the Lecher wire. Lecher wires usually consist of two parallel bare copper wires spaced by about four inches and, at one end, the two wires terminate in a small helix which is coupled to the oscillator. The other ends of the Lecher wires are left open. When energy is induced in these wires, it creates what are termed "standing waves," similar to the effect that would be produced if a rope were to be attached to some fixed support and the other end moved up and down at a certain definite rate. When the rate at which energy is given to the rope is correct, waves start to run along the rope and finally there are created a series of stationary waves similar to those induced electrically in

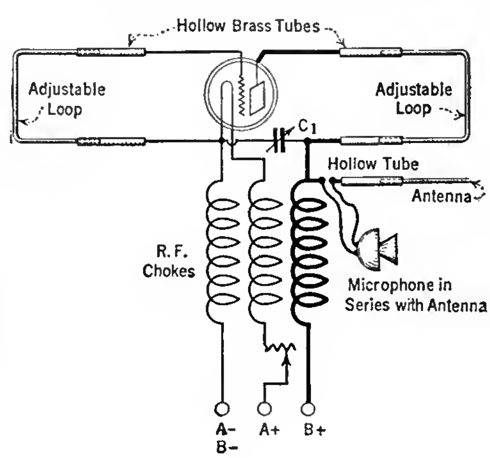


FIG. 4

An ultra short-wave transmitter. The two adjustable loops are the inductors. They are made of hollow brass tubing arranged so that one piece can slide within the other. Details for making the r.f. chokes are given in the text. Variable condenser C_1 has a maximum value of 0.0002 mfd.

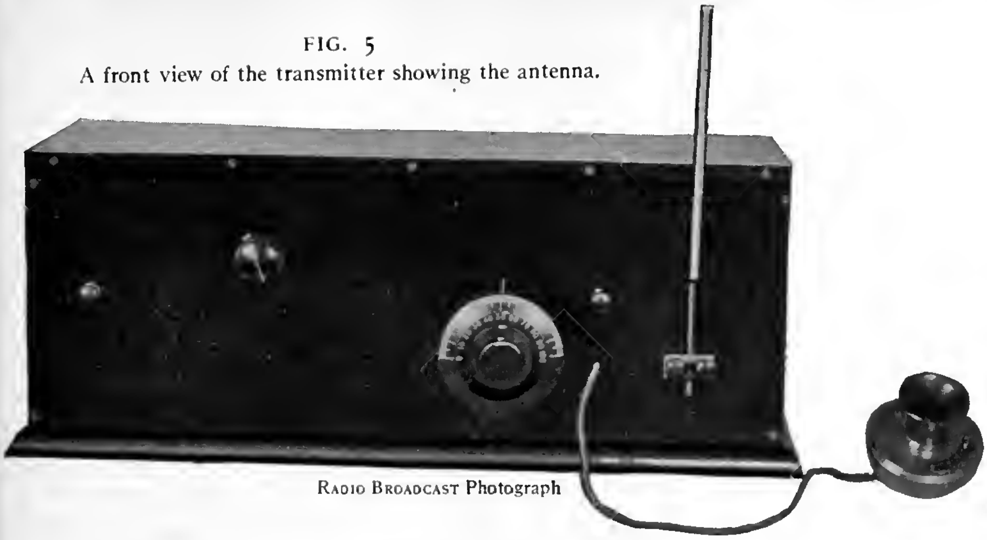


FIG. 5
A front view of the transmitter showing the antenna.

RADIO BROADCAST Photograph

along the wire until another point of maximum deflection is obtained. The distance between these two points is then measured, and this distance, in meters, is equal to one-half the wavelength. Therefore, the distance, in meters, between successive maximum deflections, multiplied by two, equals the wavelength at which the transmitter is oscillating. This method of wavelength determination is quite accurate, and Mr. Hallberg's experiments indicate that it gives the shape of the wave as well as its length.

Soon after one begins work of this sort, it becomes evident that one of the most important things is to develop an efficient beam transmitter such as was described in the Bureau of Standards Scientific Paper No. 469. Mr. F. C. Jones, of 6 AJF-6 XM, in his article in the May, 1925, *QST*, described a reflector which he used on a wavelength of about three meters. Several polar diagrams were given showing the reflection with different numbers of wires, spaced various distances apart. These diagrams are valuable, and are reproduced here in Fig. 3. The curves are practically self-explanatory. In A and B there is a considerable back loop, which is due to reflection from a moist stone wall located near the reflector system. These curves show very well that the closer the wires are together, the sharper will be the beam, and also the greater the back leakage. The reflectors were arranged in the form of a parabola and their effect, as can be seen from the curves, is similar to that which is obtained through the use of a reflector in an automobile head light, for the purpose of directing the light along a certain path. The antenna is placed at the focus of the parabola. The reflector wires are one-half wavelength long minus a small amount due to the loading effect of the other nearby wires. For 3 meters, the wires may be 1.5 meters long, for work on the second harmonic. They may also be made 3 meters long if the fundamental is to be used. The antenna should be of the same length, with a single turn at the center to be used for coupling purposes. These curves are given because of their value to the experienced experimenter and will be especially valuable to those who desire to work using such a reflector system fed through an r. f. feeder line. With such reflectors, the received energy can be increased hundreds of times without any change in the input to the transmitter. If an intensive study is to be made, the reflector and antenna systems should be arranged so that many different combinations and sizes might be set up. We hope to do some of this in the Laboratory and the results will be published in a future article. However, a great deal of excellent experimental work can be carried on by merely using a simple antenna, as described in this article. The designing of a reflector system will be an interesting job after the simple antenna system has been brought up to its maximum efficiency.

WEAF REBROADCAST ON 1 METER

THE tests and experiments that Mr. Hallberg has done to date using a simple antenna have proven very satisfactory, and the editors of RADIO BROADCAST witnessed a very nice demonstration of rebroadcasting using a wavelength of 1 to 1½ meters. The signals from WEAF were picked up with an ordinary 610-kc. detector, and the telephones held near the microphone of the short-wave transmitter. The modulation in the transmitter was excellent and clear signals could be picked up with the 1- to 1½-meter receiver without any difficulty.

RADIO BROADCAST Photograph

FIG. 6
Looking down on the transmitter. Note how simple is the construction

In these tests no antenna was used on the receiver, the pickup from the transmitter being merely by means of small loops that comprise the coils of the receiving set. On the transmitter an antenna is used, and a part of it can be seen in Fig. 5 accompanying this article. This antenna consists of two brass tubes which telescope one within the other. The length of the antenna is varied until it is brought into resonance with the oscillations in the tube. A great deal of development work on both the transmitter and receiver is necessary. It is possible that results will be better with the antenna coupled to the transmitter in some other manner. The range can be extended considerably if an antenna were to be used in conjunction with the receiver.

The transmitter diagram is shown in Figs. 4, 5, and 6. Fig. 6 is a top view of the transmitter. The construction of the r. f. choke coils can be plainly seen. The two loops, one in the grid circuit and the other in the plate circuit, are made of hollow brass tubing so arranged that one can slide within the other and in this way the length varied. Fig. 6 shows very well how simple the construction of this transmitter can be made. Amateurs will recognize from the schematic diagram, Fig. 4, the form of modulation as being similar to the so-called "loop modulation," in which a single turn of wire in series with the microphone is placed close to the transmitter inductance. Talking into the microphone causes the amount of power absorbed by the loop to vary in accordance with the sound waves. Fig. 8 illustrates the arrangement of apparatus in the self contained portable receiver, and Fig. 9 is the circuit diagram. The choke coils for use in the receiver are constructed in exactly the same manner as those used in the transmitter. Be sure that the turns are not too close together since it does not require much capacity to produce an effective bypass for these high frequencies.

The transmitter is not at all difficult to make up and practically all the information necessary can be obtained from the accompanying illustrations and diagrams. The grid and plate coils, or loops, should preferably be made up of copper tubing but satisfactory results will be obtained if a large size copper wire is used. The radio frequency choke coils can be seen in Figs. 4 and 6. They consist of about 10 turns of wire. They are easily made up by closely winding approximately this number of turns on a ½" dowel

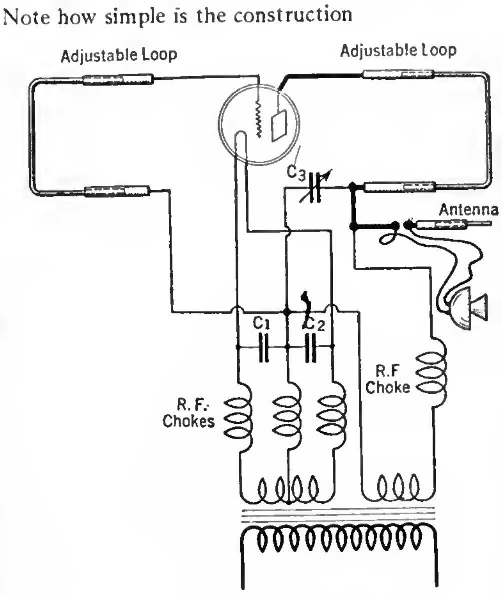
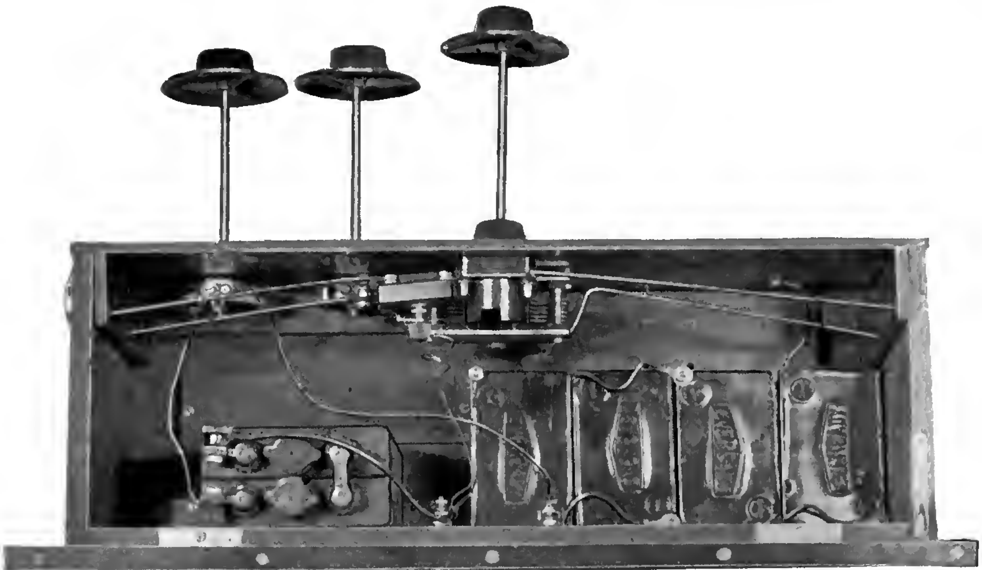


FIG. 7
An a.c. operated transmitter. The signals from this transmitter can be picked up on an ordinary crystal. C_1 and C_2 may be 0.001 mfd. condensers. C_3 has a maximum capacity of 0.0002 mfd. The transformer supplies energy for the filament and plate circuits



Radio Broadcast Photograph

FIG. 8

A top view of the receiver, showing the arrangement of batteries. The two adjustable loops can be seen near the front of the set

stick. The coils are then stretched so the turns are spaced about ½″ apart. The size of the loops should be varied until the tube oscillates. When the tube begins to oscillate, the plate current will generally change. Another test for oscillation is to touch the plate terminal with a screwdriver and watch to see if the plate current changes. If a type 210 tube is being used, with, say, 200 volts on the plate, a good size spark can be seen as the screwdriver touches the plate terminal.

The microphone is connected in series with the antenna. See Fig. 4. In the preliminary experiments, it is not necessary that a microphone be used. Perhaps the best method would be to supply the plate and filament directly from the a. c. power lines. The circuit diagrams of a transmitter using alternating current for the filament and plate supply is given in Fig. 7. It is the same as the circuit diagram shown in Fig. 4 with the exception that the energy is supplied through two transformers instead of by batteries. With a. c. on the plate, the transmitter output can be picked up on an ordinary crystal detector since the 60-cycle note will be audible in the telephones. On the other hand, with battery supply for the transmitter, the signal could not be picked up unless an oscillating detector were to be used. In making the first tests it is very much easier to work with a crystal detector rather than with a tube.

A fine little wavemeter can be made as illustrated in Figs. 10 and 11. This wavemeter consists of a single loop of wire, L, connected in series with a midget variable condenser, C, which should have a maximum capacity of 25

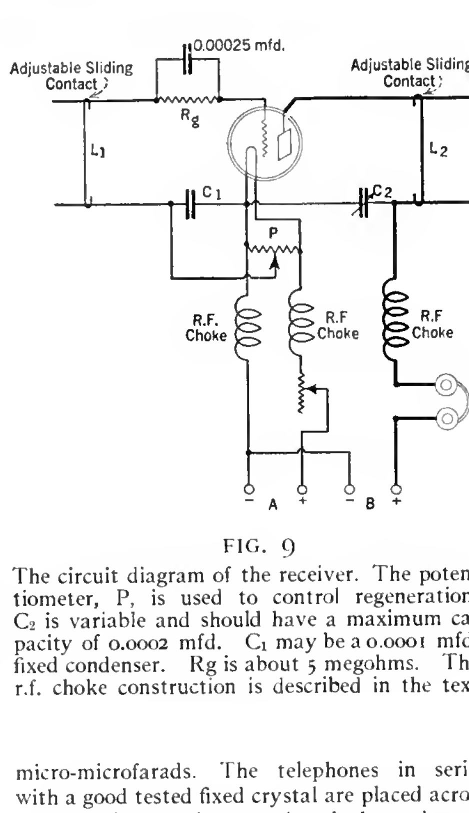
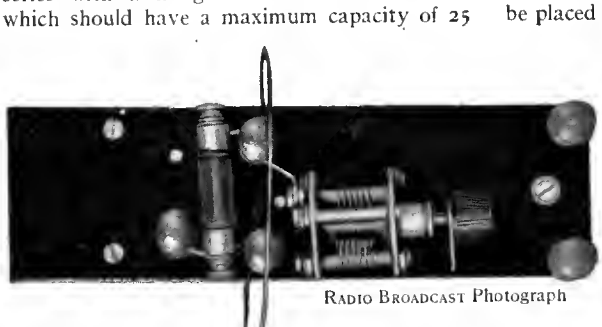


FIG. 9

The circuit diagram of the receiver. The potentiometer, P, is used to control regeneration. C_2 is variable and should have a maximum capacity of 0.0002 mfd. C_1 may be a 0.0001 mfd. fixed condenser. Rg is about 5 megohms. The r.f. choke construction is described in the text

micro-microfarads. The telephones in series with a good tested fixed crystal are placed across the variable condenser. A telephone bypass condenser, C2, having a capacity around 0.001 mfd., should be placed across the two terminals of the telephones. The whole set of parts may be placed on a small piece of bakelite measuring not more than 2″ x 4″.



Radio Broadcast Photograph

FIG. 10

The wavemeter. A telephone bypass condenser is located under the panel

The details concerning the receiver can be obtained from the various diagrams and photographs that are illustrated in this article. See Figs. 8 and 9. The two short-circuiting wires, L1, and L2, on the inductances, must be adjusted so as to tune to the same wavelength as the transmitter. The potentiometer controls oscillation. For phone work, the detector should be operated in a non-oscillating condition.

The extension handles are plainly shown in Fig. 8. They are very essential since the hand capacity is considerable and it will be difficult to hold the signal if the extensions are not used. For the first experimental work it is hardly necessary that the receiver be housed in a cabinet for any other reason other than the fact that it makes it somewhat more portable. A bread board layout could be put together very much simpler and would be just as good insofar as the experiments are concerned.

In starting these experiments, the first thing to do would be to make up a transmitter and be sure that it oscillates. Two simple tests for oscillation were given at the beginning of this article. Now set up the Lecher wire and determine the wavelength. The layout of apparatus used in the Laboratory is shown in Fig. 1. The author is sliding the hooked wire along the Lecher wire and in this way obtaining a maximum deflection on the meter. When a maximum deflection is obtained, this point is marked on the wire and then the whole apparatus is slid along further until another maximum point is obtained. The distance between these two is measured with a meter stick and this distance, multiplied by two, equals the wavelength. All the apparatus should then be left just as it is, and a wavemeter, such as is illustrated in Figs. 10 and 11, coupled to the transmitter, and the resonance point obtained. The process of measuring the wavelength by means of Lecher wires is satisfactory but is too troublesome to bother with every time a wavelength determination is to be made. It will be better to determine the wavelength on which one desires to work and then to adjust the oscillator to this wavelength with the aid of the Lecher wire. This point can then be determined on the wavemeter and any future calibrations can be made using it rather than the Lecher wire.

It is hoped that sufficient interest will be created by this article to cause readers of Radio Broadcast to make up apparatus similar to that illustrated in this article. Experiments of all sorts can be made, different types of antennas can be used, and the method of coupling it to the transmitter can be varied. In the transmitter shown in Figs. 1, 3, 4, and 5, the antenna is connected directly to the end of the plate inductance loop in which position it seems to give quite good results. Possibly better results will be obtained if a loosely coupled antenna system is used. Also the antenna used in these experiments was tuned to the fundamental wavelength and radiation on a harmonic frequency might give better results. Radio Broadcast will be pleased to receive any reports of experiments that are done on the outside, and it is expected that these reports, together with the experiments that are to be done by the magazine, will be reported in an early issue

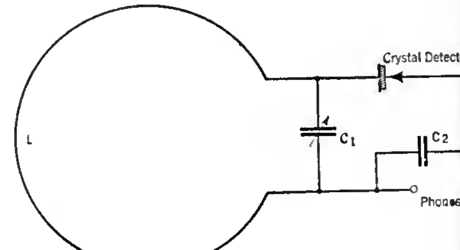


FIG. 11

A piece of wire and a midget condenser comprise the tuned circuit of this wavemeter. C_2 may have a capacity of 0.001 mfd. Be sure to use a good crystal

Further Notes on the Inverse Duplex System

Pertinent Data Respecting the Audio Channel—Why Combining Two Efficient Transformers Will Cause Distortion, and How It Is Eliminated in the Inverse Duplex Circuit—Choosing Correct Transformer Ratios—The Prevention of Overloading

By DAVID GRIMES

IN THE early days of broadcasting, the question of quantity rather than quality completely dominated our desires of achievement. The mere novelty of receiving anything at all without the aid of intervening wires was sufficient to offset completely the fact that those weird sounds emanating from crude loud speakers resembled only in a very minor way the original sounds at the studio. Standard transformer coupling was universally used, but we would blush to glance at the jagged curves of some of these embryonic audio coupling units!

Transformer coupling certainly delivered the volume, and the imperfections in most horn type loud speakers did not disclose the quality limitations. As broadcasting stations improved, and the cone speaker came into use, the transformers were placed aside, and almost every conceivable resistance and impedance coupling arrangement came into existence. Most of these combinations were quite satisfactory from an audio quality standpoint but were considerably lacking in volume output. A three-stage resistance- or impedance-coupled amplifier was usually required to equal even a low-ratio two-stage transformer-coupled amplifier. The resistance and ordinary impedance amplifier also appeared to choke up when required to deliver a great deal of volume so that their high quality was confined to rather modest output.

This last fact caused the return of the transformer, but the new type transformer coupling was a vast improvement over its predecessor. It brought in the bass notes as well as the high tones, and it certainly delivered the volume up to the tube limit without itself choking up. But a rather peculiar thing was noted in the extensive tests conducted by the author on the improved modern transformer. If one stage of transformer amplification only were to be used, the quality was all that could be desired, and the actual results checked with the theory. An amplification curve of such a high-grade one-stage transformer coupling is shown at "A" in Fig. 1. When two such stages are then connected in tandem, or cascade, theory would give curve "B," which would be very desirable. Actual results, however, were more like those presented in curve "C." The transformers themselves were obviously not to blame—it was a circuit trouble.

The distortion and tendency toward "peanut whistling," indicated by the peaks in "C," were found to be due to audio regeneration. The circuit in Fig. 2, consisting of three stages of audio amplification, the first and third transformer-coupled, with an intermediate resistance-coupled stage, overcame all of the distortion shown in curve "C", Fig. 1, and was very stable in operation. This system is employed in the latest Inverse Duplex circuit.

In addition to its stabilizing influence, the resistance-coupled stage was made to deliver real amplification by employing a 25,000-ohm resistance in the plate circuit, and operating the tube on an impressed potential of 135 volts. The 25,000-ohm value is most efficient as this practically equals the internal impedance of the tube and permits the plate to receive a full 70 volts, which is quite satisfactory for the plate of a first audio tube. The choking of resistance stages before full volume is reached is not present here as the last transformer-coupled audio stage is called upon to deliver the real volume.

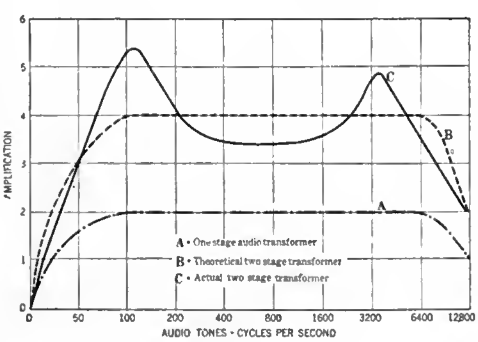


FIG. 1

This audio circuit now produces excellent quality even under super-selective radio circuit conditions, if good quality is delivered at its input. Eliminating the relatively few poor quality broadcasting stations from the discussion, still another problem presents itself before good quality reproduction can be obtained from strong local broadcasting stations. This problem arises from the overloading or choking of the detector tube, and the omission of the low bass notes resulting therefrom. A perfect audio amplifier would utterly fail to register the bass notes if the detector grid was being choked by too strong energy from the local station. This has led many engineers to abandon the sensitive grid leak method of detection for the less efficient plate rectification system. But the real answer is found by employing three audio stages for the desired volume without being compelled to force the detector beyond its limit, and then, on local reception, to provide means for reducing the antenna input so that detector choking will not take place. A tapped antenna primary winding arranged according to Fig. 3 has been found to be satisfactory for this means.

The antenna taps are taken off in a geometric manner so that each successive tap doubles the number of primary turns. In this way, not only does this switch act to reduce the input on local stations, but it also tunes the antenna circuit somewhat to the benefit of distant reception. Incidentally, by reducing the antenna coupling, its resistance loss is partially removed from the set and the selectivity is proportionately increased. This antenna switch performs three functions, then, and its proper adjustment is essential for best results. It must be remembered that a change in the position of the antenna tap switch necessitates a re-tuning of the first or left-hand tuning condenser. The tuning condenser will drop below the proper settings on the other two condensers upon an increase in the number of antenna primary turns.

AUDIO TRANSFORMER RATIOS

THE next discussion in order pertains to proper audio transformer ratios for the several stages in the Inverse Duplex Circuit, as there appears to be a great deal of misinformation on this particular subject. The average radio experimenter uses transformer ratios in a rather haphazard manner, tending usually to place the highest ratio right after the detector. A few tests showed this to be absolutely wrong, as was pointed out by Julian Kay in the November, 1924, RADIO BROADCAST. The low ratio should be placed immediately after the detector and the high ratio in the last stage, especially when using the new

ALTHOUGH this is the second of a series of articles on the new Grimes Inverse Duplex System, the first of which was printed in the January RADIO BROADCAST, *the data contained herein are complete and the reader does not have to depend altogether upon the January article. It is recommended, however, that those readers who intend experimenting with this Inverse Duplex System, or who wish to build a receiver from the published details, should read the whole series of articles, the third of which will appear in an early issue. In essence, the following is the information contained in last month's paper: The receiver described is a four-tube set in which the first tube acts in the dual capacity of first r.f. stage and second audio stage (resistance-coupled); the second tube acts as the second r.f. stage and the first audio stage (transformer); the third tube is the detector stage, and the fourth tube is a power audio stage. Tuned radio frequency amplification is employed. Amplification and selectivity are excellent, and equal for all frequencies, a special filter arrangement providing for this. Increasing the amplification on the longer waves, has not, as one might suppose, the effect of broadening the tuning. This is one of the unique features of the new Inverse Duplex Circuit. Hand capacity effects have been obliterated. In some preliminary remarks concerning the audio amplifier, the author stated last month that the transformers should have a rising characteristic, i.e., they should exaggerate the higher tones slightly, to compensate the slight cutting of side bands in the radio frequency amplifier.*

—THE EDITOR.

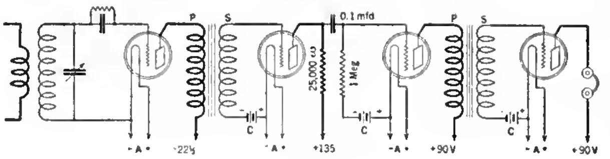


FIG. 2

UX-171 type of power tube. The 2 to 1 transformer usually has a comparatively large number of primary turns because the number of secondary turns is generally a fixed value, for commercial reasons. The low ratio between the two windings in the case of the 2 to 1 transformer is thus obtained by increasing the number of primary turns so that they more nearly approach the number of secondary turns. This high wound primary has, as a result, a rather high impedance, which ideally matches the high internal impedance of the detector tube. The high-ratio transformers, with their smaller primary windings, are much less suited for the detector tube. It is apparent, then, that poor quality may be expected on the low notes from the use of a high-ratio transformer in the first audio stage. A 2 to 1 transformer has therefore been adopted in the first stage in the new Inverse Duplex System.

The word "power," as applied to the new UX-171 tube, is really a misnomer. It has led many to believe that this tube will create tremendous power. As a matter of fact, the amplification of this particular tube is much less than the standard 201-A type tube. The amplification factor is only 3 while that of the 201-A tube is approximately 8. The "power" tube is designed, however, to handle powerful signals without distortion but power must be delivered to the tube if good volume is expected out of it. With this thought in mind, a 6 to 1 ratio audio transformer was installed in the last stage. Its results were very gratifying. A 6 to 1 transformer is therefore recommended in this stage. It tends to make up for the decreased amplification of the 171 tube, thus giving more volume on the weak distant station. It must not be forgotten that the impedance of the 201-A tube, in the plate circuit of which is the primary winding of the 6 to 1 ratio transformer, is considerably lower than that of the 200-A detector tube. The primary winding of the first transformer, the 2 to 1 instrument, is in the plate circuit of this detector tube. Even were a 201-A tube to be

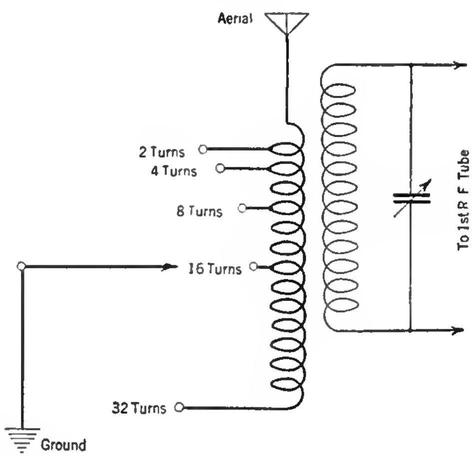


FIG. 3

used in the detector stage it would still be preferable, for matching purposes, to put the low ratio transformer first, *i.e.*, the one with the high primary ratio, for the impedance of the 201-A type tube is higher when used as a detector than when placed in an audio stage socket.

Although an output device is shown in the diagram on this page, this may be omitted if an UX-171 tube is employed with a plate potential not in excess of 135 volts. The omission of the output device, consisting of the choke marked on the diagram "Audio Output Choke" and the 1.0-mfd. condenser, is a simple matter. Leave all the other connections as they are but connect together the two leads that are shown leading to the 1.0-mfd. condenser, thus placing the loud speaker directly in the plate circuit of the 171 tube. Also omit the lead to the choke from the plate, and from the choke to the 135-volt terminal.

PREVENTING INHERENT INTERFERENCE

FOR some unknown reason, it is generally believed that radio and audio currents cannot be placed through the same tube simultaneously without interfering with each other. Perhaps the fact that some of the first reflexes did run into trouble accounts for this prejudice.

In order to ascertain this point definitely, a series of extensive tests was run. These tests proved conclusively that no interference took place between the two currents unless the grid potential became "plus" during the operation. In order to prevent this happening, it is merely necessary to operate the duplex tubes with a "minus" bias on the grids. The standard 4½-volt negative bias is used for this purpose. Under these conditions sufficient audio volume can be obtained to completely overload the audio power tube long before the duplex tubes reach that point where modulation takes place. A 250,000-ohm potentiometer is connected in the circuit across the secondary of the first audio transformer as a means of controlling the audio volume. This potentiometer does not affect the grid bias, but permits the gradual reduction of audio volume without impairing the quality. This method of volume control does not affect the distance-getting ability either, as it is not associated with the radio circuits.

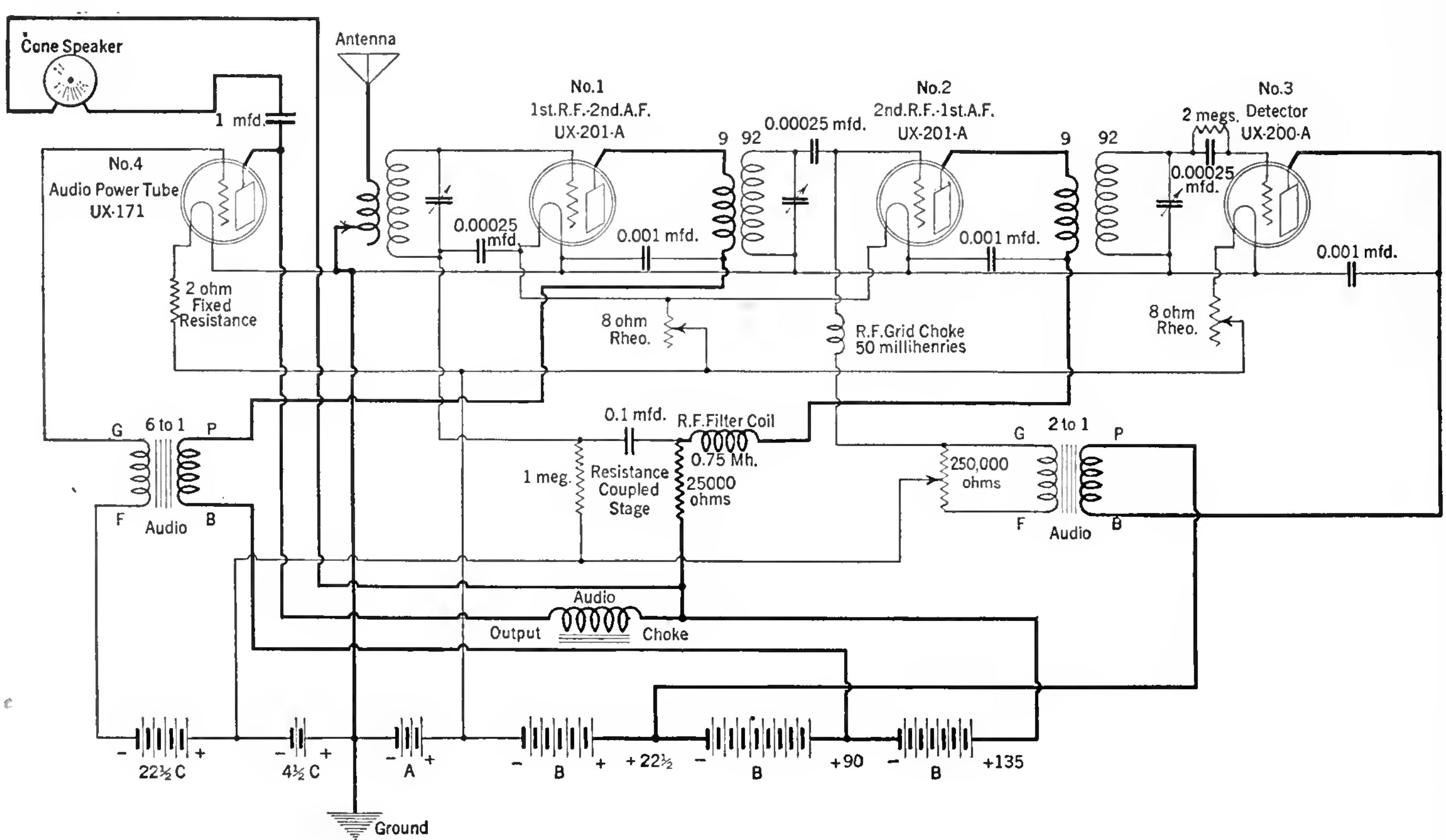


FIG. 4

The potentiometer enables the operator to keep the audio volume below the overload point of the last power tube. If, however, he insists on boosting the audio volume beyond this value, distortion of the signals will first take place in the power tube and then modulation (interference between the radio and audio currents) will occur in the first duplex tube. This modulation was originally referred to as "overload howl" because it resulted in a sustained howl that was quite disagreeable in both volume and pitch. This howl has been overcome in the new Inverse Duplex System arrangement, the resistance-coupled stage being responsible for this improvement. This resistance stage is never called upon, in normal operation, to deliver the volume that would ordinarily choke it. The last audio transformer produces this volume. However, the instant that the grid becomes positive on the No. 1 duplex tube (the condition necessary to cause modulation), a great number of electrons are attracted to it. These flow down into the 0.1-mfd. condenser, completely choking up this tube. This action interrupts the modulation so that only a low pitch choking sound is heard. This serves as warning that too much audio volume is being sent through the tubes. The potentiometer is then dropped back to restore the circuit to its operating condition. This choking causes no damage and is a great improvement over the old modulation howl method. This is the third function of the resistance-coupled stage. It not only serves as an efficient audio coupling and as a filtered r.f. feed-back circuit, but also as a choking circuit to prevent the modulation howl as well. The potentiometer is a necessary part of the new Inverse Duplex System to keep the audio volume below the choking point on strong local broadcasting stations.

The above choking function is somewhat controlled by the audio phases but these phases are easily determined. The action is here described as a matter of information. On a very strong local signal, the grid leak and condenser in the detector tube suddenly choke up, cutting off the plate current in the detector tube. This sudden stoppage of the primary current in the first audio transformer generates an inductive voltage surge, or "kick," in the secondary. This kick is amplified by the No. 2 tube, and appears on the grid of the No. 1 tube where modulation takes place if the surge exceeds the grid bias. Now, this surge is either positive or negative, according to the polarity of the connections on the first audio transformer. A positive surge performs the choking of the resistance stage at the instant modulation occurs. A negative surge creates modulation also but does it by reducing the plate current of the No. 1 tube. This negative surge does not attract electrons to the grid so no choking of the resistance stage takes place. Under these conditions, the modulated howl is not interrupted, and it becomes an unpleasant note. The proper polarity of the primary of the first audio transformer can therefore be easily determined. If a bad overload howl occurs on local stations when the potentiometer is set too high, merely reverse the connections on the primary of this first transformer and the choking action will be obtained. With the average audio transformer, this primary polarity will be reversed, as shown in Fig. 4, for the choking conditions.

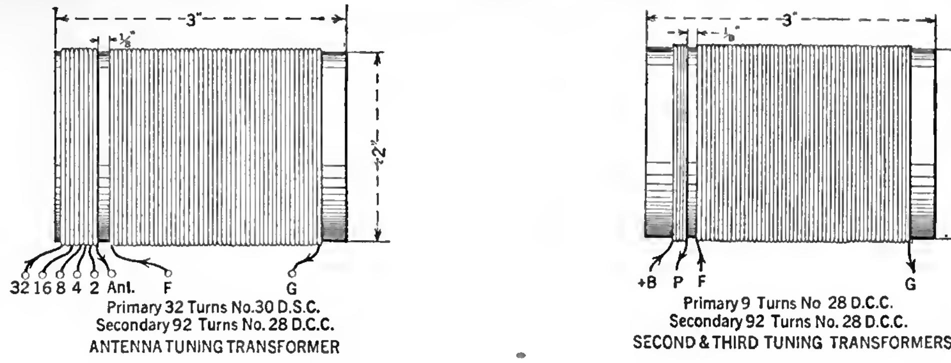


FIG. 5

With this first audio polarity determined for least overload, the polarity connections for the primary of the second audio transformer must be ascertained. In this latter case, it is not a question of choking modulation but of reducing any tendency for whistles due to common B battery impedance. The phase or polarity of the primary connections on this second transformer should be such that the loud speaker current flowing through the B battery will be out of phase with the detector plate current flowing through the 22½-volt section of this battery. These connections can be determined experimentally. A steady howl or whistle (with the antenna disconnected and the detector tube fully warmed up) will occur if the connections are wrong. Reversing them will stop the trouble.

This concludes the special duplex considerations and brings this series up to the study of the radio frequency design.

COIL DATA

BECAUSE of the rather efficient operation of the r.f. filter circuit, the rest of the radio frequency apparatus is very simple. One of the desirable features of the new Inverse Duplex System, from the constructor's point of view, is the feasibility of winding one's own tuning coils if desired. There are no complicated mechanical contraptions or fussy electrical specifications. The second and third tuned r.f. transformers are built alike. The primary of the first, or antenna transformer, is slightly different, but the secondary winding is identical with the other two tuned secondaries.

Reference should here be made to Fig. 5, which shows the mechanical details of the tuned transformers. The coils are designed to cover the wavelength band from 175 to 575 meters (1714 to 521 k.c.) with 0.00035-mfd. variable condensers. Each secondary consists of 92 turns of No. 28 d.c.c. wire. The second and third primary windings each have 9 turns of the same kind of wire as is on the secondaries. It should be noted that the primary and secondary are wound in the same direction of rotation, and that the grid of the tube is connected to the end of the secondary farthest from the primary. The coils are wound on bakelite or micarta tubing having an outside diameter of 2 inches. The primaries of the second and third coils are wound on the same tubing and separated ⅛" from their respective secondaries. The antenna primary may be wound on the same tubing as its secondary and the taps taken off as shown, or it may be wound on a piece of tubing slightly smaller than the secondary tubing so that the primary may be slipped just inside the secondary, at the filament end. The latter arrangement is to be preferred. The three coils should be mounted at right angles where no shielding is employed. A suggested layout for the apparatus is shown in Fig. 6.

The next article in the series will take up in detail the building of an actual receiver giving plans, photographs, operating instructions, and some results obtained when using the receiver in different receiving locations.

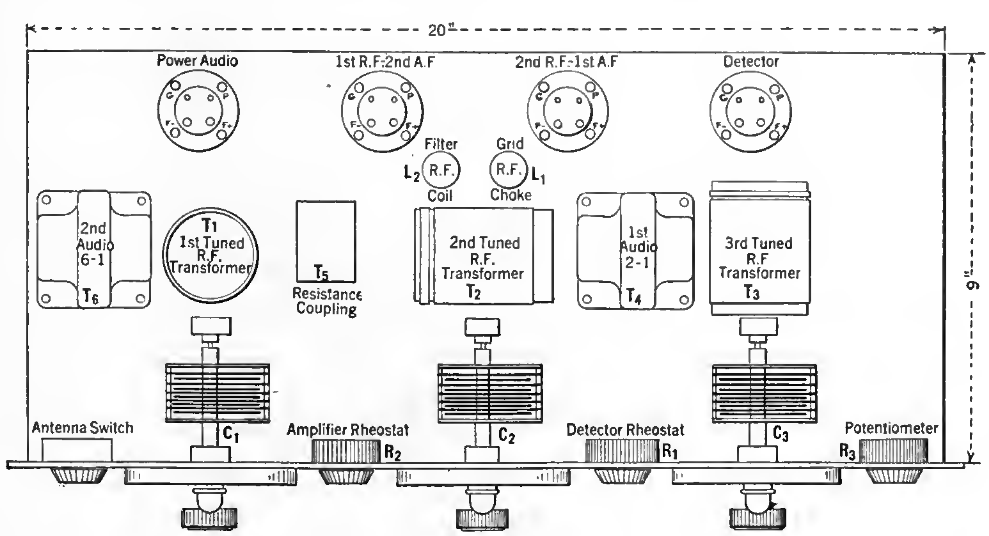


FIG. 6

Radio Broadcast Photograph

IN ITS CABINET

The R. B. four-tube "Lab" receiver equals in appearance, a factory-made job

A Four-Tube "Lab" Receiver

Further Improvements for the Four-Tube "Lab" Receiver—Putting in New Coils, Including a Loading Coil—Overloading of the Detector Tube Is Prevented by Using C-Battery Detection —A Different Volume Control System

By JOHN B. BRENNAN

Technical Editor

After the completion of the construction of the four-tube R. B. "Lab" receiver, which was originally described in the November, 1926, Radio Broadcast, the Laboratory Staff felt that for a time it could sit back and rest on its laurels with the satisfaction that comes in doing a job well. However, this resting period was short-lived, due mainly to the many excellent suggestions received from the readers of this magazine.

The two-tube tuner unit, practically a new departure in modern receiver design, was then presented to Radio Broadcast readers, in the January issue. This two-tube tuner unit incorporated many novel features of design which it was thought were worth while to apply to the previous four-tube receiver. And, too, during that time which elapsed between the November, 1926, and January, 1927, issues, new material made its appearance, all of which gave rise to the pertinent query "Can the R. B. 'Lab' four-tube receiver be improved?"

Many of the improvements contained in the construction of the two-tube R. B. "Lab" receiver can be made in the four-tube model without much difficulty.

One of the most important of these improvements is the substitution of different coils for the two binocular ones originally employed. Then too, the use of an antenna loading coil permits individual builders to adjust the antenna circuit of their receiver for maximum signal pick-up, making it possible to utilize the antenna at its utmost efficiency.

Hand in hand with the problem of providing the very best volume control is that of supplying a detector circuit capable of handling all the signal energy that can be supplied by a radio-frequency amplifier operating at its peak of efficiency. It was observed, in the operation of the first four-tube R. B. "Lab" receiver, that some distortion took place even though the volume output was reduced by means of the volume control, because the detector had become overloaded. The first problem then was to employ a detecting circuit which did not tend to overload, even on very strong signals. The solution lies in the use of the C-battery method of detection, as shown in B, Fig. 1. While not as sensitive as the grid leak and condenser method, this C-battery system has virtues which outweigh the point against it of poor sensitivity. The problem of providing a suitable volume control has been solved by placing this volume adjustment in the radio frequency amplifier circuit—proper enough because, in this position, strong local signals can be reduced to the desired volume and of course no overloading will take place in the detector circuit.

In the four-tube set described in the November issue, the volume control consisted of a 0–500,000-ohm variable resistance unit shunted across the secondary of the first audio transformer. In the model described here, the variable resistance has been re-located in series with the plus-B plate lead going to the r.f. amplifier. Instead of being a 500,000-ohm potentiometer type of volume control having three terminals, this new volume control is the Electrad Royalty, Type L, having a similar resistance range, but it is of the two terminal type. The two volume-control circuits, that formerly used and the one used at present, are shown in A and B respectively, Fig. 2.

As regards the antenna loading coil, it was found, by actual test, that as great as a 4 to 1 increase in signal strength was obtained when the approximately correct inductance was included in the antenna circuit at the particular wavelength to which the receiver was tuned. The loading coil was then provided with taps so that, on the first tap enough inductance was inserted in series with the primary so as to make the circuit function satisfactorily at 250 meters, (1200 kc.), the second at 350 meters (857 kc.), the third at 450 meters (666 kc.), and the fourth at 500 meters (600 kc.). For the individual experimenter, the placement of these taps to coincide in resonance with these figures is, of course, approximate, since everyone's antenna is not exactly the same. However, not a great difference will result as the loading coil taps are arranged to work with what is considered an average antenna. The complete winding specifications for the new coils are given in Fig. 3.

Where a solenoid coil is used in a tuning circuit it will have an electromagnetic field which, if not taken

The Facts About the Receiver

Name of Receiver	Four-tube R. B. "Lab" Receiver.
Type of Circuit	One stage tuned neutralized radio frequency amplification, regenerative detector, and two stages of transformer-coupled audio frequency amplification, followed by an output device.
Number and Kind of Tubes	Four; 201-A's for r.f. stage, detector, and first audio stage; UX-171 in last audio stage.
Volume Control	A 500,000-ohm variable resistance in series with B battery lead to plate of r.f. tube.
Regeneration	Condenser feedback.
Neutralization	Rice.
Tube Voltages	R. F. and 1st a.f., 90 volts; Detector, 45 volts; last a.f., 135 volts for 112 tube or 180 volts for 171 tube. Filament voltage, 5 volts. C battery voltage, r.f. $4\frac{1}{2}$ volts; detector, $4\frac{1}{2}$ volts; 1st a.f. $4\frac{1}{2}$ volts; last a.f., 9 volts for 112 with 135 B volts, or 40.5 volts for 171 with 180 B volts.

Essentially this four-tube "Lab" Receiver is the same as that described in the November issue. Briefly, the circuit changes consist mainly in the insertion of a loading coil in the antenna circuit, the substitution of a solenoid coil for the binocular in the radio frequency amplifier stage, and the use of C battery detection instead of the grid leak and condenser method. The mechanical changes involve the substitution of a grained aluminum panel for the former insulated one, the addition of an interstage shield, and a tap switch.

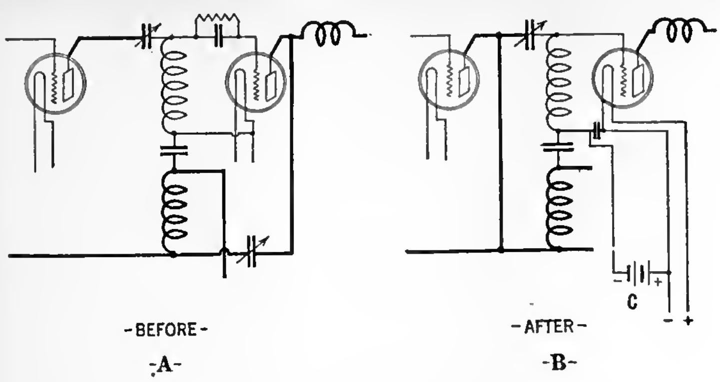


FIG. 1

Originally the grid leak and condenser were used to obtain rectification but in the rebuilt "Lab" receiver the C battery method of detection is employed. Its use insures against overloading of the detector tube. Both system are shown here

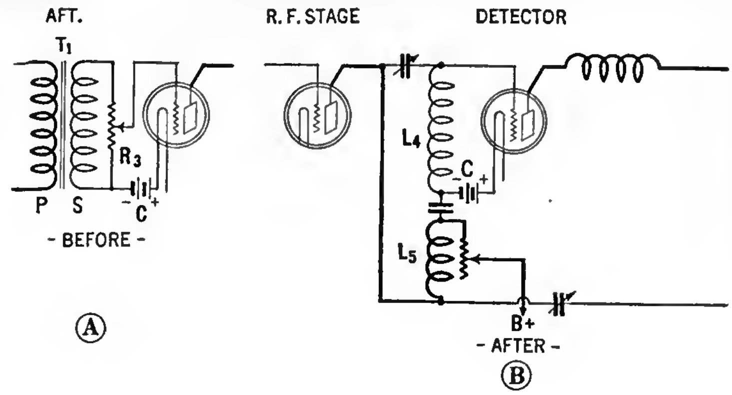


FIG. 2

"Before "shows the original volume control system. "After" shows the system now employed. With the volume control in the latter position, the output of the radio-frequency amplifier stage may be decreased without affecting tone characteristics

Radio Broadcast Photograph

THIS REAR VIEW OF THE RECEIVER

Clearly denotes the use of bakelite strips to insulate the volume control and regeneration condenser from the metal panel. The Sangamo condenser which is employed as a protective condenser in series with the regular Precise neutralizing condenser may also be seen. The cabled leads are run along the rear edge of the baseboard and are terminated at the Yaxley plug receptacle

At the time of going to press on the January Radio Broadcast, in which was described the two-tube "Lab" circuit, it was not possible to show the use of Marco illuminated controls because of the insulation problems involved, which at that time had not been solved. Since then these controls have been provided with insulated bushings which allow their use in receivers employing metal panels. They are employed in the receiver described here.

It will be noticed by referring to the circuit diagram that neither of the two tuning condensers have either of their sections at ground potential as in other circuits. Since the condensers are mounted upon the dial frames and, in turn, the dial frames attach to the panel, it is easy to see that, unless some insulation precaution is taken, the condensers will have a common connection between them which is not at all desirable. It is absolutely necessary then, that some means be employed to insulate the dial frames from the metal panel. The Marco Company

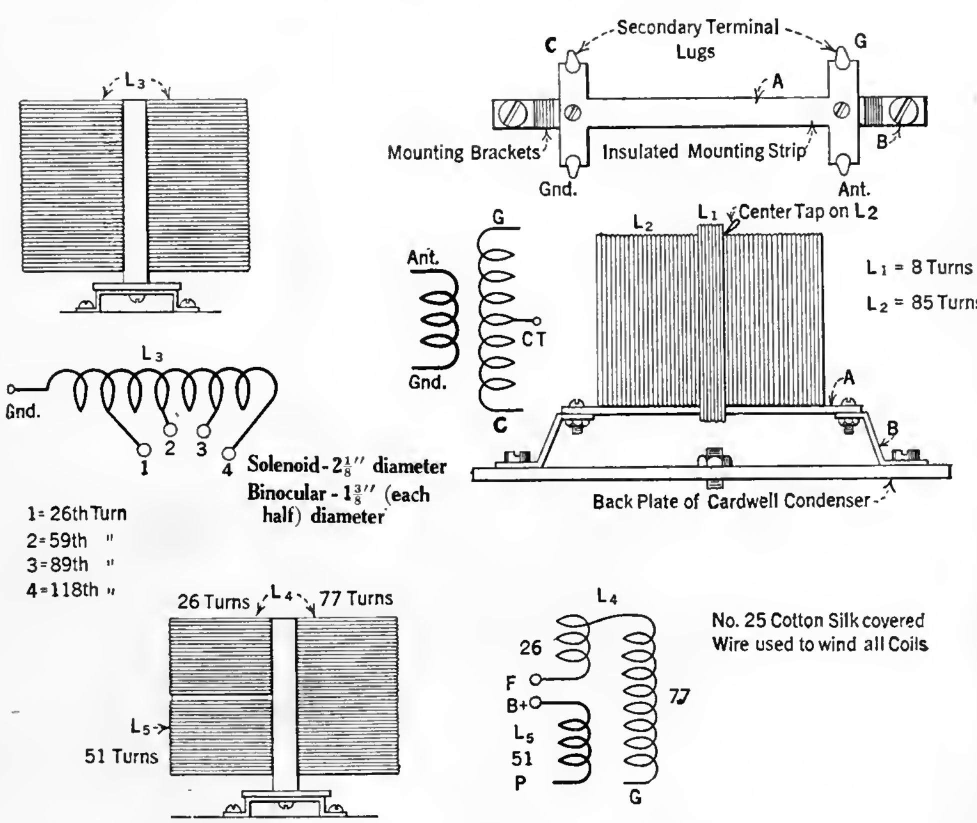


FIG. 3

Complete coil specifications necessary for winding the tuning coils used in the receiver are given here. Three coils, instead of two, are now employed in the "Lab" receiver. The extra coil takes the form of an antenna loading coil

care of, will inter-couple with adjacent tuning circuits so as to cause uncontrollable oscillations. One way to overcome this difficulty is in the use of a type of coil which will not set up such a great field. Coils of the confined field type, such as binoculars and toroids, are satisfactory on this score but are not generally as efficient as solenoids. To employ the solenoid but not experience inter-coupling effects, a sheet of aluminum, if placed between the adjacent interfering coils, will decrease the inter-coupling effects to a negligible minimum. Such a shield has been employed for just this reason in the revamped four-tube set described here. The interstage shields, manufactured by the Aluminum Company of America, fit in to this plan extremely well. See Fig. 4.

The circuit itself is shown in revised form in Fig. 5. Changes, purely of a mechanical nature, have also been considered and, with the circuit changes, were incorporated in the present receiver.

MECHANICAL ALTERATIONS

THE mechanical alterations consisted of substituting one of the new Aluminum Company panels for the insulated panel. These metal panels are to be obtained in several finishes, such as walnut, mahogany, etc., and make the outward appearance of the receiver pleasing indeed.

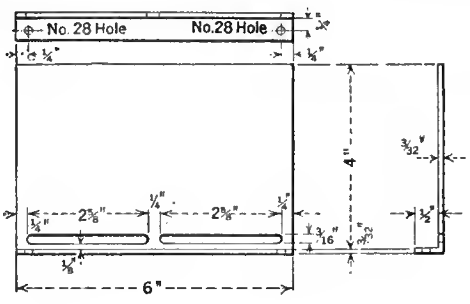


FIG. 4

For those who desire to make their own interstage shield the specifications given here will prove helpful

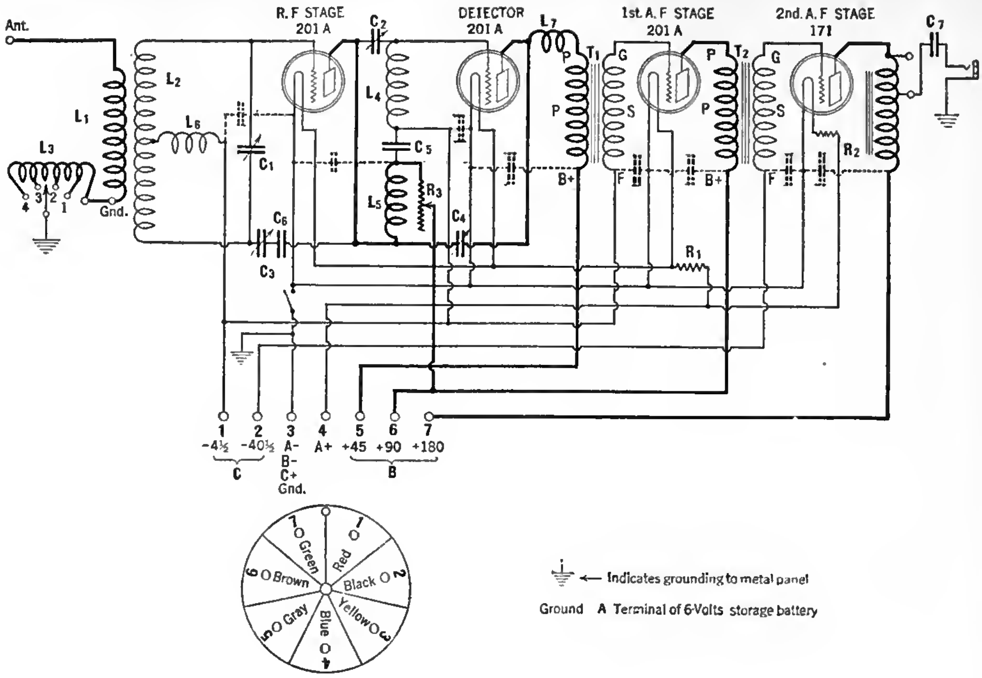


FIG. 5

This is the circuit diagram of the four-tube R. B. "Lab" receiver in its altered form. The 1-mfd. bypass condensers, shown in dotted lines are to be recommended especially where the power supply is obtained from an a. c. operated B power unit. In any event, the inclusion of these condensers tends toward greater stabilization in the operation of the receiver

furnishes, for a small extra charge, a set of insulated bushings designed to fit snugly over the various mounting parts of their dial so that this objectionable feature of contact with metal panels is successfully overcome. Reference to Fig. 6 will show how the bushings are employed to insulate the dial frames from the panel.

In order to simplify the assembly of the output terminals, a single-circuit jack was substituted for the pin jacks formerly used. It is not a difficult matter to make the change since one side of the output circuit returns to the minus A circuit—very easily accomplished by mounting the frame of the jack in the metal panel, which in turn is connected to the minus A-battery circuit.

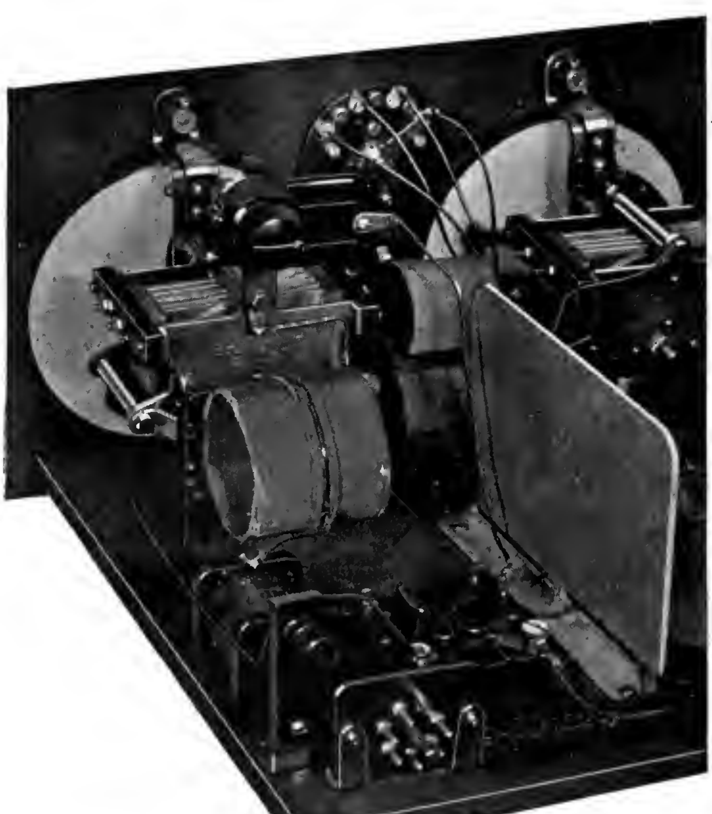
In Fig. 7 are shown the specifications for the new panel layout, and with few exceptions there is very little difference from the original layout.

In the neutralizer circuit, a 0.01-mfd. fixed condenser is connected in series with the regular neutralizing condenser, which has a value of 10 mmfd. In this newer construction the Precise type 940 condenser has taken the place of the mica insulated type of condenser which was formerly employed.

To conserve space and prevent the crowding of parts and wiring, the terminal strip supporting the binding posts has been replaced by a Yaxley receptacle and 7-wire battery cable. There are just enough wires in this cable to make connection to all the batteries. A separate binding post mounted on a strip of bakelite is mounted in a convenient spot as shown in the illustrations, to accommodate the antenna lead-in connection. Since the ground connection can be made direct to the minus post of the A battery, no separate ground terminal in the receiver is necessary. Fig. 8 gives the specifications for the antenna post mount, brackets, and other insulating strips necessary for the assembly of the receiver.

The circuit diagrams and photographs accompanying this article are illustrative of the changes and alterations made, and serve well to guide the constructor in the duplication of these modifications.

The following lists of parts show the apparatus that was used in the original circuit and that specified for the present receiver:



Radio Broadcast Photograph

THE RADIO-FREQUENCY AMPLIFIER STAGE

Which comprises the first tuning circuit, amplifier tube, neutralizing condenser, r. f. choke coil, etc., are situated at the extreme right of the base-board as may be seen from the illustration above. The loading coil which is connected in series with the antenna circuit is situated forward of the interstage shield. Practically all of the apparatus employed in the construction of the receiver retains the same position it originally occupied as described in the November, 1926, Radio Broadcast

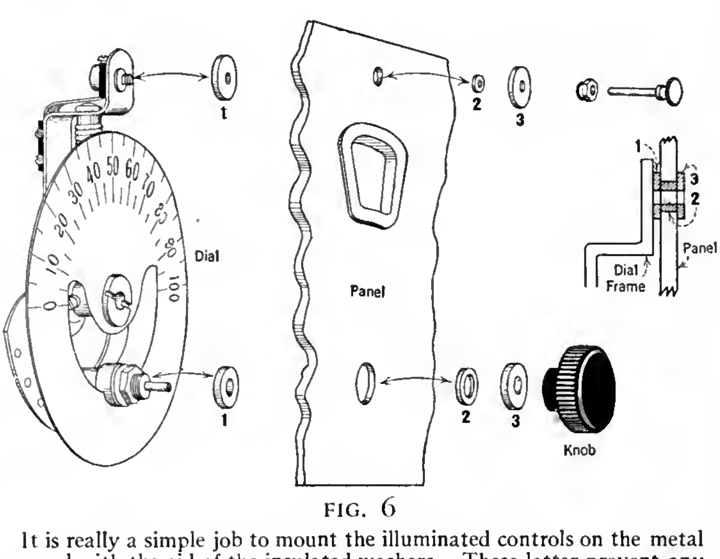


FIG. 6

It is really a simple job to mount the illuminated controls on the metal panel with the aid of the insulated washers. These latter prevent any connection between the dial and the metal panel. The sketch above will clearly indicate the method employed. Explained, it is briefly this: An insulated washer is slipped over the two mounting bushings of the dial and another smaller washer is fitted in the hole in the panel. Then the dial is held to the panel while, on the front, another washer is passed over the mounting bushing. The dial is then securely fastened by means of the metal washers and nuts provided

ORIGINAL FOUR-TUBE R. B. "LAB" RECEIVER MATERIAL LIST

1 Set Gen-Win R. B. "Lab" Coils. .	5.50
2 Cardwell Taper-plate Condensers, Type 169E, 0.00035 Mfd. . .	9.50
4 Airgap Sockets	3.00
2 Amertran Deluxe Audio Transformers, 1st and 2nd Stages . . .	20.00
1 Samson Output Impedance . .	5.00
1 Tobe Output Condenser, 4 Mfd. .	3.50
1 Precise 55-mmfd. Regeneration Condenser, Type 940	1.50
1 XL Neutralizing Condenser, Type N	1.00
2 Samson No. 85 R. F. Chokes . . .	4.00
1 Tobe Bypass Condenser, 1 Mfd. .	.90
1 Electrad Royalty Variable Resistance, 0–500,000 Ohms, Type E .	2.00
1 Electrad Filament Switch . . .	.40
1 Electrad Grid Condenser, 0.00025 Mfd.	.30
1 Electrad Fused Metallic Grid Leak, 4 Megs.	.60
9 XL Binding Posts	1.35
1 Radion Binding-Post Strip . . .	.50
2 Marco Illuminated Controls . .	7.00
2 Frost Pin Jacks	.30
1 Formica Panel 7" x 21" x $\frac{3}{16}$" .	3.00
2 Brachstats, $\frac{1}{2}$ Amp. and $\frac{3}{4}$ Amp. .	2.00
1 5-Wire Fused Belden Battery Cable	2.00
Total	$73.35

IMPROVED FOUR-TUBE R. B. "LAB" RECEIVER MATERIAL LIST

1 Set Improved Gen-Win R. B. "Lab" Coils	8.50
*2 Cardwell Taper-Plate Condensers, Type 169E, 0.00035 Mfd.	9.50
*4 Airgap Sockets	3.00
*2 Amertran Deluxe Audio Transformers, 1st and 2nd stages .	20.00
*1 Samson Output Impedance . .	5.00
*1 Tobe Output Condenser, 4 Mfd.	3.50
*1 Precise 55-Mmfd. Regeneration Condenser, Type 940 . . .	1.50
1 Precise 10-Mmfd. Neutralization Condenser, Type 940 . . .	1.25
*2 Samson No. 85 R. F. Chokes . .	4.00
1 Electrad Royalty Variable Resistance, 0–500,000 Ohms, Type L	1.50
*1 Tobe 1-Mfd. Bypass Condenser.	.90
*1 Electrad Filament Switch . . .	.40
*2 Marco Illuminated Controls . .	7.00
*2 Brachstats; $\frac{1}{2}$ Amp. and $\frac{3}{4}$ Amp..	2.00
1 Electrad Single-Circuit Jack . .	.25
1 Yaxley 4-Point Tap Switch . .	1.00
1 Yaxley Cable and Plug	3.50
1 Sangamo Condenser, 0.01 Mfd. .	1.15
1 Alcoa Interstage Shield . . .	.45
1 Aluminum, Walnut-Grained, Panel 7" x 21" x $\frac{3}{32}$'	1.75
Total .	$78.15

*All the parts starred are retained from the former construction and may be satisfactorily employed in the improved four-tube R. B. "Lab" receiver.

LETTERS ABOUT THE "LAB" RECEIVER

IN COMPLETE justification of our faith in the circuit, letters of praise and commendation have been received testifying to its excellence of performance.

Mr. Harvey Merwin, of Jensen, Florida, built an R. B. "Lab" circuit receiver and among other things says: "I have just been listening to the Yale-Harvard football game through WJZ using only four tubes." This at four o'clock in the afternoon, too. A receiver must be good to get through in this location. Mr. Merwin continues, "You folks are living in a radio paradise—ours is DX or nothing."

At another time Mr. Merwin had occasion to write us as follows: "You probably will think I am stretching the truth a bit but the owner of an eight-tube super was here examining some remodelling we were doing on his receiver. We were trying out both sets together (super and R. B. 'Lab' receiver). Four feet of antenna wire were used. The R. B. 'Lab' receiver cut circles around the super, for both distance and volume!"

Mr. H. C. Sherer of Montclair, New Jersey, enthusiastically endorses the R. B. "Lab" receiver in the following words: "Your R. B. 'Lab' set is a handsome job. Quality is of the best and it is miraculous for selectivity considering but one stage of r.f. is used. I consider it the equal of any six-tube circuit."

RADIO BROADCAST Photograph

THE DETECTOR AND AUDIO AMPLIFIER STAGES

On the end of the metal panel may be observed a single circuit jack. This jack replaces the two pin jacks which were formerly employed to obtain connection between the set and loud speaker

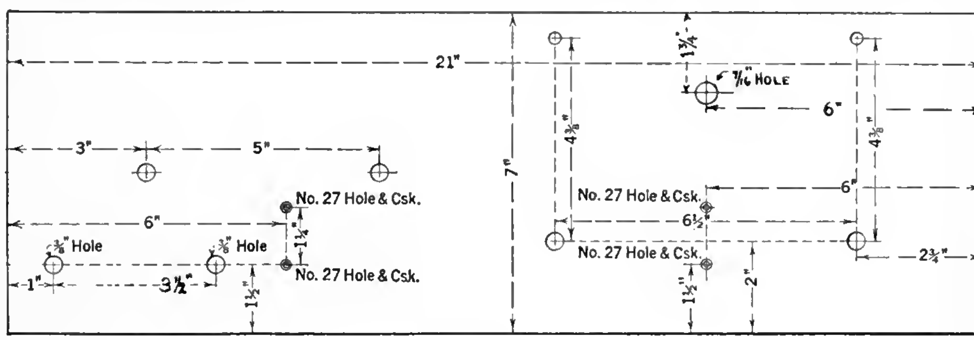


FIG. 7

The metal panel is drilled in accordance with the layout given here. Those holes, the sizes of which are not specified, must be drilled with a small drill first (No. 27) and then enlarged so as to either clear the mounting nut or just take the insulated bushings, as the case may be

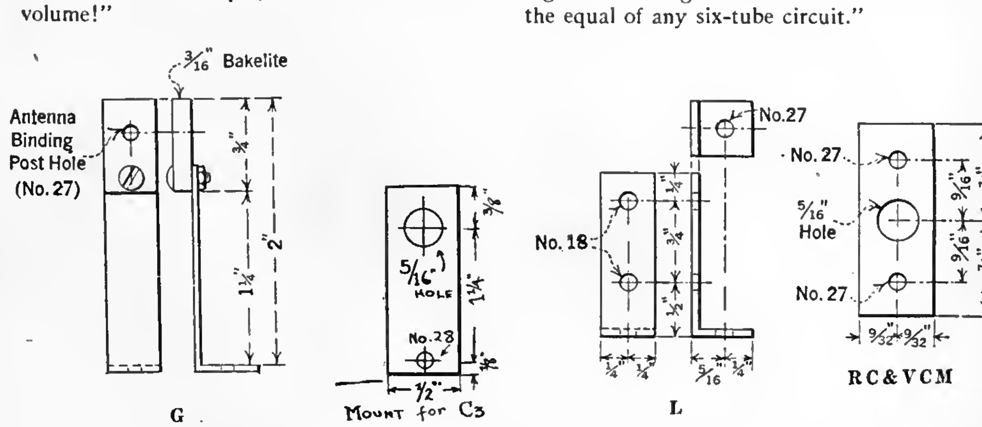


FIG. 8

Here are given the specifications for the various insulated mounts and angle pieces necessary for the assembly of the receiver. RC and VCM, shown at the right, is made of insulating material for preventing connection between the metal panel and the regeneration condenser and volume control. The mount for the condenser C_3 is constructed of brass strip, as is G and L

Looking for Trouble?

When the Neighbor Calls Upon You to Overhaul a Recalcitrant Radio Receiver, Here Is the Way to Go About It in a Systematic Manner

By EDGAR H. FELIX

EXPERT diagnosticians in analyzing radio troubles are rare. The position of a radio oracle is fraught with danger. Reputations quickly fall by the wayside when friends and neighbors call upon "experts" to repair their sets. They expect that one look at an anemic receiver is sufficient to diagnose the trouble and that one telling flip of the screw driver is all that is necessary to repair it. But radio receivers are often mysterious in their ways. Even service men employed by radio dealers often find themselves stumped by the notorious stubbornness of radio sets out of order.

As an aid to unfortunates who, with or without reason, have attained reputations as radio experts in their circle of acquaintances, the suggestions which follow, for a systematic trouble search, have been prepared. Substituting this procedure for the haphazard hit-and-miss trouble hunt will enable you to maintain your reputation and dignity, and to go about the task of finding what is wrong with a radio receiver in a professional manner.

Briefly, a receiver out of order can be classified in one if the following groups:

1. Totally dead.
2. Signals weak but clear.
3. Signals accompanied by whistling and uniform distortion.
4. Reception accompanied by clicking, crackling noises.

A receiver is often classified as dead when it is merely in a state of coma. When you are unctuously conducted to a receiver reputedly dead, behave as you would in the presence of the dead. Turn on the A-battery switch gently, displaying no emotion or expectation that the tubes will light. If they light, you have already determined that the A battery is functioning and that the tube filament circuit is complete. Be sure that all the tubes light to a normal brilliancy though, before presuming this.

Continue your superficial inspection of the remains by pulling the loud speaker plug in and out. It there is a click as you do so, you may be sure that B battery current is flowing through the last tube circuit at least. If there are separate r. f., detector, and amplifier B battery leads, test the completeness of each of these plate circuits by clicking the leads from the batteries to the binding posts. This should give you healthy clicks if all is well with the A and B battery connections.

Next proceed to test the grid connections by tapping with your moistened finger the grid binding post of each tube, beginning with the last and working forward. If you secure clicks all the way through, it is a sure indication that the grid-plate circuits are complete throughout. The nearest high-power broadcasting station should then be weakly audible. The clicks are evidence that the slight change in grid circuit capacity caused by your touch is sufficient to affect the output of the receiver.

These tests correspond to those of the physician who first looks at your tongue and then feels your pulse. Sometimes this superficial examination leads to important evidence, confining your trouble hunt to one particular tube circuit. It is hardly necessary to explain what to do if the tubes do not light or if clicking one of the plate potential leads causes no sound in the loud speaker, for this definitely confines your trouble search to the power-supply circuit.

If the superficial inspection yields no conclusive evidence, check up the voltage of the A, B, and C batteries with a meter, and note the polarity of their leads and inter-battery connections. If these prove to be connected correctly and deliver the requisite voltage to the set, but still no signal or receiver noise can be induced from the recalcitrant radio device, it is a good time to remember an important appointment elsewhere and leave the premises forthwith! The chances are that a broken wire or short-circuit has put the receiving set out of business. Professional service men, discovering this to be the case, usually subject the tubes to test and, if they find the tubes are good, take the receiver to the repair shop. Undoubtedly the set requires a tracing of its wiring, a tedious task not likely to be appreciated by an ordinary broadcast listener as a manifestation of expert technical knowledge.

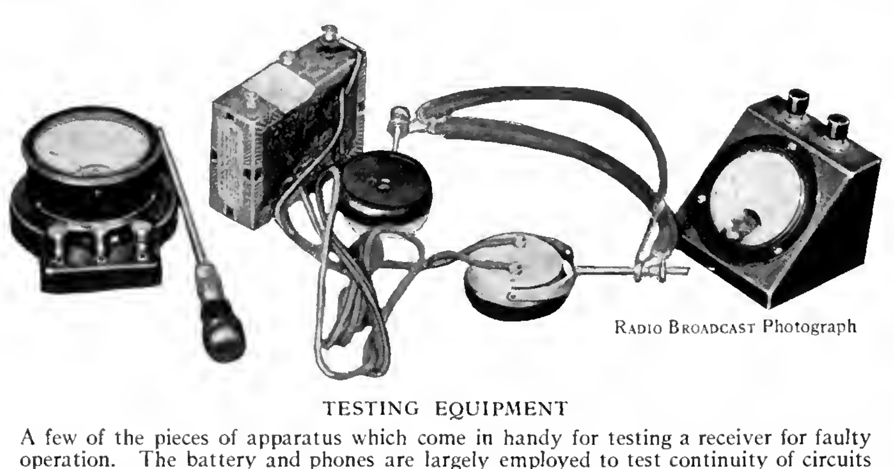
Receivers equipped with a headphone jack give one more point of test before this difficult process or flight must be undertaken. Listen-in with the headphones or, if they are not available, plug the loud speaker in the headphone jack. If good reception is secured through the headphone jack but not through the loud speaker jack, trouble is definitely restricted to that part of the circuit which comes after the first jack. A burned-out transformer, a broken lead, or a defective coupling resistance in the audio amplification system are then likely causes of the receiver's infirmity. If headphones in the loud speaker jack give a very loud signal on local reception, but the loud speaker does not make a sound in that position, the fault is, by this evidence, confined to the loud speaker, its leads, or the loud speaker plug. Examine the loud speaker wiring, including the flexible cord near the plug and the speaker itself. With sets giving excessive current output, loud speaker windings are sometimes burned out, although sets with moderate power rarely cause loud speaker burnouts.

With receivers of the neutrodyne or radio frequency type, it is often possible to localize the trouble in a defective r. f. stage to the particular tube circuit out of order. This is accomplished by disconnecting the antenna lead and applying the antenna input direct to the detector circuit. A convenient place to make this connection is at the plate socket terminal of the final radio frequency stage. If signals are now heard, though the receiver is silent with the antenna connected to its regular binding post, it is a sure indication that the trouble lies within the r. f. amplifier circuit. The antenna should next be connected to the plate post of the preceding r. f. tube. If signals are still heard, it is definitely established that the fault is in the 1st r. f. circuit (in a circuit with two r. f. stages). If no signals are heard with the antenna in the latter position (yet they are heard with the antenna on the second r. f. tube plate), the fault is necessarily in either the first or second r. f. amplifier circuits.

The work of tracing the wiring is materially reduced by confining the trouble to a single-tube circuit as outlined above.

If it is necessary to trace the set's wiring, disconnect the set from its power source and antenna system and follow the wiring logically through from circuit to circuit. Begin with the antenna system, the first grid inductance, the plate circuit of the first tube, the input circuit of the second, and so on until the end. A short-circuited grid inductance, for example, does not affect the continuity of any of the circuits (superficially dismissed by the click test) but may completely eliminate signals.

An open in the antenna circuit, with a receiver located far from any broadcasting stations, may manifest itself as a dead receiver so far as signals are concerned and yet show adequate A, B, and C power, and otherwise complete connections. Receivers of a hundred miles range or more reproduce the familiar atmospheric noises even without antenna connected. Consequently, a receiver is not likely to be classed as "dead" when in working order by reason of antenna or lead-in breakage.



RADIO BROADCAST Photograph

TESTING EQUIPMENT

A few of the pieces of apparatus which come in handy for testing a receiver for faulty operation. The battery and phones are largely employed to test continuity of circuits by the click method. The milliammeter shown at the extreme right, if connected in series with the battery and the circuit to be tested, will give a visual indication. The voltmeter is handy for checking voltages of batteries

Radio Broadcast Photograph

TESTING THE R. F. STAGES

You can readily tell whether or not the radio frequency stages of your receiver are supplying noticeable gain over preceding stages by touching the antenna lead to the grids of the various r.f. tubes

A pair of phones and a C battery are valuable equipment for tracing circuits, especially in finding breaks in pigtail connectors and in testing the continuity of inductances. It is advisable not to undertake more than the superficial tests suggested in the set owner's home. Tracing all circuits with the aid of phones and battery, and detailed examination of the set, is a matter for the laboratory or repair shop.

WEAK SIGNALS

PROCEEDING to the receiver with weak signals, the obvious and most frequent possibilities are run down plate power supply or worn out tubes. The only way to test the power supply properly is with a voltmeter of adequate range. Tubes must be tested with a tube tester or else a complete set of borrowed tubes, known to be in good condition, substituted. If substitution remedies the set's weak volume, the cause of trouble has been determined as run down tubes.

But there are other causes. Weak signals caused by a broken ground or antenna lead-in are always accompanied by exceedingly sharp tuning, both because of the removal of antenna circuit resistance and the increased regenerative action therefrom. A break or disconnection in one of the grid circuits, a gang condenser slipped off tune, or a poor contact of a tube grid pin with its spring in the socket, are likely causes of weakened signals.

WHISTLING

WHEN reception is accompanied by a steady whistle, the nature of the whistle should be carefully analyzed before conclusions are reached. Determine first whether the whistle is entirely independent of tuning or whether it occurs only when the receiver is in resonance with an incoming signal. If it occurs all over the dials, a likely cause is a defective grid leak or a reversed or run down C battery. On the other hand, if it occurs only with a certain station, the cause probably lies outside of the receiver. Heard only when in resonance with a station, especially at the lower end of the dial scale, it may be due to the fact that the receiver has become regenerative. Radio frequency receivers of all types depend for absence of regeneration upon some method of balancing out or resisting the tendency toward regeneration. These systems may be upset by large changes in coupling of the plate potential source, whether of the B battery or line supply type. Since the B battery is common to all plate circuits, they are coupled through it. A run-down B battery, or a softened rectifier tube in a line power-supply device sometimes causes a shrill whistle.

Sometimes a neutralized receiver becomes regenerative even though the plate potential source is in good shape. This may be due to changes in tube characteristics or in the adjustment of neutralizing condensers. By reducing the filament brilliancy gradually when tuned to a near-by high-power station, the signals may become clear although weak after a certain point in filament reduction. This indicates that the receiver needs re-neutralization. A dead C battery sometimes makes a terrifying and omnipresent whistle.

A whistle which discontinues entirely when the detector tube is removed is very possibly caused by a defective grid leak. Moisture and temperature conditions sometimes cause grid leaks to deteriorate.

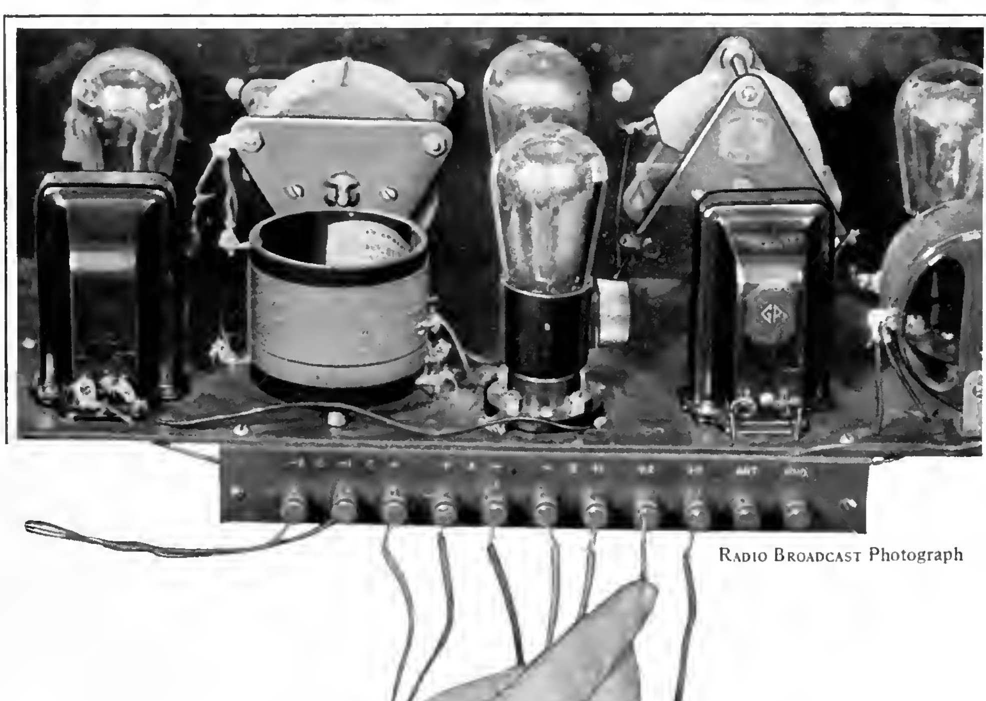
Clicks when a receiver is touched or jarred slightly, indicate a loose wire or a defective tube. Observe whether the click has a ringing quality or whether it is fairly regular and sharp. The ringing quality generally indicates a microphonic tube while harsh clicks accompany broken wires or loose connections. When tracing connections examine first the battery leads and loud speaker cord, then remove and restore the tubes one at a time to confine the break to a single tube circuit. If you find the receiver silent when all the tubes are in except one, the chances are your break is in that particular tube circuit. An exception is the output tube of the receiver, the removal of which silences clicking because there is no plate current through the loud speaker circuit. Its functioning can be checked through the phone jack. If reception is quiet and satisfactory through that jack, the break lies in the amplifier or its special power supply.

Steady clicks experienced with mathematical evenness, unaffected by "jiggling" the receiver, are due, most frequently, to defective grid leaks.

When looking for a broken wire, first check the power input connections, antenna lead-in, ground wire, and examine the leads to the rotors of the variable condensers, variometers, and couplers.

A click heard at a certain position of the tuning dial is obviously caused by touching condenser plates or weakened rotor connections at that particular adjustment.

The essential equipment of the trouble hunter includes a voltmeter covering the full range of A and B battery voltages, some means of testing tubes or a set of replacement tubes for comparative purposes, pliers, screw driver, a set of headphones, and a flashlight for examination purposes and its use in supplying a convenient means of testing completeness of circuits with headphones in series with one of the cells.



Radio Broadcast Photograph

TESTING THE PLATE CIRCUITS

One way to determine whether the various plate circuits of the audio channel are complete is to unfasten one by one the B battery leads from their binding posts and touch them against the posts. If the circuit is complete a click will be heard each time in the loud speaker

THE LISTENERS' POINT OF VIEW

Conducted by John Wallace

Much Sound and Fury About Radio Education

MR. ZEH BOUCK, in his column in the New York *Sun*, "What are the Air Waves Saying?" attacks our attack on radio education in the October number and conclusively proves that several conclusions we did not wish to draw are utterly false and incompatible with even a moron's reason. He did this in such excellent and devastating fashion that we were greatly relieved that we hadn't actually advocated all the things he objected to!

Mr. Bouck took up two statements we made in the article, viz: that an educated man is a disciplined one, and that the well informed man is not necessarily well educated, and informed his readers that "in these two rash assumptions Mr. Wallace has considerately and effectively committed suicide; for the arguments contradict each other and demonstrate the general untenability of his stand. Then Mr. Bouck kindly and considerately did a little suiciding himself by refraining from evidencing wherein the second statement was untenable or how the two were in conflict.

To support his disbelief in "discipline" he rang in the aid of Messrs. Plato and Spencer, with which two eminent gentlemen we do not intend to engage in controversy in a public print. However, towards the end of this article, Mr. Bouck becomes more convincing and very persuasively presents the side of the believers in radio education:

> Of course Mr. Wallace is right when he says that broadcasting does not educate, but merely informs. But he might have said the same of books, colleges, and life itself.
>
> Education is something entirely within ourselves, and consists of arranging and rearranging all the information we assimilate into logical interrelations. Education is the process of making philosophy out of knowledge. An education is, therefore, a subjective edifice constructed of objective materials supplied by books, life, radio broadcasting, and academic instructors. In a limited sense, any one of these factors may be considered as educating or educational, with radio by no means placed last in effectiveness.
>
> We particularly emphasize the educational possibilities of broadcasting because of the complete absence of disciplinary imposition. The information imparted by radio comes to us, for the greater part, in the guise of entertainment. Sugar coated, it is assimilated effortlessly by the listener, his mind, in the repose of recreation, highly receptive to thoughts and ideas that strike a sympathetic note in his mental symphony.
>
> It is almost needless to say that the effectiveness of broadcasting as an educational factor depends largely on the broadcasting station; and as yet no station has done more than a partial justice to these possibilities.

Referring to Mr. Bouck's first paragraph, we will gladly say the same thing about "books, colleges, and life itself"—and here it is: they do not educate. Education is the result of the inherent, latent capacity of any given mind to become educated. An individual possessing such a mind will inevitably become educated. He will arrange and rearrange all the information he assimiliates into logical interrelations. He will assimilate this information from any and every source, *including* radio broadcasting. But what of any depth, or subtlety or complexity or real meaty value will he ever hear in a radio lecture?

Moreover—he is a rare bird! There is not more than one of him in every thousand radio listeners. Thus it is ridiculous to claim that lecture broadcasts are "educating" when they are failing to "educate" 999 out of every thousand persons who hearken to them. It would be just as reasonable to claim that a palsied marksman was a "crack shot" because he at one time shattered one clay duck out of eighty.

GERTRUDE O'NEILL GANLEY

Impersonator; one of the most popular entertainers heard from WCCO, Minneapolis

How a Great Symphony is Broadcast

EIGHT microphones are used in sending out the series of twenty-four Saturday evening concerts which are broadcast by the celebrated Boston Symphony Orchestra through arrangement with W. S. Quinby, of Boston, through WBZ and the "blue" chain network, including WJZ, WGY, and WRC. While two sets of three microphones each have been installed in the hall for picking up the music, only one set is used during a single broadcast. The second or emergency set of three microphones is installed so that immediate switching may be accomplished in case of trouble with the first set. The other two microphones used in this broadcast are installed in the control room in the WBZ broadcasting booth at Symphony Hall where the operators and announcers monitor all the programs.

For picking up the music of the orchestra, two microphones have been suspended from the ceiling on each side of the hall slightly in front of the stage, and another is set up on a stand on the floor of the hall directly in front of the conductor's platform. The emergency set has been installed in the same manner and requires only the throwing of a switch to transfer from one set to the other.

The musicians check for poor musical balance and the operators guard against poor mechanics in the broadcast.

The specially constructed booth containing the amplifying apparatus, announcers' microphones, and associated control instruments is located at the rear of the hall over the stage. This room is soundproof so that good monitoring by the operators may be done. A very small window in the proscenium enables the announcers to watch constantly the orchestra conductor so that special announcements may be made from time to time without interrupting the music.

Two specially constructed wire lines connect Symphony Hall with the central control room of WBZA in the Hotel Brunswick. One pair of wires is normally used for the broadcast and the other for the operators to communicate over. Both lines, however, may be used for broadcasting. At WBZA, another operator checks the programs thus further reducing the chances of poor broadcasting. The concert is put on the air from WBZA and at the same time sent over wire lines to WBZ at Springfield. At Springfield it is re-amplified and put on the air from WBZ. Additional wire lines with amplifiers at Waterbury, Connecticut., connect the Springfield control room of WBZ with the central control room of WJZ in New York.

The program is split at WJZ, one pair of wires feeding the music to Schenectady where WGY sends out the concerts and the other line carries the music to Washington, District of Columbia, where it is sent out through WRC.

Nearly two hours before the start of each Saturday evening concert, the engineers of the Westinghouse station test the various broadcast controls. One operator tests the microphone circuits through to the amplifiers. Another tests out the wire lines connecting the stations on the chain for the evening by putting musical tones varying in pitch from low to high frequencies over the lines. All corrections are thus made before the start of the broadcast to assure the desired intensities. A few seconds before the opening symphony announcement is to be made, the operator at the hall signals the various station operators for "the air." Then the control is given to the symphony announcer who has full charge of the chain for the remainder of the broadcast.

BROADCASTING THE BOSTON SYMPHONY THROUGH WBZ

The Symphony Hall studio of WBZ, showing the control panels and microphone set-up for the broadcasting of the Boston Symphony Orchestra. Standing, left to right: W. S. Quinby, the public-spirited citizen who sponsors the programs; Alwyn E. Bach, WBZ announcer. Seated, foreground: Professor John Patten Marshall, of Boston University, who gives interpretative talks before the selections; D. A. Myer, engineer in charge, WBZ, and G. W. Lang, assistant chief operator

Overlapping of First Rate Program Features Should Be Avoided

ENTER Messrs. Alphonse and Gaston! Accompanied by sundry bowings and scrapings, the radio stations are beginning to defer to one another. True they have done so before in matter of lending time to sister stations for some special broadcast where both share a wavelength. But now we find them altering their programs to avoid competition with some particularly good feature offered by a rival station.

Thus it was that WRNY shifted its New York Edison Hour back thirty minutes to avoid overlapping the Eveready Hour of WEAF. And WJZ, back in the football season, cancelled its broadcast of the popular Yale-Princeton game upon learning that WEAF was to do the job and made last minute arrangements to broadcast the Army-Notre Dame game instead. Other instances have occurred.

This evidences a noble and magnanimous spirit on the part of broadcasting stations and likewise a very practical one, for it seems reasonably certain that a few really "high-powered" weekly features have built up a reputation that enables them to enjoy a monopoly on a majority of the listeners' ears during their specified hours of broadcast. This must mean that a station offering something new and good during one of these reserved hours is taking a long chance on having its effort properly recognized. For instance, if we were an eastern station and were about to spring a new and expensive high-brow feature on the Sunday night listeners we should hesitate a long while before billing it for 9:15 P. M. for the Atwater Kent Hour has, we suspect, a monopoly on the high-brow listeners for that period.

This problem of duplication is not a very serious one at present for there aren't so many not-to-be-missed features that they can't all manage to fit themselves nicely into the week without treading on one another's toes. But, if the amazing rush of indirect advertisers to the broadcasting studios, and their profligate handing out of money to first rate artists continues, not many years will go by before we will find ourselves confronted, during certain nights of the week, with more good things than we can hearken to with only one set of ears.

If the broadcasters can be persuaded to spread them out through the whole week and over the less desirable hours it will be so much the better for us, the listeners. Under such an arrangement, priority should be the arbiter and an advertiser who has uninterruptedly furnished a first-class program over a period of years should not be interfered with. Not only as a matter of polite respect to seniority but as a matter of business: for if several advertisers pick on a highly desirable Sunday night period they will find themselves engaged in terrifically expensive competition; to outshine one another in a scramble for listeners they will be forced to either spend more money than the publicity is worth or drop out of the race.

Broadcast Miscellany

WBBM, bless its heart!, one of the foremost of the low-brow stations, has decided to get itself up in the world and is doing a little cultural climbing. Its efforts, while distressingly sincere, are at times even

THREE RADIO PERSONALITIES

Left to right: Louis Meehan, George Junkin, and Fred Smith. Louis Meehan, unheralded by press agents, slipped on to the vocal staff of KYW in Chicago and we find him one of the three or four best radio tenors. George Junkin is director-manager of KMOX, "The Voice of St. Louis." Fred Smith has again resumed his duties as director of WLW, Cincinnati, after an absence of a year

TELL US WHAT YOU LIKE IN RADIO PROGRAMS

IF YOU have not already sent in your reply to the questionnaire, which was printed in the January RADIO BROADCAST, it is reprinted below. A large number of extremely interesting replies to our questions have already been received and the large mass of material is being tabulated as rapidly as possible.

Many correspondents suggested that space should have been allotted for a list of radio features that are distinctly unpopular with listeners. Expressions of that sort of opinion are always welcome to the conductor of this department. However, it was felt that there was a sufficiently wide range of subject covered in the present list.

While the names of readers of this magazine who are good enough to trouble to reply to these questions will be kept confidential, it will be of considerable assistance if those who reply to this questionnaire will include their name and address.

In replying to question four, please indicate definitely the title of a special part of an evening's broadcast, defining it by the title of the program. Some replies to this question merely indicated the call letters of a favorite station, which is, obviously, pretty indefinite.

The questions below are few, and some of them have the special virtue that they have never been asked before. Please use the space provided for your answers. Tear this sheet from the magazine, and if possible typewrite your replies. If the space provided is not sufficient, attach an additional sheet to this with your remarks. If you are interested in reading the replies—contribute some yourself. Address all questionnaires to

JOHN WALLACE,
RADIO BROADCAST,
Garden City, New York.

Please Answer These Questions

1. Do you listen to your radio evenings as you would to a regular show, or do you simply turn it on and use it as a background to other activities?

(This question may seem silly, but we ask it because we have a growing suspicion that radio programs aren't as reverently listened to as the broadcasters suppose.)

2. Do you regularly tune-in on distant stations or do you regularly rely on your local stations?

(They tell us that the DX hound is a fast-disappearing breed. Is he?)

3. If you had a hundred minutes to listen to all, or any part of the following broadcasts, how would you apportion your time? (Answer in spaces provided in the next column.)

Instrumental Music	*Serious*	___	minutes
	Light	___	minutes
	Popular	___	minutes
Vocal Music		___	minutes
Radio Play		___	minutes
Speech		___	minutes
Educational Lecture		___	minutes
Miscellaneous Novelties		___	minutes
TOTAL		100	minutes

(In answering this question, assume that each of the offerings is the best of its kind, say Coon-Sanders Nighthawks for the jazz, the New York Symphony for classical music, Ford and Glenn for the novelties, and so on.)

4. What are the six best broadcasts you have heard?

(We could refresh your memory with some notable broadcasts, but that might influence your choice. Anything is eligible, from an especially good dog fight broadcast, to a high-powered soprano solo, heard four years ago.)

Please answer these questions briefly and mail them at once to Mr. Wallace, at the editorial offices of RADIO BROADCAST, Garden City, New York. We prefer to have you write your replies on this page. The results of the questionnaire will be announced just as soon as it is possible to compile them.

droll. Witness: Its Tuesday night feature is proclaimed as "An Hour with *Ultra*-Modern Composers," which same "ultra" individuals turn out to be such old standbys as Tschaikowski, Rachmaninov, and Saint Saens! The announcer was doing his best to give some informative remarks about Ravel (who was evidently about as familiar to him as the Chinese coinage), and assured us that he had once won the "Prix de Rome"— the first word being pronounced as in pins and needles.

WBBM is an excellent station in kind and immensely popular with the mass of listeners around Chicago, but we wish it would be itself. Its sub-title is an ingenious one, easily the best of all the station "slogans." It calls itself WBBM—The Stewart-Warner Air Theatre."

EMASCULATING NEWSPAPER PROGRAMS

AT A recent meeting of the Publishers Association of New York, a set of rules was adopted designed to eliminate free advertising in radio programs. Edwin S. Friendly, business manager of the New York *Sun*, was appointed censor to see that the rules are followed. All names of advertisers or possible advertisers and their trade-marks are to be eliminated from the radio programs published each day in the papers. This step, we suspect, will go far to alienate the general reader of the newspaper and to bring nearer the day when a national radio program paper, sold on subscription, will be widely circulated.

AND NOW THE CLEVELAND SYMPHONY

THE entire winter series of Thursday night symphony concerts by the Cleveland Symphony Orchestra is to be broadcast through WTAM. Those yet to be heard fall on January 13 and 27, March 3 and 31, and April 21. The Cleveland orchestra has never previously been heard in a full symphony program through any broadcasting station. Some four years ago part of a program was broadcast from the Masonic auditorium by WJAX, predecessor of WEAR and WTAM. Since that time, many efforts have been made to arrange for broadcasting of the orchestra's concerts, but until the present contract was made, there had been no broadcasting.

Under the new arrangement, the broadcast is sponsored by the Sandusky Cement Company which places $1000 to the credit of the orchestra's maintenance for each concert and also a fee to WTAM to compensate for time in the air and telephone line charges in connection with the broadcast. The series, as broadcast, is known as the Medua Concerts. WTAM forwards to its listeners an excellent booklet containing the program and notes shortly before each concert.

WEEKLY RECITALS WORTH HEARING

WORTH your attention is the series of weekly musicales of the Adolph Lewisohn Course in Appreciation of Music broadcast by WNYC from Hunter College on Wednesday evenings at 8:30 (EST). These musicales are under the supervision of Dr. Henry T. Fleck of Hunter College. The works of one or two of the standard composers are discussed at each of the sessions and performed by some chamber music organization.

A GENUINELY BAD "REGULAR FEATURE"

THE Champion Sparker's program broadcast by WJZ, WGY, WRC and WBZ on Tuesday nights bids fair for the honor of being the worst of all the indirect advertiser's programs. This, you may recall, is the feature which affects singing announcements, the which is done by Milton J. Cross. The announcements are not bad, if rather silly, but the band introduced is terrible. Its ailment we shall not attempt to diagnose; perhaps it's simply loose-jointed. The solos and duets with which the program is interspersed are uneven in quality with only a very occasional good number supplying the necessary crests to the unevenness.

ALL RIGHT FOR THEM AS LIKES IT

ANOTHER WJZ offering in which we take little delight is the Thomas Cook and Son travelogue series. It appeals to us as a grand waste of time. Not that we dislike travelogues; a sure enough travelogue with either "still" or moving picture illustrations may be interesting as well as instructive. But the radio travelogue's method of illustrating the scene under discussion with a tune strikes us as being far fetched. The melody, no matter how well selected, seldom has much connection with the site to which it is attached. There is no guarantee that the associations a particular song has for the arranger of the program are the same for each or any of his listeners. For instance, in our alleged mind, the Song of the Volga Boatman is inseparably associated with—not a winding stream in Russia—but garlic. (Which was the burden of the breath of the person who sat next to us when we first heard it at the Chauve Souris.) So the travelogue program resolves itself into two distinct, and in our opinion, unconnected parts: a series of tunes, and a series of episodical descriptions. Why not just the tunes—or just the description? Or preferably neither?

But somebody must like the things or they wouldn't still be going on, so we will cease quarreling with them and merely refrain from listening to them. In fairness to the Cook travelogues, they're not half as dull as the score of lesser imitations to be heard from various stations throughout the country.

ONE of KDKA's regular weekly features is "Teaberry Time," which is to be heard Fridays from 9 to 10 P. M. It is a potpourri of orchestral selections, vocal solos, and quartettes and monologues. The whole is alleged to be bound together by a slight yarn. The yarn might just as well be omitted.

FOR the afternoon listener within range of Chicago, the firm of Lyon and Healy offers a series of recitals introducing young local artists at 2:30 in the afternoon of each week day, and they are broadcast by WGN.

WMAQ and WLS of Chicago have got together for the joint presentation of a light opera company recruited from both studios. So far they have presented "The Mikado," "The Pirates of Penzance," "The Bohemian Girl," and "The Chimes of Normandy,"—and all in excellent fashion.

WLS swears up and down that a twenty minute sermon broadcast by one Samuel R. Guard in connection with its "Little Brown Church in the Vale" drew ten thousand three hundred and forty-one (10,341) letters of appreciation! Which leaves us with nothing whatever at all to say.

ANOTHER series of Sunday afternoon concerts is that of the Atlanta Symphony Orchestra as presented by WSB. And in case you can "get" WSB in broad daylight, they are to be heard at 3:30 P. M. Eastern Standard Time.

BROADCASTING of investment talks has been inaugurated by the Cincinnati Better Business Bureau. These talks are five minutes in length and are broadcast from WSAI every Thursday evening at 6:40.

THE HARTT HOUSE STRING QUARTETTE

This quartet is established at Hartt House, the art and recreational center of the University of Toronto. From left to right: Geza de Kresz, first violin; Milton Blackstone, viola, and Harry Adaskin, second violin. These musicians have been together for three seasons and have achieved great success in chamber music. By special arrangements with the syndics of Hartt House and the radio department of the Canadian National Railways, these artists are broadcasting a series of recitals at the various Canadian stations

Practicable Applications of Some New Equipment

An Explanation of the Uses and Functions of Various Pieces of New Apparatus Submitted to the Laboratory for Test

By THE LABORATORY STAFF

IT IS the purpose of this department to explain more fully than is possible in the monthly "New Apparatus" pages the uses and adaptions of some of the equipment illustrated thereon. That these "New Apparatus" pages are received with considerable interest by our readers is attested by the numerous letters received that request more information about the various pieces of apparatus listed. While it is not possible to explain at length the functions and theory of every "gadget" shown, an endeavor is being made here to place before the reader brief yet accurate and lucid information pertaining to that equipment which is likely to attract the greatest interest.

GANG CONDENSERS

THERE have been many requests for information as to how the new ganged tuning condensers, such as those made by the Alden Company, and which are illustrated in Fig. 1, should be connected in a circuit. The questions regarding the use of these gang condensers generally arise from the fact that the grid return to the detector tube must connect directly to either the positive or negative terminals of the detector tube whereas the grid returns of the radio frequency amplifiers quite frequently connect to a C-battery. If then, all the grid returns were connected together to the common shaft of the gang condenser, it would not be possible to obtain different bias on the r.f. tubes than on the detector. In order to overcome this difficulty, a special arrangement is necessary. The necessary circuit can be seen by referring to Fig. 2. It should be noted that the rotor plates of the variable condensers, which in a gang condenser are, of course, all fastened to the common shaft, are connected to the low-potential sides of the various radio-frequency transformer secondaries, with the exception that the low-potential side of the coil connected in the grid circuit of the detector tube does not connect directly to the rotor plates, but is connected to the positive filament, thus obtaining a desirable positive bias. A bypass condenser is incorporated in the circuit so as to make it unnecessary for the radio frequency energy in this circuit to pass through the A and C batteries. The arrangement shown is only one of several possible circuits that might be used. An Alden "four-gang" condenser unit was listed in the "New Apparatus" pages last month.

Radio Broadcast Photograph
FIG. 1

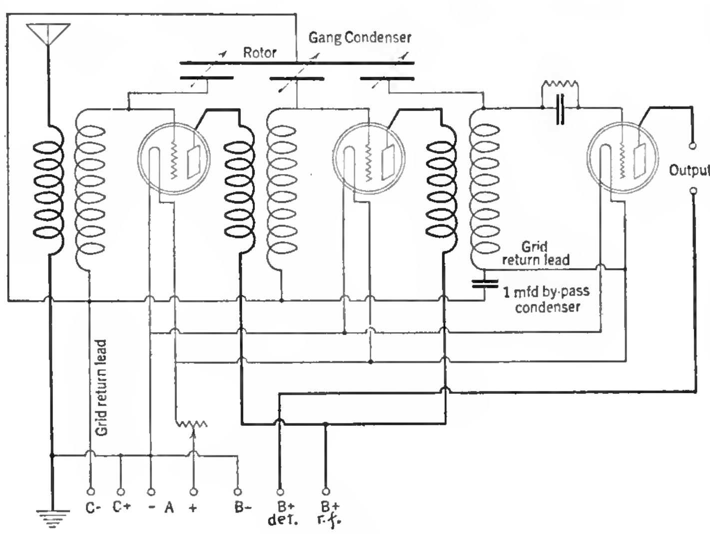


FIG. 2

THE TRUPHONIC AMPLIFIER

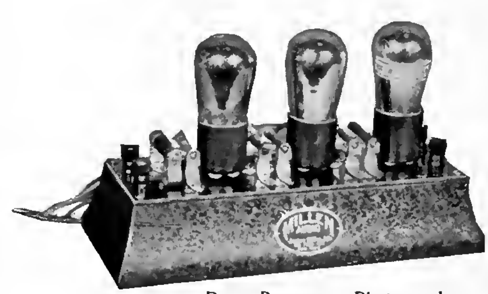
ANOTHER unit made by the Alden Company is the Truphonic amplifier, which is shown in Fig. 3. It consists essentially of a three-stage amplifier similar in design to double-impedance amplifiers, using choke coils in both the plate and grid circuits. This type of amplifier is preferable to one using ordinary grid leaks in the grid circuits in that there is no tendency for the grids to block on strong signals as they would if high-resistance leaks were to be used. The blocking is due to the grid current, which does not have time to leak off through a high-resistance leak. However, the grids cannot block with a properly made impedance in the grid circuit of the tube, for such an impedance has a very low resistance to the flow of direct current although its impedance to the flow of alternating currents is very high. The amplifier is arranged so that it can be easily connected to any receiver, and instructions are enclosed with the unit so that anyone purchasing the device should have no difficulty in obtaining satisfactory operation. The same batteries are used to operate the amplifier as are used to operate the radio receiver. A unit such as the Truphonic is to be recommended since it affords an easy means whereby any home-constructor can add a complete amplifier to his receiver and do it with a minimum of trouble. The amplifier unit is entirely complete and includes the sockets, rheostat, and a special cable for connecting it to the batteries. A power tube should preferably be used in the output stage, with proper B and C batteries. The Truphonic amplifier was listed in the December Radio Broadcast "New Apparatus" pages.

Radio Broadcast Photograph
FIG. 3

THE MILLEN AMPLIFIER

ANOTHER ready-made unit is the Millen resistance-coupled amplifier illustrated in Fig. 4, particulars of which were given in the January "New Apparatus" pages. This unit is also equipped with a cable, and it can, of course be operated from the same batteries that are used for the remainder of the receiver. All types of tubes may be used, it merely being necessary to insert the correct size of filament-control resistance for the tubes being employed. High-Mu tubes should preferably be used in the first two stages. This amplifier will require somewhat higher plate voltages on the first two stages than is required by the Alden Truphonic; 90 volts is sufficient for the Truphonic while 135 is preferable on the resistance amplifier. However, the B-battery current consumption of a resistance amplifier is less generally than that of other types.

The amplifier incorporates several other worth



Radio Broadcast Photograph
FIG. 4

while features. In the first place, it contains a radio frequency choke in the input circuit to keep the r.f. energy out of the amplifier. This choke, essential in receivers using a condenser to control regeneration, makes the amplifier suitable for use in conjunction with such as the Radio Broadcast two-tube "Lab" and the new "Universal" receivers. The first stage is impedance-coupled (we should really call this unit an impedance-resistance amplifier) so as to permit the use of the new 200-A detector tube, the plate current of this tube being too great to pass through an ordinary resistor. Quite fre-

Radio Broadcast Photograph

FIG. 5

quently amplifiers of this sort have a tendency to "motor boat" when used with B power-supply devices, and to eliminate this action, a choke coil is connected in the grid circuit of the last tube. And finally, the output circuit includes a condenser-choke circuit so as to permit the use of a 171 tube and high B potential without the necessity of purchasing any extra apparatus to eliminate the direct current from the loud speaker windings. The amplifier is constructed on a cast iron base of very sturdy construction.

REACTIVATING TUBES

Most of the tubes now in common use are of the thoriated filament type, and it is frequently possible to reactivate these tubes after they have lost their emission qualities. The Jefferson Electric Manufacturing Company has placed on the market the Jefferson radio tube charger with which it is a simple matter to reactivate any type of tube. This instrument was listed in the December Radio Broadcast, and is here shown in Fig. 5. If one desires, the terminals on the tube charger may be connected directly to the A-battery terminals on the re-

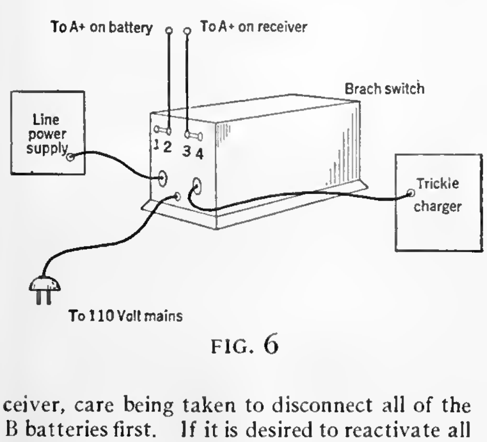


FIG. 6

ceiver, care being taken to disconnect all of the B batteries first. If it is desired to reactivate all of the tubes, they may all be left in their sockets and reactivated at once, or only one tube may be left in the receiver at any one time. There are two sets of terminals, one set marked L and the other set marked S. For storage battery type tubes the L terminals are used, while for dry cell tubes the S terminals are used. There is a small switch on the front of the unit one terminal of which is marked F and the other B. Throwing the switch on the F terminal places high voltage on the tubes and this high voltage is left on the tubes for 45 seconds. This procedure is called "flashing." The switch is then thrown on to the B terminal and the tubes permitted to "cook" for at least ten minutes. This treatment will generally make old tubes perform very much better. The reactivating process is so easily carried out and is generally so effective that it is always worth while to try reactivating old tubes before discarding them. Radio Broadcast Laboratory Sheet No. 21 gave some useful information relative to reactivation, while some actual data on the plate currents of rejuvenated tubes may be found on page 662 of the April, 1926, Radio Broadcast.

AN ELECTRICALLY OPERATED SWITCH

The Brach Manufacturing Company's "Controlit" (Fig. 7) is a special switch designed for use in conjunction with a receiver when the set is supplied with plate current from a line power-supply device and a trickle charger is used in conjunction with the storage battery. When the filament switch on the receiver is thrown to the "on" position, this Brach switch functions to turn off the trickle charger and turn on the power-supply device. When the filament switch is thrown off, the power-supply device is auto-

Radio Broadcast Photograph

FIG. 7

matically disconnected from the mains and the trickle charger turned on. The connection of the device to a typical installation is shown in Fig. 6. The switch can be adapted to either dry cell or storage battery type receivers by altering the connection to the binding posts on the front.

The device consists of an electro-magnet, to the armature of which is fastened the center blades of a double-pole double-throw switch, as shown in Fig. 8. These two center contacts, fastened by an insulating member to the iron armature, are connected to the a.c. supply. Without any current in the coil, a spring pushes these contacts against the two outer contacts which are connected to the trickle charger, and, of course, the battery will begin to charge. This is the position of the switch when the radio receiver is not being used.

The coil of the electro-magnet is connected in series with the plus A lead so that, when the filament switch is turned on, the filament current for the tubes flows through the coil, energizes the magnet, and the armature is pulled over to the core. This opens the trickle charger circuit and connects the a.c. line to the other two contacts which then supply current to the line supply device connected to them. It is evident that the switch does not require any extra energy to operate it, since the filament current is utilized to supply the coil current.

A switch of this type makes a modern radio installation practically automatic in operation. Filling the storage battery with water when necessary, is all the attention that need be given it.

OUTPUT DEVICES

The Technical Information Service has answered a great many inquiries as to how an output device should be used in conjunction with a 171 tube if a high plate potential is employed, to eliminate the direct current in the plate circuit from the windings of the loud speaker.

There are two general types of output devices —transformers and choke-condenser combinations.

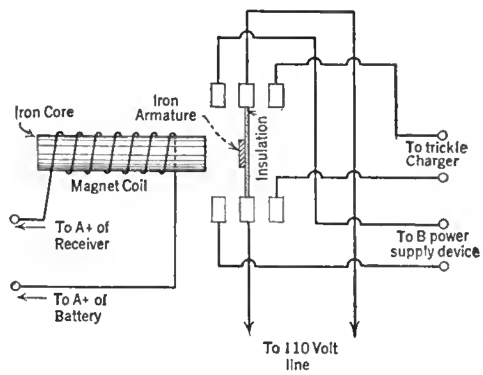


FIG. 8

Until quite recently it was necessary to purchase, separately, a choke and a condenser, and to then place them in circuit as shown in Fig. 9. Now, however, several companies have placed on the market tone filters or speaker filters, as they are sometimes called, which consist of a choke and condenser assembled into a simple unit. The Mayolian tone filter illustrated in Fig. 10 (extreme right) is especially suited to those receivers into which a 171 power tube has been incorporated, with the high value of plate potential, but in which there is no room to place an output device. To install the device it is merely necessary to attach a telephone plug to the extension cord on the filter and to place the plug in the output jack of the receiver. The loud speaker is then connected to two binding posts on the filter. The General Radio Company also puts out an output unit device which is illustrated in Fig. 10 (second from left). It has four terminals, number 1 and 2 being the input and numbers 3 and 4 the output. The National Company's output filter (third from the left in Fig. 10), and the "Orthophone" filter, made by the Amsco Products Incorporated, are also illustrated.

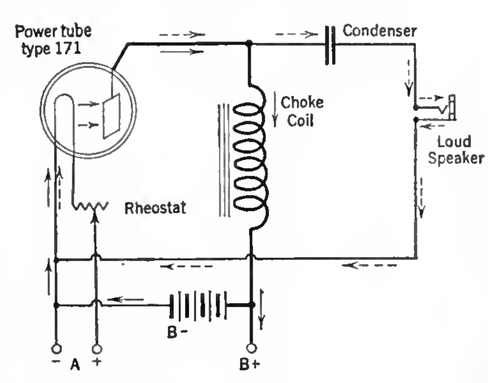


FIG. 9

In Fig. 9 the solid arrows show the path of the direct current and the dotted arrows the path of the alternating or signal currents when an output device is employed. The direct current does not pass through the loud speaker windings but passes from the plate through the choke coil to the battery, whereas the signal current passes from the plate through the condenser and loud speaker back to the filament. The elimination



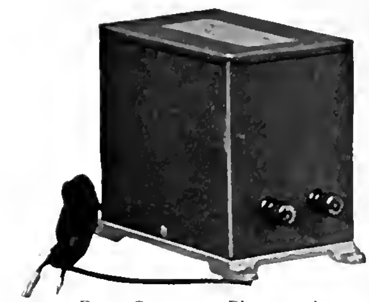



FIG. 10

Radio Broadcast Photographs

of the direct plate current from the loud speaker windings is essential when a 171 tube is used with a plate potential of more than 135 volts, since the plate current for this tube is so great as to seriously affect the operation of the speaker if it were permitted to pass through it.

A HIGH-RESISTANCE VOLTMETER

Very few home-constructors can put together a receiver and its accessories and then leave it alone. Even though the set works perfectly, there is always the itch to get one's fingers inside of the cabinet and try something different. When we do this we begin to feel the need of a few instruments, the most useful of which is the milliammeter, while next in usefulness comes the voltmeter. A milliammeter, in conjunction with a fixed resistance, can be used as a voltmeter (see Radio Broadcast Laboratory Information Sheet No. 27, September), but there are many who would prefer to purchase a meter especially suited for the job. Now, as explained in Laboratory Sheet No. 30 (September) the only type of voltmeter suited for use in measuring the output voltage of a line power-supply device is one having a very high resistance, such as that possessed by the Jewell voltmeter illustrated in Fig. 11. This meter has a 50-volt range and a 250-volt range. Two hundred and fifty volts divided by 1.25 milliamperes, the current this meter requires for full-scale deflection, equals 200,000 ohms internal resistance. This high resistance makes the instrument well suited for voltage measurements of all sorts, including the measurement of the output voltage of line power-supply devices.

A SET TESTER

"For the Home-Constructor," might have been written on the nameplate of the Hanscom set tester, for it is a bit of apparatus particularly well suited for use in the home-constructor's laboratory. This tester is actually a small oscillator, similar to that described in the September, 1925, Radio Broadcast, under the name of a modulated oscillator. It draws all of its energy from the power mains, and it is to be used in hunting trouble in a receiver. It may be placed in one corner of the room and the receiver placed in the other corner, and when the receiver is tuned to the frequency of the oscillator, a low hum about 120 cycles in pitch will be heard in the audio output of the receiver if it is functioning properly. The set tester can be set on any wavelength between about 200 and 550 meters (1500 and 545 kc.). The unit is shown in Fig. 12. It consists of a coil (which may be any type since the losses are of no consideration) placed across a variable condenser, a vacuum-tube socket, and an ordinary electric-light socket. If the device is used in a 110-volt circuit, a 25-watt lamp should be placed in the socket; on a 220-volt circuit a 50-watt lamp should be used. A 201-A tube is used in the tube socket. The circuit of the tester is given in Fig. 13. It was listed in the December Radio Broadcast.

FIG. 11

FIG. 12

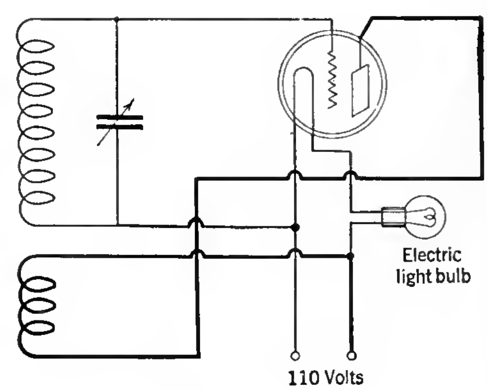


FIG. 13

THE ALL-AMERICAN COMPANY'S B POWER SUPPLY

This unit employs a Raytheon rectifier tube which is located in a protected tube compartment. Suitable controls for adjusting the detector and intermediate amplifier voltages are situated on the front panel, as are the output terminals

Radio Broadcast Photographs

ANOTHER B SUPPLY DEVICE

The George Electric Company's B power supply is a compact unit housed in a metal case. Two controls afford regulation of the detector and intermediate tap voltages. A rectifier tube of the Epom type is supplied

A. C. Operated Amplifier-Power Supply Devices

How to Combine the Various Kinds of Audio Amplifiers with Different Power-Supply Systems—Some Typical Combinations—A Comparison of the Different Audio Channels Available—How to Prevent "Motor-Boating"—Choosing Your Rectifier Tube

By JAMES MILLEN

NOT so long ago the criterion of good radio reception was expressed in miles. Quality of reception was given little consideration and was quite beyond the experience of many people.

But today conditions are quite the reverse. Every set owner is now hunting quality instead of the elusive, weak, and distorted signals from across the continent that were once so much discussed on the 8:15 every morning. Now, who boastfully tells his neighbors that he got PWX, Havana, on the loud speaker last evening? No, that same individual today speaks of such things as bass notes, overtones, harmonics, straight frequency line, cone loud speakers, power amplifiers, and what not!

One of the requirements for high quality reception is a well nigh perfect audio amplifier. Such amplifiers require higher plate voltages and currents which can be easily obtained from a power supply device. As a result, a plate supply device is generally incorporated as an integral part of the power amplifier nowadays.

In the first article of this group, which appeared in the January RADIO BROADCAST, the design, assembly, and use of a very fine combined power-supply unit and audio amplifier, now on the market in kit form, was described.

Many readers, no doubt, may already have on hand a B power unit, a pair of good quality audio transformers, or some other of the material essential for the construction of a high quality lamp socket operated audio channel. Or again, perhaps the dimensions of the device described last month were such as not to readily fit in some available space where the constructor might like to place it. Then, there are those readers who have the necessary time and facilities for assembling many of the individual units, such as chokes and transformers, themselves.

For these reasons, a number of amplifier-power supply units have been constructed, and will be described in this and succeeding issues of RADIO BROADCAST. These employ parts of different manufacturers and, in one case, home constructed parts. The circuit in all cases, is fundamentally that shown on page 288 of the January RADIO BROADCAST. Slight variations of circuit, however, have been incorporated in the design of some of the new units. For instance, in some cases, resistance-coupled amplification, and in others, transformer-coupled amplification, has been employed. All of the different arrangements shown are entirely satisfactory and the choice of one in place of another is largely a matter of individual taste and financial considerations.

As the constructional details of the amplifier-B power unit were described quite completely in the January article, the matter will not be covered again this time, but rather the functions of some of the individual parts, the merits of one system of amplification over another, and some data which should prove helpful on the adjustment and operation of the complete device, will be taken up instead.

THE AUDIO CHANNEL

FIRST, then, let us consider the different types of audio channels available for use in high quality amplifiers to see which will best fit our individual requirements.

Whether the amplifier employs transformer, resistance, impedance, or a combination of resistance-impedance coupling, very fine results can only be obtained by using the very best of parts.

If cheap, or even medium-quality transformers are employed, the result will be noticeably poorer than when the best are used. Likewise, with resistance coupling, unless high-grade resistors and grid coupling condensers are employed, the amplifier is likely to be noisy, is apt to "motor-boat," and may go entirely bad after a few months use. Most resistors of the impregnated paper type enclosed in a small glass tube are entirely unsatisfactory for resistance-coupled amplification. They are noisy and not permanent in ohmic resistance value. The resistors used in the construction of the amplifiers described in this article are of the metalized type, such as are manufactured by several dependable concerns—Durham, Dubilier, Electrad, Lynch, Amsco, etc.

As to difference in cost, the advantage is slightly in favor of resistance-coupled amplification even though an additional coupling socket and tube are required. When a combination of impedance and resistance coupling is employed, the cost of its components is nearer to that of the transformer coupled amplifier parts.

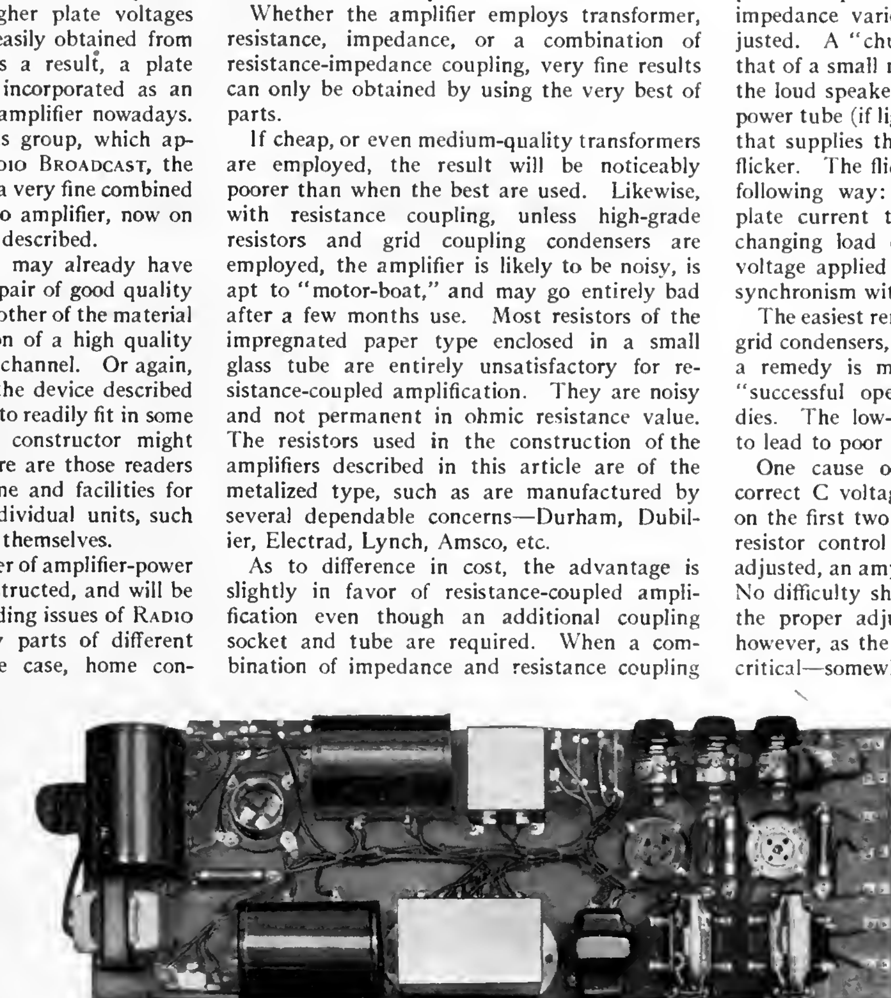
There will be no noticeable difference in quality output between the various amplifiers described in this article. All of the systems of amplification are fundamentally sound and capable of giving excellent results, provided good units are used. Follow the design data given in this article, use the products of reputable manufacturers and you may be sure that results will be satisfactory.

"MOTOR-BOATING"

MOTOR-boating is a rather accurately descriptive term applied to that condition into which some high quality a. c. operated power amplifiers of both the resistance and impedance variety get when not properly adjusted. A "chug-chug-chug" sound, similar to that of a small motor-boat engine, is heard from the loud speaker. At times the filament of the power tube (if lighted from the same transformer that supplies the B power) will be observed to flicker. The flickering may be explained in the following way: The "chugging" causes the plate current to vary considerably, and this changing load on the transformer makes the voltage applied to the filament rise and fall in synchronism with the "chugs."

The easiest remedy is to use very low-capacity grid condensers, but this is not desirable. Such a remedy is much in the same class as the "successful operation" in which the patient dies. The low-capacity condensers are bound to lead to poor quality audio amplification.

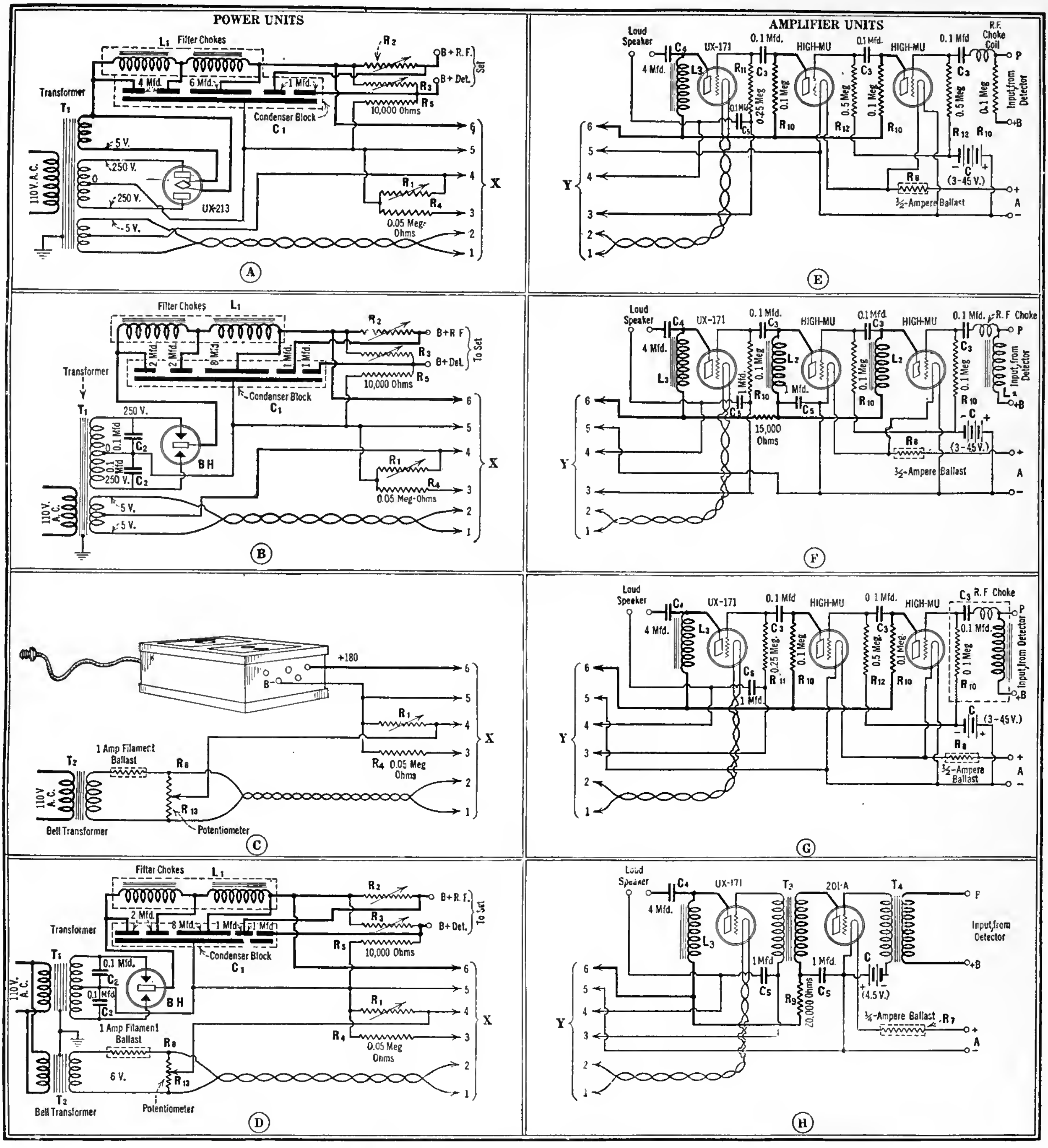
One cause of motor boating may be incorrect C voltage, but, if the grid bias voltage on the first two tubes and the grid bias voltage resistor control on the last tube are properly adjusted, an amplifier should not "motor-boat." No difficulty should be experienced in securing the proper adjustment of this latter resistor, however, as the proper ohmic value is not at all critical—somewhere around 2000 ohms in most cases. In fact, fixed resistors were employed with complete success for this purpose in some of the models made by the writer. If the value of resistance is too low, "motor-boating" results. If too high, the amplifier distorts and lacks volume. In the case of the special Royalty resistor made for this use and marked No. 1 in the Royalty kit, somewhere near the full value of resistance will in most cases result in most stable operation and best quality. The grid



RADIO BROADCAST Photograph

A TYPICAL AMPLIFIER-POWER SUPPLY UNIT

This unit, which is a combination of circuits D and H in the diagram on page 382, consists of a two-tube transformer coupled amplifier with Raytheon power supply. The power tube filament is heated by a separate bell transformer



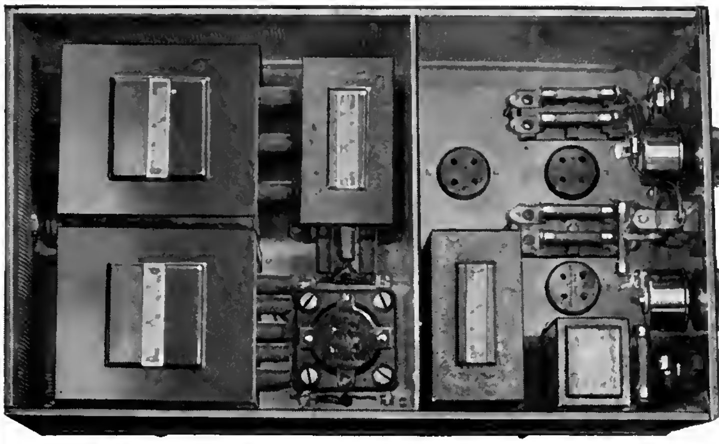
HOW TO COMBINE AMPLIFIERS AND POWER-SUPPLY UNITS

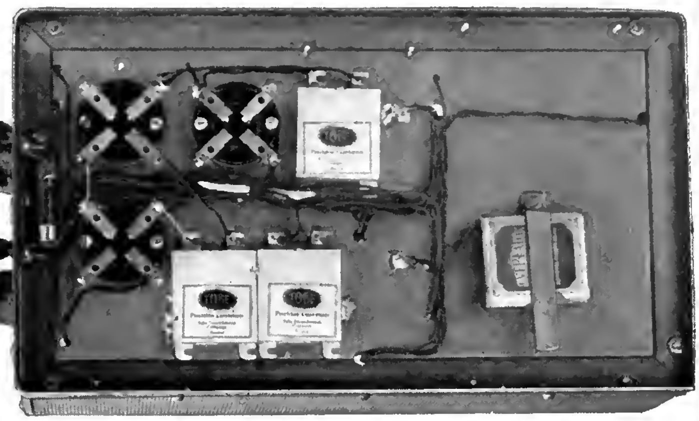
On the left of this diagram are given four power-supply unit diagrams for use in conjunction with either of the power amplifier circuits shown to the right of the diagram. That lettered "A" is the circuit diagram when a rectifier tube of the Rectron 213 type is employed. With this arrangement it is necessary to employ a power transformer with two filament windings, one to supply the current for the filament of the 213 tube and the other to heat the power tube filament in the amplifier used in conjunction with this power-supply unit. "B" is a power-supply unit employing a Raytheon filamentless rectifier tube. Only one filament wiring is necessary on the power transformer in this circuit—that to light the power-tube filament. "C" shows a standard so-called "B eliminator" with a separate filament-supply transformer as an additional unit. Diagram D shows a Raytheon filamentless tube used in conjunction with a power transformer which has no filament wiring whatsoever. A separate filament transformer is therefore included in the layout to supply the current for the amplifier power tube. Such an arrangement has been resorted to in the unit illustrated on page 381 and 384. All of these circuits, it will be seen, supply B potentials for all of the tubes in a receiver, including the amplifier tubes, grid bias for a power tube, and also filament current for the latter. Filament current and grid bias for the other tubes must be obtained from separate batteries. D, E, F, and G are standard amplifier circuits, each with an output device. The last tube in each case is a power tube, its filament current being pure a.c Either of these amplifier circuits may be combined with any one of the power units, A, B, C, D, by connecting the set of terminals marked Y with those marked X, joining the correspondingly numbered ones with each other. The lettering on the various parts is explained in the parts list for the amplifier-power units illustrated on other pages of this article. The amplifiers, from top to bottom, are: Resistance-coupled; impedance-coupled; combination impedance-resistance coupled; and transformer coupled

Radio Broadcast Photographs

THE LIST OF PARTS

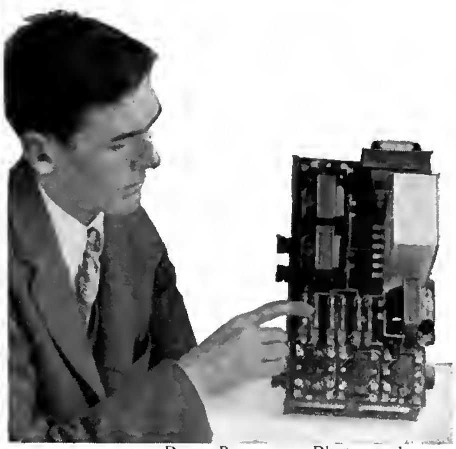
T_1—National Power Transformer	$ 16.50
L_1—National Filter Choke Unit, Type 35	7.00
C_1—National Filter Condenser Bank	17.50
C_2—Two Tobe No. 310 Buffer Condensers	1.40
C_5—Tobe No. 301 Bypass Condenser	1.25
C_3—Two Tobe No. 210 Coupling Condensers	1.20
L_3, C_4—National Tone Filter Unit	7.50
National Impedaformer	5.50
R_1—Clarostat Variable Resistor, Grid Bias	2.25
R_2—Clarostat Variable Resistor, R. F. Amplifier	2.25
R_3—Clarostat Variable Resistor, Detector	2.25
R_5—Tobe Veritas Fixed Resistor, 10,000 Ohms	1.10
R_4—Lynch Fixed Resistor, 0.05 Megohms	.75
R_{10}—Two Lynch Fixed Resistors, 0.1 Megohms	1.50
R_{11}—Lynch Fixed Resistor, 0.25 Megohms	.50
R_{12}—Lynch Fixed Resistor, 0.5 Megohms	.50
R_8—Amperite No. 112 Filament Ballast	1.10
Three Lynch Double Resistor Mountings	1.50
Two Electrad Short Jacks	.50
One Eby Socket	.75
Three General Radio Sockets	1.50
Four Eby Binding Posts	.60
Eveready No. 703 C Battery	.35
Brass, Bakelite	5.00
Wire	.50
Raytheon BH Tube	6.00
Two High Mu-Tubes	5.00
UX-171	4.50
Total	$ 96.25





NEATLY CONSTRUCTED AMPLIFIER-POWER UNIT

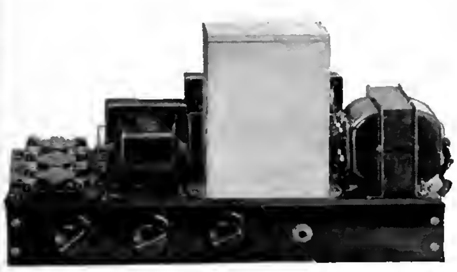
The form of construction used in this model is less costly than that employing a bakelite panel and a low-priced cabinet. A hack saw, hand drill, an old pair of scissors, and a soldering iron are all the tools necessary. The brass base plate, 10" x 14" x $\frac{1}{16}$", is fastened between two frames of angle brass, the lower of these being of $\frac{3}{4}$" angle brass and the upper $\frac{1}{2}$" brass. The sides, which are of perforated brass (as also is the top), are six inches high. Brass strip, $\frac{1}{2}$" x $\frac{1}{16}$", is used at the top and bottom to stiffen the perforated material. Note the shield separating the amplifier and power-supply sections of the unit. This device is a combination of circuits G and B in the diagram on page 382. The detector voltage is fixed in this particular model. When the r. f. and detector circuits require more than 10 mA., employ a National type 80 choke in place of the type 35 specified

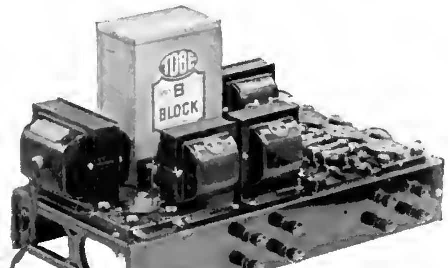


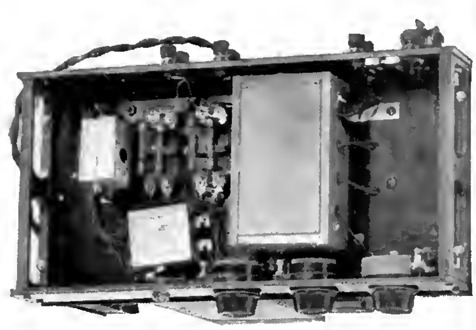
Radio Broadcast Photographs

THE LIST OF PARTS

T_1—Jefferson Power Transformer	$ 7.00
L_1—Two Jefferson Filter Chokes	8.00
C_1—Tobe No. 760 Filter Condenser	11.00
C_2—Two Tobe No. 310 Buffer Condensers	1.40
C_5—Tobe No. 301 Bypass Condenser	1.25
C_3, C_4—Mayolian Block Condenser	8.00
Samson R. F. Choke No. 85	2.00
L_3—Jefferson Choke	4.00
R_1—Royalty No. 1 Variable Resistor, Grid Bias	1.50
R_2—Royalty No. 2 Variable Resistor, R. F. Amplifier	1.50
R_3—Royalty No. 3 Variable Resistor, Detector	1.50
R_5—Tobe Veritas Fixed Resistor, 10,000 Ohms	1.10
R_4—Lynch Fixed Resistor, 0.05 Megohms	.75
R_{10}—Three Lynch Fixed Resistors, 0.1 Megohms	2.25
R_{11}—Lynch Fixed Resistor, 0.25 Megohms	.50
R_{12}—Two Lynch Fixed Resistors, 0.5 Megohms	1.00
Four Lynch Double Resistor Mountings	2.00
R_8—Electrad Rheostat, 10 Ohms	.85
Electrad Short Jack	.25
Four Eby Sockets	3.00
Eight Eby Binding Posts	1.20
Eveready No. 703 C battery	.35
Bakelite	3.00
Garfield-Radion Brackets	1.25
Wire	.50
Raytheon BH Tube	6.00
Two High-Mu Tubes	5.00
UX-171 Tube	4.50
Total	$80.65



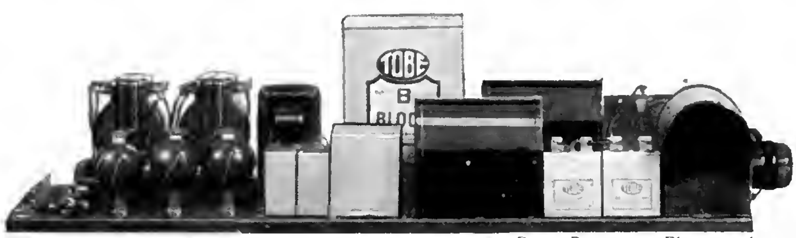




AN AMPLIFIER-POWER SUPPLY DEVICE USING SOME JEFFERSON PARTS

This unit is a combination of those circuits designated as E and B in the diagram on page 382. Three stages of resistance coupling, and a Mayolian coupling condenser block (shown in that photograph of the under-panel view) are employed. The Mayolian coupling condenser block consists of the three amplifier coupling condensers and the 4-mfd. tone filter condenser. Lynch metalized-filament resistors are used for inter-audio coupling purposes. The Jefferson parts include the power transformer and chokes bias resistor, whether it be the special No. 1 Royalty, a Clarostat, or a fixed resistor, should never be so adjusted or connected that there is less than about 1000 ohms in the circuit as, otherwise, a destructively high plate current will be drawn by the UX-171. In the case of the special Electrad "Royalty" variable resistors, stops are provided so that it is never possible to reduce the value of the resistance below a certain point. Few experimenters realize that a 171 tube will draw approximately 100 mils. of plate current at a plate voltage of 180 when the grid voltage is zero. Of course, where the plate current is obtained from an a. c. operated power-supply device, this full value of plate current will not be obtained due to the regulation of the rectifier-filter system, but the resulting current is, nevertheless, excessively high.

When the proper adjustment of the grid voltages does not stop "motor-boating," the trouble is generally due to a leaky grid condenser. A simple test to determine the value of the condenser (in most instances the one in the last stage causes the trouble) as far as insulation resistance is concerned, is as follows: Connect up the two terminals of the condenser to any high-voltage supply, such as a B battery, or a line power device, of 100 volts or more. Then disconnect the wires and allow the condenser to remain open for three or four minutes. At the end of that time, short-circuit the two terminals, and if the insulation in the condenser is good, a spark should be obtained. If the condenser is leaky, no spark will be obtained. A good condenser will, on a dry day, retain its charge for a considerable time.



RADIO BROADCAST Photograph

THE AMPLIFIER-POWER UNIT ALSO ILLUSTRATED ON PAGE 381

The following parts are specified for this combination (D and H, page 382): All American power transformer (T_1, \$5.00) and filter chokes (L_1, \$8.00); six-volt bell transformer (T_2, \$1.00); Tobe filter condenser block (C_1, \$11.00); Tobe 4-mfd. condenser (C_4, \$3.50); two Tobe 1.0-mfd. condensers (C_5, \$2.50); two Tobe 0.1-mfd. condensers (C_2, \$1.40); General Radio impedance (L_3, \$5.00); two Ferranti audio transformers (T_3, T_4, \$24.00); three Clarostats (R_1, R_2, R_3, \$6.75); Yaxley jack (\$0.50); Yaxley No. 200 potentiometer (R_{13}, \$1.35); Amsco double resistor mount (\$0.30); three sockets (\$2.50); Electrad 20,000-ohm resistor (R_9, \$1.00); Lynch 0.05 resistor (R_4, \$0.75); Amperite filament ballasts, 0.25 and 1.0 amp. (R_7, R_6, \$2.20); base-board, wire, Fahnestock clips, etc. (\$1.00). The tubes and C battery are considered as extras

Where the insulation resistance of a grid condenser is only poor and not definitely bad, the use of lower value grid resistors will stop "motor-boating." In the case of resistance-coupled amplifiers, or amplifiers in which an impedance is used only in the input circuit, one of the most certain, but yet seldom necessary methods of remedying the difficulty, is by the use of an impedance in place of the non-inductive grid leak in the last or power audio stage. The purpose of this impedance is to change the phase of the grid circuit by approximately ninety degrees. A convenient way in which to apply this remedy is to substitute for the double resistor mount, in the last stage of the resistance-coupled amplifier, a National Impedaformer. They both take up about the same base space. Where space is not a limiting factor, any impedance having an inductance of between 75 and 200 henrys may be used. If the National Impedaformer is used, disregard the markings on the terminal strip and connect the terminal marked P to the grid of the last tube, the terminal marked G to the plate of the next to last tube, the terminal marked plus A to the plus B supply, and the terminal marked plus B to the negative grid bias lead. As a coupling condenser is contained within the Impedaformer, the external one formerly used in connection with the double resistor mount is removed.

THE OUTPUT DEVICE

AN OUTPUT device of one sort or another is essential for the safe and satisfactory operation of a power amplifier. The output device, by keeping the heavy d.c. plate current from passing through the speaker windings, results in better quality and at the same time removes the possibility of damage to the delicate windings. Still another distinct advantage in using an output device is the elimination of the possibility of anyone receiving a serious shock upon coming in contact with exposed speaker terminals or metal jack parts.

There are two distinct types of output devices—the transformer type and the impedance-capacity unit form. The latter is the more preferable of the two for a. c. operated power amplifiers using the present-day tubes and the Western Electric 540 AW or similar loud speaker.

Perhaps the outstanding advantage of the impedance-capacity unit over the transformer is that the use of the former makes it possible to prevent audio frequency coupling of the plate circuit of the last tube with the plate circuits of the other tubes by means of the otherwise common plate impedance of the B power-supply device.

THE GRID BIAS FILTER

IN CONNECTION with the variable resistor (either a Clarostat or a No. 1 Royalty) used for obtaining the grid biasing voltage for the last tube, will be noticed the use of a 1-mfd. fixed condenser and a fixed resistor having a value anywhere between 0.05 and 0.1 megohms.

These may be noted in "E," "F" and "G" of the combination diagram on page 382. This fixed resistor-condenser combination forms a filter circuit which prevents the passage of audio frequency currents through the grid bias variable resistor. Should the audio frequency current pass through this resistor, a pulsating biasing voltage would be produced having such phase relations with the signal voltage applied to the grid of the last tube as to tend to partially neutralize or buck the signal voltage, and thereby reduce to a considerable extent the amplification which would otherwise be obtained in the last stage.

TUBES

THERE are at present three different double-wave rectifier tubes on the market which have been used with good results by the author. First, there is the 213 type. This is an excellent rectifier tube for use where the a. c. transformer voltage on each side of the high voltage secondary is under 250 volts and preferably about 225 volts. A power-supply circuit employing a 213 rectifier tube is shown in "A," on page 382.

With higher voltages, and currents in excess of 60 milliamperes, the life of the 213 is very materially shortened. The drop in voltage under the same conditions, of the 213 and the Raytheon BH, are almost identical. The difficulty to be encountered, however, in the use of the 213 as a rectifier, is the failure of most transformer manufacturers to provide an additional filament winding on their transformer for lighting the rectifier tube filament in addition to a winding to light a power tube filament, with raw a. c. Thus, except in the cases where the National, General Radio, or another transformer equipped with two filament windings, is used, it is necessary to choose between a filamentless rectifier tube, or an additional filament heating transformer. The Raytheon BH tube (which has no filament) is a fine rectifier and has the additional advantage over the 213 that it may be used with much higher transformer voltages and heavier currents without materially affecting its useful life.

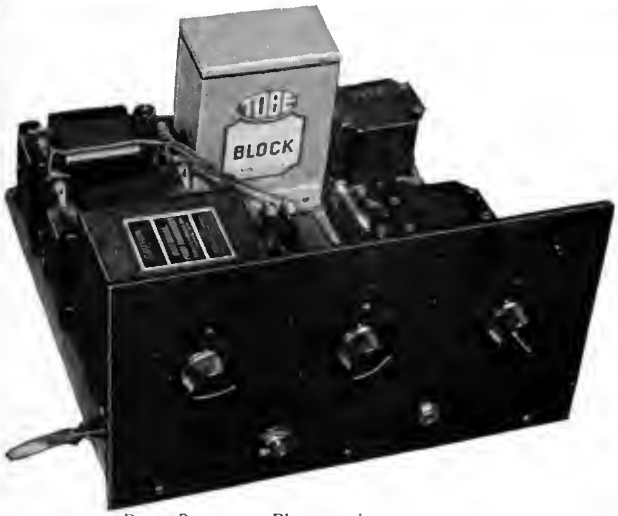
The main difference, electrically, between the B and the BH Raytheon tubes is that the voltage drop across the B tube is considerably more than across the BH tube. The B tube is rated at a maximum current of 60 mils whereas the BH tube is rated at 85 mils.

With Raytheon and similar filamentless tubes, it is necessary, for smooth operation, to use two small buffer condensers across the two sides of the high-voltage transformer secondary. These, in the diagrams on page 382, "B" and "D", are designated as C_2. The purpose of the condensers is to prevent internal tube arcing. If the capacity of these condensers is less than 0.1 mfd., they will not be sufficiently effective, while if they are much larger than 0.1 mfd., they will consume too much power from the line. The condensers must also be so designed as to withstand any high voltage surges to which they may be subjected. For this reason it is generally desirable to use condensers having an a. c. voltage rating of at least 1500 volts. The UX-213 does not require the use of buffer condensers as it functions on a different principle.

In the resistance- and impedance-coupled amplifiers, high-mu tubes will in most cases be found to give the best results. Occasionally, however, when the receiver is located close to a powerful local broadcasting station, and no means of volume control is employed on the r. f. amplifier, it is possible to overload the second high-mu tube. The use of a 201-A in the second stage will overcome the trouble, but a better solution is to reduce the volume slightly by means of some sort of volume control on the r. f. amplifier, preferably a filament rheostat.

When dry-cell tubes are used in the set proper, and it is desired to use dry-cell tubes in the first and second audio stages too, quite good results can be had by using the new CeCo high-mu 199 type tubes. The tube to use in the last stage is the 171 type.

In the case of a transformer-coupled amplifier, a 201-A should be used in the first stage and an UX-171 in the second, or power, stage. It is not advisable to apply the full amplifier voltage (180 or so) to the first tube in a transformer amplifier. A lower voltage may be obtained by means of a fixed resistor, as shown in "H," on page 382 and designated as R_9.



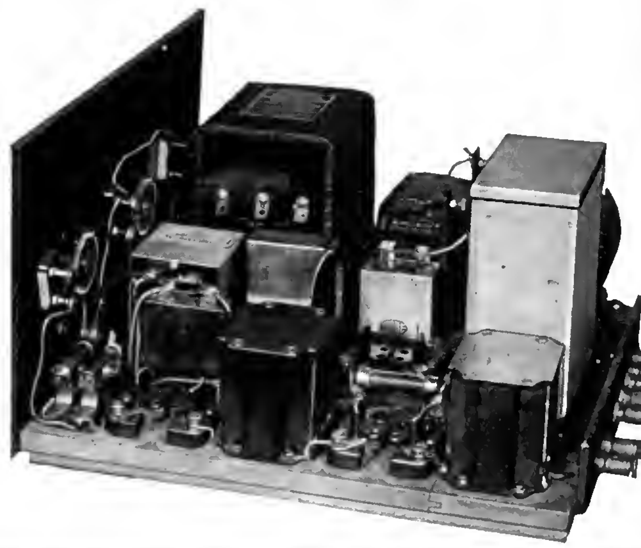
Radio Broadcast Photographs

THE LIST OF PARTS

T_1—National Power Transformer	$16.50
L_1—Two Amertran Filter Chokes	12.00
C_1—Tobe No. 760 Filter Condenser	11.00
C_2—Two Tobe No. 310 Buffer Condensers	1.40
C_5—Two Tobe No. 301 Bypass Condensers	2.50
L_3—Samson Choke, Type 0	5.00
C_4—Tobe No. 304 Condenser	3.50
T_3, T_4—Two Amertran Audio Transformers	20.00
R_1—Royalty No. 1 Variable Resistor, Grid Bias	1.50
R_2—Royalty No. 2 Variable Resistor, R. F. Amplifier	1.50
R_3—Royalty No. 3 Variable Resistor, Detector	1.50
R_5—Tobe Veritas Fixed Resistor 10,000 Ohms	1.10
R_9—Electrad Heavy Duty Fixed Resistor 20,000 Ohms	1.00
R_4—Electrad Fixed Resistor, 0.05 Megohms	.75
R_7—Elkay Equalizer No. 4.	.75
Muter Double Resistor Mounting	.50
Yaxley No. 760 Switch	1.20
Electrad Short Jack	.25
Three Airgap Sockets	2.25
Seven Binding Posts	1.05
Eveready No. 703 C Battery	.35
Base-Board	.50
Bakelite Panel	1.50
Wire	.50
Raytheon BH Tube	6.00
UX-201-A Tube	1.75
UX-171 Tube	4.50
TOTAL	$100.35

A UNIT WITH TRANSFORMER-COUPLED AMPLIFICATION

Amertran Deluxe transformers, Amertran chokes, Tobe condensers, and a National power transformer have been incorporated in the unit. It is a combination of circuits H and B as shown in the diagram on page 382. A Yaxley No. 760 double-pole single-throw "short jack" type of switch is mounted on the panel so as to control both the 110-volt house current and the storage battery, or A power, unit. This result is accomplished by using one switch lever and its associated stationary contact in the 110-volt line to the transformer and the other lever and contact in the A-power line. The case of the power transformer, the cases of the condensers, and the cores of the chokes, should all be connected together and grounded



THE LIST OF PARTS

T_1—Mayolian Power Transformer	$ 9.50
L_1—Two Mayolian Filter Chokes	10.00
C_1—Tobe No. 760 Filter Condenser	11.00
C_2—Two Tobe No. 310 Buffer Condensers	1.40
C_5—Tobe No. 301 Bypass Condenser	1.25
C_3—Three Tobe No. 210 Coupling Condensers	1.80
L_2—Samson Choke, Type 0	5.00
C_4—Tobe No. 304 Condenser	3.50
Samson Plate Impedance	5.00
Samson R. F. Choke, No 85	2.00
R_1—Clarostat Variable Resistor, Grid Bias	2.25
R_2—Clarostat Variable Resistor, R. F. Amplifier	2.25
R_3—Clarostat Variable Resistor, Detector	2.25
R_6—Tobe Veritas Fixed Resistor, 10,000 Ohms	1.10
R_4—Lynch Fixed Resistor 0.05 Megohms.	.75
R_{10}—Three Lynch Fixed Resistors 0.1 Megohms	2.25
R_{11}—Lynch Fixed Resistor 0.25 Megohms	.50
R_{12}—Lynch Fixed Resistor 0.5 Megohms	.50
R_8—Amperite No. 112 Filament Ballast	1.10
Lynch Single Resistor Mount	.35
Four Lynch Double Resistor Mounts	2.00
Electrad Short Jack	.25
Four Air-Gap Sockets	3.00
Six Binding Posts	.90
Eveready 703 C Battery	.35
Brass Mounting Material	.80
Base-Board	.35
Bakelite	.65
Wire	.50
Raytheon BH Tube	6.00
Two High-Mu Tubes	5.00
UX-171 Tube	4.50
TOTAL	$ 87.55

Radio Broadcast Photographs

A COMPACT ARRANGEMENT OF APPARATUS

Hollow bases on the Mayolian power units, make it possible to run wires between them and the base. The bend in the $\frac{1}{16}$-inch brass base plate can be made by the local tinsmith. This unit is a combination of circuits G and B as shown on page 382. The buffer condensers are located in the space under the transformer base

Notes on the Shielded Dual-Control Receiver

Some Trouble-Shooting Hints on the Receiver Described in the October Issue—How to Distinguish Between the Two Types of Coils Employed—Where to Expect Trouble in the Volume-Control Resistance—What Kind of Antenna to Use

By McMURDO SILVER

GETTING THE "SIX" READY FOR OPERATION

In conjunction with a Balkite trickle charger, a storage battery, a line power-supply device, and a Yaxley automatic switch. "Zero left" dials were specified in the original article, October, 1926, so as to have the dial readings increase with increasing frequency. If the builder prefers to tune by wavelength and have the long wavelength stations tune-in on the upper instead of the lower part of the dial, counter clockwise dials should be procured

THE data presented herewith are intended primarily for those readers of RADIO BROADCAST who have built the receiver described in the October, 1926, issue, under the title of "A Shielded Dual-Control Receiver." This present article deals particularly with methods for insuring that the best operation of the outfit is obtained, and, in a measure, it might very well be termed a symposium, for it presents in condensed form the information and suggestions gleaned from several thousands of builders who have already constructed the "Shielded Six." While some of these home constructors have commented unfavorably on the receiver, the majority has been very satisfied with the results obtained.

The author has one of these receivers, built from standard store parts, in operation in his home in Chicago. This set is situated about two miles from KYW, one and one-half miles from WMAQ, three miles from WEBH and WQJ, a thousand yards from the Moody Bible Institute station WMBI, and, in addition, in the center of the Chicago hotbed of some twenty stations. So situated, it is possible to tune-in Schenectady, Pittsburgh, Detroit, Davenport, Fort Worth, Cincinnati, Denver, and many other stations on almost any evening. Station KFI, Los Angeles, has been heard with a ten-foot wire as an antenna.

One of the first points to come up in connection with the building of the receiver was the fact that the four inductance coils, or radio frequency transformers, look very much alike, and once they have been removed from their cartons carrying the different type markings, many builders have found it impossible to tell them apart. This is unfortunately a serious condition, for if the coils are improperly inserted in their sockets, that is, if the antenna coil is placed in one of the radio frequency stages, there will be a short-circuit which will burn out one of the windings on the antenna coil. It is very important that the 115A coils be placed in the three right-hand coil sockets of the receiver, as viewed from the front. The 116A coil should be placed in the left-hand (first r. f. stage) or antenna compartment of the receiver. Reference to Fig. 1 will explain how to tell the 115A from the 116A.

THE VOLUME-CONTROL RESISTANCE

IT IS very important that the volume-control resistance, or 25,000-ohm Hi-Pot, be exactly as specified—a Carter 25,000-ohm No. 25. It should be carefully tested with headphones and battery, and clicks should be obtained on all contacts. It will be found that a comparatively weak click will be gotten between terminals Nos. 1 and 3, whereas a strong click will be obtained between terminals Nos. 1 and 2, if the contact arm is turned around close to terminal No. 1. As the contact arm is turned away from No. 1, and toward No. 3, the strength of the click will decrease. This is correct, and the same condition will apply between terminals Nos. 2 and 3.

Should a 500,000-ohm standard potentiometer be used in the receiver instead of the 25,000-ohm one specified, trouble is bound to develop. The receiver will not be sensitive for distant stations, will be very unstable and prone to oscillate continuously.

Every Carter No. 25 Hi-Pot is supplied with two insulating washers having small projections which fit inside the actual panel and chassis holes intended to receive the shaft bushing of this resistance. One washer should be placed on the inside of the chassis and one on the outside of the panel. If this is done, there is no danger of a short-circuit between the chassis and volume-control resistance, providing also that the three arms of the Hi-Pot carrying the binding posts are bent up and away from the chassis when the resistance is in place in the receiver assembly. In other words, none of the metal parts of the Hi-Pot should touch the chassis or the front panel.

FIG. 1

The difference between the 115A coil at the right and the type 116A coil at the left may easily be told. The differentiating characteristic is the slot at the bottom of the winding form through which light is visible in the left-hand coil, whereas, in the right-hand coil, the slot is completely filled with the wire turns. These coils must not be interchanged in the receiver, for the 116 A coil, if placed in the wrong socket, will cause damage. At the present time, long-wave coils, to adapt the "Shielded Six" for reception between 500 and 3000 meters (600 and 100 kc.), are not obtainable, but the writer will furnish data for such coils to anybody writing for it. The set will not function well below 200 meters (1500 kc.)

THE 200-OHM BALANCING RESISTANCES

THE 200-ohm balancing resistances, connected between terminals No. 3 of the radio frequency coil sockets and the grid posts of the radio frequency tube sockets, need not be exact in their resistance values, and may vary at least five per cent. either way. These resistances should be tested before the receiver is put in operation with head phones and battery, a click being obtained between the mounting clips when they are touched with the battery lead and phone cord tip. Either Carter or Yaxley resistances can be used in this position, but it is important that they be wire-wound resistances and not graphite, carbon, or deposit types of resistances, for the inductive effect provided by the wire-wound resistances assists in the operation of the receiver.

ASSEMBLING THE SHIELD TOPS

THERE is a slight trick to fitting the shield tops down over the tubes, coils. and variable condensers, and getting the edges to fall well inside of the edges of the shield pans. One precaution must be observed, and that is to leave at least a $\frac{3}{32}$ to $\frac{3}{16}$-inch space between the front lock collar of the variable condensers and the lock collars of the link motion, in which space the front edge of the shield body must fit.

If a shield is taken in the right hand and dropped down into its proper pan, this should be done with the front end inclined downward. Thus, the front end of the shield top can very easily be fitted inside the front edge of the shield pan and pushed down, while the rear end of the shield top stands above the edge of the pan. If the hand is then transferred to the back side of the shield and pushed forward slightly toward the panel, it will be found that this rear side may be slipped down very easily inside the up-standing edge of the shield pan.

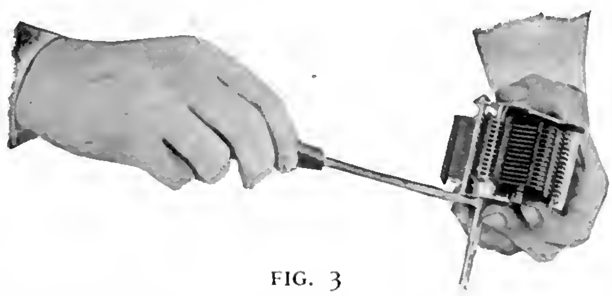


FIG. 3

How to loosen the lock collars on the variable condensers so that the shaft may be re-positioned or the compression on the small spring washer tightened up. Pressure is exerted by the thumb and fingers of the left hand on the rear end of the shaft and on the lock collar respectively

SELECTIVITY AND QUALITY

IN THE "Shielded Six" every possible endeavor has been made to obtain as perfect quality of reproduction as could be gotten. It is the writer's belief that the design has not failed in this matter for this belief has been borne out by the enthusiastic comments of builders of the receiver. Nevertheless, in any radio receiver, a certain amount of extreme selectivity must be sacrificed if thoroughly good quality of reproduction is to be obtained. This is because the radio frequency circuits are essentially band selection filters designed to accept and pass a band of frequencies such as would be required for proper transmission of voice and music, and to reject all other frequencies falling outside of the particular band tuned to at the moment.

Obviously, if the receiver is designed to be very selective, the band will be so narrow that the higher frequencies in music will be cut off: while, if the band is too broad, several stations operating at different frequencies will be received. A very considerable amount of time and energy was devoted to this single consideration in the design work, and it is believed that the "Shielded Six," giving selectivity sufficient for the most congested broadcasting centers of the country, should be entirely satisfactory to the average builder irrespective of the locality in which it is used.

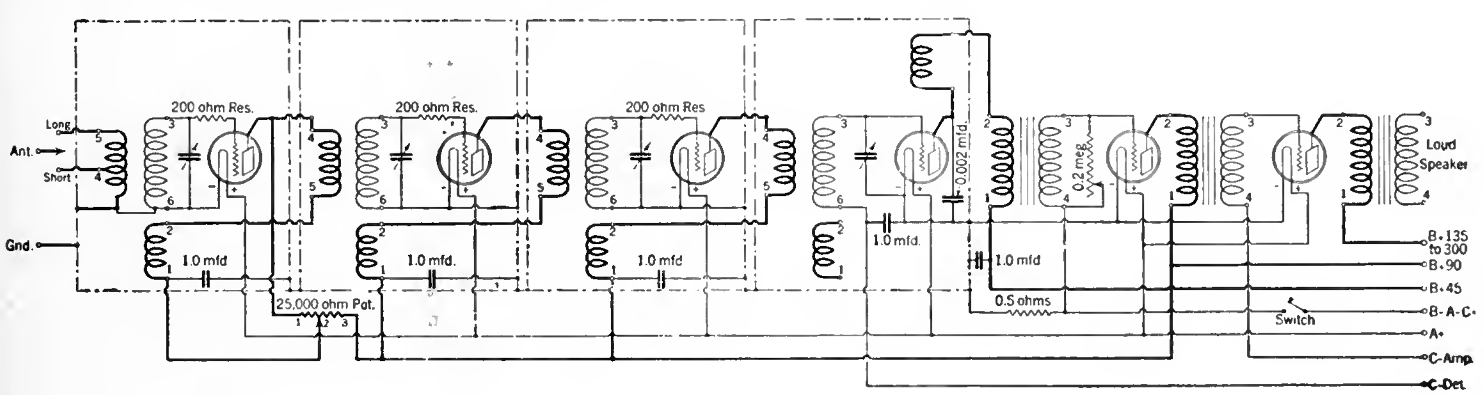


FIG. 2

This is the circuit diagram of the "Shielded Dual-Control Receiver" as described in the October, 1926, RADIO BROADCAST. The shielding is indicated by the dotted lines. The volume-control potentiometer may be seen to the left of the diagram between the first and second tubes. The second, third, and fourth condensers are controlled by one knob

THE ANTENNA

THE use of an antenna much over 70 feet is not recommended with the "Shielded Six." It has been found in Chicago that a ten-foot antenna would give ample volume on local stations, and will allow the reception of some out-of-town stations. A thirty-foot antenna will give very satisfactory results and will frequently bring in West Coast stations with fair loud speaker volume. A seventy-foot antenna will give all that can be desired in the way of results. In practically all cases the antenna switch should be kept turned to the "short" position, which represents loosest coupling between the antenna and receiver, since in this position of the switch, selectivity will be greatest and reception most free from static or other atmospheric noises. The "long" position of the switch should only be used when few local stations are operating or with a very short antenna, say, one from ten to thirty feet long. The "Shielded Six" may be used with an indoor antenna of from ten to fifty feet in length, consisting of a single wire run around the picture moulding or otherwise disposed of to suit the owner. A water-pipe ground may be used, and if it is desired to dispense with an antenna altogether, another piping system other than that used for the ground connection may be used for the antenna. Thus gas and water-pipe systems, or water and steam-pipe systems, would serve nicely for both antenna and ground. An electric light socket antenna plug may be used.

BOOSTING DETECTOR CAPACITY

DUE to the fact that there is no radio frequency load in the plate circuit of the detector, the effective grid to filament capacity is considerably lower than that of the three radio frequency amplifier tubes. It is therefore sometimes advisable to connect a condenser made of, let's say, two two-foot lengths of ordinary insulated magnet wire tightly twisted together, between the shield and terminal No. 3 of the detector coil socket in the detector stage compartment. Of course, one end of each wire should be left free and disconnected in order that the capacity formed by the two adjacent wires may not be short-circuited.

CONDENSER ADJUSTMENT

THERE is one factor which will affect the selectivity, and, for that matter, the operation of the entire receiver—the condenser, ganging and adjustment. As the condensers recommended for the receiver leave the factory, they have all passed mechanical and electrical inspections which insure that, if received by the builder undamaged, their uniformity is such that they will operate in any gang control circuit quite satisfactorily. The possibility of their being slightly strained in transit or in assembly is not remote, although every endeavor was put forth in their design to produce a rigid and substantial mechanical assembly. Upon receipt, the condensers should therefore be carefully examined before being placed in the receiver. The link motion should be slipped over the shafts of the three condensers as shown in the photograph on page 495 of the October issue, after which they should be adjusted as follows: The rotor plates of all condensers should be inter-

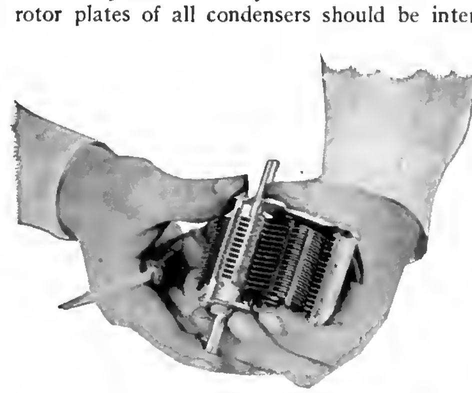


FIG. 4

Pushing the shaft into a new position. Once the shaft has been located as desired, the whole assembly is re-locked by means of the two set screws visible in the rotor shaft collars. Needless to say, if this adjustment is made according to instructions in this article, no change in the capacity characteristics of the condensers will occur

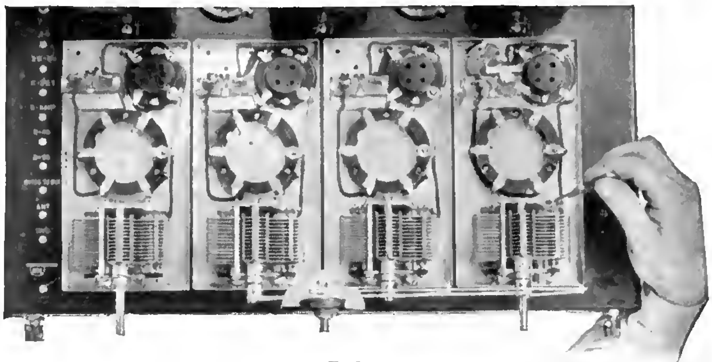


FIG. 5

Note how the bypass condensers have been placed touching both the coil socket and tube socket. Some of the condensers manufactured since this receiver was first described, have mounting lugs that will not exactly match those in the chassis and shield pan. This can be corrected by clipping out whatever parts of the mounting lugs get in the way of the fastening screws. This photograph also shows how a condenser damaged in transit should be adjusted so as to obtain perfect interleaving of the rotor and stator plates

leaved with the stator plates, and carefully examined at each side to see that they interleave centrally. They should then be turned approximately all the way out so that stators and rotors overlap but half an inch along their periphery, and should be re-examined. It is vitally essential that at this point the rotors interleave absolutely centrally with the stator plates. If they don't, a small wrench should be procured—such as will be found with all of the later B type condensers—and the lock nuts on the brass rods, to which the stator plates are soldered, loosened up, as these lock nuts serve to hold the brass stator bars tightly in position in their mounting holes in the bakelite insulating strips on each end plate.

When these nuts are loosened up, the entire stator plate section at one side may be shifted either forward or backward and thus moved to a position where the rotor plates interleave absolutely centrally with the stator plates on this right-hand side. With the two nuts on the rear end of the stator rod left loose, the two nuts at the front end should be tightened up on either side of the bakelite strip until they are quite tight against it, and hold the stator rod definitely in position. If first one nut is tightened half a turn, and then the other tightened likewise, it will be found that the stator plate section can be permanently locked in a position where the rotors will interleave centrally with it. The two nuts on the rear of the tie bar locking on either side of the rear bakelite insulating strip should then be moved up half a turn at a time until they are tight against the rear bakelite insulator, so as not to impose a "thrust" or "pull" between the two insulator strips. This operation is really extremely simple and can be easily accomplished since the condensers are specifically designed to permit of such adjustment by the user should the occasion require. Once the adjustment has been made, let's say, on the right-hand or low side of the condenser, the adjustment may afterwards be made on the left side stator rod so that the rotor plates interleave centrally with the stators when the plate sections are entirely engaged.

As previously remarked, an adjustment of this nature should seldom be necessary, but it is always an excellent idea, after the receiver has been assembled and the link motion put in place, simply to check over each condenser with the small wrench provided, and make absolutely sure that undue strain has not been imposed on the condensers either in transit or in assembly.

Several builders of the "Shielded Six" have noticed that the length of the condenser shafts may be easily varied. This is a feature of the condensers recommended for the set, and the shafts may be pushed either forward or backward in the condensers to any desired position. This is accomplished very simply by loosening the set screws in the lock collars on the shafts, pushing the shafts into the desired position and then performing the operation illustrated in Figs. 3 and 4. The rotor plate section lock collar should have its screw tightened up on the shaft in the position desired by the builder. Then, holding the condenser in the left hand, as shown in the photographs, with the thumb upon the rear end of the shaft, and the second and third fingers of the hand pushing the lock collar on the front of the condenser toward the thumb, the set screws in this collar should be locked up tightly. This will compress the small spring washers between the front lock collar and the frame, and will eliminate entirely any play which might creep in were the hand pressure not exerted. Several photographs (Figs. 5 and 6) accompanying this article indicate how this adjustment may be made.

The ganging of the condensers in the receiver is extremely simple and has been outlined in the previous article. A photograph (Fig. 7) indicates exactly how the builder would view them to arrive at the proper adjustment of each one before the link motion should be locked to the three condenser shafts by means of the set screws in the link motion collars.

Another feature which may come to the builder's attention is the fact that the front edge of each shield pan will have to be pressed forward a fraction of an inch to allow for the bottom mounting studs on the front end plate of each condenser. This is an intentional part of the design, the shields and condensers having been so made that, if necessary, a screw can be put through an ordinary mounting panel into the upper mounting stud of the condenser, which, if tightened up against the front panel, would thus serve to clamp the front edge of the shield pan between the bottom mounting lug, and the front panel.

Should the builder endeavor to operate the "Shielded Six" with a standard B power-supply device (battery eliminator), the connection of a 5-to 15-microfarad condenser across the high-voltage output of the battery eliminator, or possibly across the detector output, will be necessary should there be any tendency for the combination of power-supply device and receiver to howl or produce a "motor-boating" sound in operation. Such noises would be due to the high internal resistance of the eliminator, which, being common to the plate circuits of all the receiver tubes, would serve to couple these plate circuits together and cause audio oscillation. A second caution concerns the purchase of an eliminator with a sufficiently high power output to operate the receiver properly, which requires approximately 25 to 35 milliamperes when a 171 tube is used, with 180 volts plate potential.

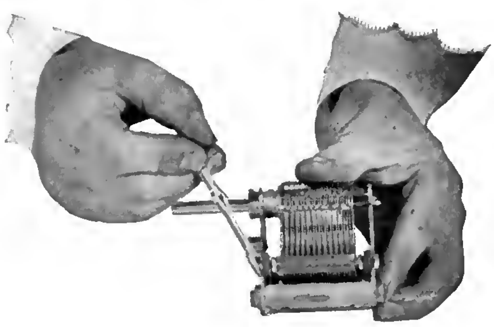


FIG. 6

The details of the plate spacing adjustment. Notice the small wrench, on one of the lock nuts which determine the position of the stator plate assembly

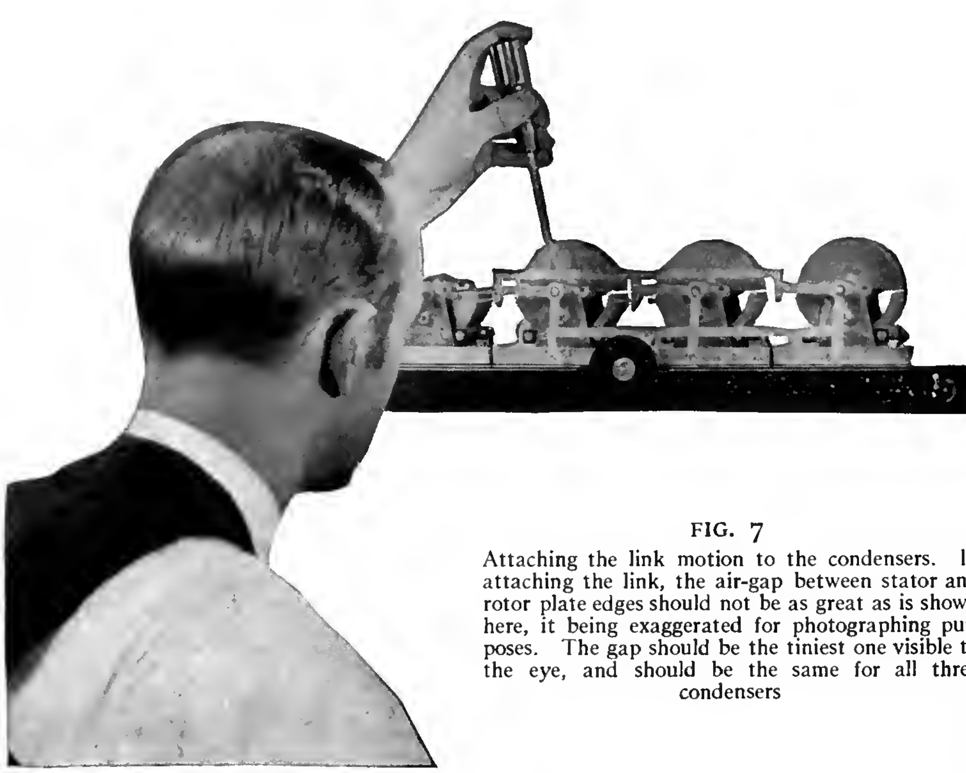


FIG. 7

Attaching the link motion to the condensers. In attaching the link, the air-gap between stator and rotor plate edges should not be as great as is shown here, it being exaggerated for photographing purposes. The gap should be the tiniest one visible to the eye, and should be the same for all three condensers

Drawings by Stuart Hay

The Broadcast Program—Pinnacle of Impermanence

IN THE conversation of a group of broadcasters the other day, there bobbed up the sad theme of the transitoriness of radio performance. There are, to be sure, elements of permanence—or what passes for permanence in this dizzy world—even in broadcasting. Artists come and go, announcers appear and vanish, wavelengths change, but the call letters of the station usually stay put, and are chanted, sometimes, year after year, until people know them as well as the streets they live on. Then, also, when a sponsoring concern pays for a program week after week, a type of permanence is attained, on which, of course, the advertising value of such a series is based.

These elements of fixity may be conceded, yet there is about broadcasting something of the nature of spring freshets, young love, and public esteem. Certainly such comparisons do not appear purely literary when one considers the amount of preparation required for a first-rate hour of broadcasting. The actors or artists are engaged, contracts are signed, a continuity is written, the orchestra rehearses, the announcer goes over his lines. A vast number of technical details must be worked out. The work of ten or twenty people may be required for several days, and anything from a few hundred to a good many thousand dollars may be spent. The setting up and testing of the wire network, if a number of stations are broadcasting, is itself an imposing task. Finally the program is sent winging through the air for its brief sixty minutes. A few hundred or a few thousand letters come in. The advertiser who put up the money reaps the benefit for some time. But what of the "show" itself—where is that? Where are the snows of yesteryear, as the poet asked? Where are the sparks that flew up the chimney last Christmas, where are the rosy cheeks of the pretty girls of the fifteenth century, where is the verdure of the hanging gardens of Babylon? That's where the broadcast hour is—nowhere. The snows, the sparks, the girls, and the gardens went there fast, but nothing ever went faster than a radio performance. It is of the essence of a jazz age, the most intangible, imponderable, evanescent thing that the restless brain of man ever created. The insects that live an hour are not more ephemeral.

But what of it? The 8-9 hour is dead; the 9-10 hour takes the air, and a hundred thousand loud speakers vibrate to its strains. The king is dead, long live the king! Step lively, king!

The Broadcaster and the Public

BROADCASTING is a public service, purveying sweet sounds and interesting noises to the multitude. Professional broadcasters earn their living through the public, and are bound to preserve a courteous demeanor toward their clients. And, in general, they feel very amiable toward the customers, who in their turn, treat the broadcasters with more than due consideration, and sometimes bestow on them rewards clearly beyond their merits. There are, however, occasional exceptions to these rules. If you have doubts, ask the telephone operator or hostess at any broadcasting station. Some of these girls have, decidedly, more sense and amiability than a lot of the people at the ends of the lines they connect. I am indebted to one of them, Miss Grace McKevitt, for most of the material in this discussion.

Generally speaking, if a listener calls up a broadcasting station about any matter connected with the material broadcast by that station, his request for service is legitimate enough. For example, when a lady telephones to explain that her baby cried during the recipe broadcast, and would the station mind telling her whether the spaghetti should be boiled or baked, her request is a reasonable one. The station wants its listeners to get the recipe, and babies will cry.

But it is annoying when people call up one station, or pay it a visit of state, in order to ask questions about another. The feeling between the stations may be amiable enough, but how can one be expected to know the internal and external policies, personnel, and history of the other, and why should it devote time to such matters? It has troubles enough of its own. No one thinks of calling up one shoe-polish firm to ask about the product of a competitor, but in broadcasting an appreciable number

"THE KING IS DEAD. LONG LIVE THE KING!"

of listeners think nothing of consulting one broadcasting station in regard to matters which are purely the concern of some other station. They ask questions about some announcer who once enchanted them with his cooings over the other fellow's carrier wave, and appear astonished and injured when no adequate answers are forthcoming. Their view seems to be that all broadcasting stations are united in one great fellowship for the pleasure of the listeners, and, anyway, broadcasting is so miraculous that ordinary social and business procedures do not apply in its field. As a matter of fact, there is as much rivalry and self-interest, enlightened and unenlightened, in broadcasting as in any other art or industry. Poets, musicians, surgeons, lobster-canners, preachers, and broadcasters all compete for public favor—broadcasters, just as much as the others, aspire for a place in the center ring of the communal circus. The broadcasters, if anything, have a harder time; in a business in which the economic basis is still somewhat unsettled, many of them do the work of two employees cheerfully, and it is unreasonable to load them with extraneous imbecilities.

A great number of listeners appear to have no notion, as yet, that there are such things as service organizations for owners of radio receivers, and that service is a specialized function requiring experienced personnel. In this benighted state, five years behind the times, they can think of nothing better to do, when their receivers get out of order, than to call up their favorite broadcasting station. They are astonished to learn that the engineers there know practically nothing about the Muddle Manufacturing Company's twelve tube set, and can't diagnose its troubles over the wire. Aren't they radio engineers? The idea that no one but the Muddle Company's technical experts knows anything about that receiver (and maybe the Muddle engineers don't know much themselves) does not seem to enter their heads. Of course, there are always the people who know quite well what they are doing, which consists in trying to get something for nothing. A service man will charge $1.50 for his advice; the broadcast station may do the job for the cost of a telephone call.

The SOS Question Again

ONE of the radio critics commends the practice of a certain broadcasting station coming in on the air at intervals during sos shutdowns with its call letters, and the reason for its silence. I am moved to disagree on this matter.

I have mingled in radio circles many moons, and most of them were in the period before Christian Science, symphonic jazz, and tire advertisements vibrated through the ether. The nefarious dots and dashes which sometimes spoil the pleasure of the BCL's were then the only burden of the wireless waves. It is my belief—and I call on all the presidents of the Institute of Radio Engineers from R. H. Marriott forward, and all the wireless operators who have leaned on a key since David Sarnoff forsook his, to support and defend me—that such a practice as the one commended by the radio critic *may* work harm to an sos sender.

Almost two years ago I urged, in this department, a revision in the regulations governing sos traffic as far as broadcast stations are concerned. What I proposed was, briefly, that some scientific discrimination be exercised in requiring broadcasters to shut down. Some, whose power is great, who are located near the coast, and whose frequency is near the marine band, may cause interference with sos traffic. They should be required to shut down promptly and to stay that way. Others, situated inland, or with lower power and higher frequency, may not be at all dangerous to sos communication, and they might as well be allowed to remain on the air. Some of the relatively feeble, short-wave telephone stations do transmit right through sos periods, even on the coast; and of course there has never been any general practice of shutting down a few hundred miles inland. I proposed the use of a mathematical formula to differentiate between harmless and potentially dangerous stations, but probably a more low brow method will work out just as well. I recount all this merely to show that I am rather liberal in this matter, and should not be confused with one of the die-hards who cry that if a tug-boat in the harbor of Bangkok sends an sos on a buzzer, the skipper having stubbed his toe, every radio station in the world must shut down for 24 hours. What I say is simply that, if a station does go off the air when an sos is transmitted, it classifies itself as a potential source of interference, and if thereafter it lets out a single peep it may jam a vital call letter or position figure. Either the transmitter should remain on the air with a good conscience, or else it should get off the air in all haste and not move a wheel until the danger is over. There is no compromise.

Broadcasting and Shows

IN BROADCASTING we often speak of a good program as a "fine show," borrowing the term "show" from the theatrical business, where things are seen as well as heard, and, thank heaven, sometimes look better than they sound. Employed in broadcasting, the term is a misnomer, albeit one of those natural ones which may ultimately establish itself in the language, over the objections of the purists. Be that as it may, real "shows" sometimes fall to the lot of the broadcaster; he is required, to put on the air something intended primarily to be seen as well as heard: a theatrical performance, a banquet with musical trimmings, a political meeting, or something else on that order.

The results, from the broadcasting standpoint, are always more or less dubious. No man can serve two masters, according to Scripture. The text was not written about broadcasting, but it holds just the same. The effort to astound and thrill an audience present in the flesh, as well as the larger audience present only with their ears, is always a risk, and frequently a mistake. Broadcasters turn out their best performances—and certainly they are most at their ease, when they are allowed to run things to suit themselves. In a studio, on his own carpet, within his own padded walls, with the microphone where he wants it and the musicians submissive at union rates, the broadcaster is able to work. He can do the job properly, the conditions being under his control. Then he best serves the listeners, and retires to his suburb tired but happy. But think of what he goes through when his enterprise is merely a by-product.

A merry banquet, say, where the anti-Volsteadian sentiments of the diners are given rein, and everybody is happy, ready to laugh at and applaud everything. They have eaten, they have drunk, and now they lean back to listen to a noted soprano, who has also eaten and drunk. Understand me—the lady is in no unseemly condition; she can walk, slap her escort, talk correctly to the pastor of her church, and sing; but she could sing even better if she had fasted for the past three hours. She is ravishingly beautiful, but that doesn't help the radio listeners. Facing a large audience which flatters her with deafening applause (they would probably applaud the ex-Kaiser, Leon Trotsky, or the late Carrie Nation, in the state of happy digestion in which they find themselves), the soprano puts her best leg forward. She has two good ones, and she uses both, in fact. In other words, she acts. This is perfectly natural, but bad for the microphone, which is unable to follow the lady in her prancings. A stationary *Carmen* suits it better. The announcer is also on the platform, and he likewise does his stuff like a fencing master. Goaded by one of the broadcast functionaries listening on the outside and barking his commands over the order pair, one of the technical crew manages to clutch the coat tails of the announcer as he circles near the wings. Half his announcements are not going out, he is told, and the piano-soprano imbalance is such that the station engineer is writing his last letters in preparation for jumping off the towers; two hundred threatening telephone calls have been received. But nothing sounds very bad when one has ten or fifteen cubic centimeters of good ethyl alcohol under one's belt, and Mr. Announcer has at least that. He reforms for about two minutes, and then forgets it. Everybody in the ballroom is happy, and two thousand people clapping their hands, with twenty reinforcing this genteel form of appreciation with loud yells of approbation, somehow impress one far more than fifty thousand disembodied spirits sitting quietly around the table lamps. Out of sight, out of mind, it is said. But for broadcasters there could hardly be a worse motto. Shows generally lead to it. Hence if they are wise, program managers will go easy on booking great spectacles; they breed grand flops on the air.

Personal Note by the Author

IN HIS scintillating radio column, which vies with the tabloid newspapers in amusing me on Saturday afternoons, Zeh Bouck implied recently that I was not educable, having been in radio eighteen years without showing signs of cultural eminence which would put me on a par with Thomas Aquinas, Spinoza, Upton Sinclair, and the M. Bouck himself.

The observation is correct, but Mr. Bouck is wrong as to the cause. The fact is that recently I had my brain taken out and examined by a committee of distinguished craniologists. Doubts had begun to assail me. The superb confidence which has enabled me to dominate door-openers, women (with exceptions), soda clerks, and radio announcers, began suddenly to waver. I reflected that I was not yet a vice-president of something or other, that several of my classmates at the various institutions of learning from which I have been expelled now live on sweller streets than I do, that I do not possess a Minerva limousine like Bouck's, and have not been nominated for public office. With this inferiority complex gnawing at my lights and liver, I was impelled to have my brain thoroughly tested. Placed in a Riehle machine, it withstood a tension of 24,000 pounds before the frontal lobe broke off. Holes were drilled in the remaining section and the borings analyzed. The quality was found to be much better than that of street-sweepings or orange peel.

"A good brain," was the report of the doctors. "It compares favorably with the bean of a radio columnist. All it needs is a little re-rivetting. This done, you will be competent to teach chiropractic, pretzel varnishing, or broadcasting."

What, then, is wrong? The blame must be cast on radio itself. The harrowing experiences of trying to eliminate static, reading a bug at thirty words a minute, answering the questions of friends whose receivers are out of order, and keeping cockroaches out of the condenser transmitters—such are the real reasons why I am uneducable. I have been beaten over the head too much; my ears, inured to watts and watts pouring from loud speakers, are no longer sensitive to the still, small voice of learning; my eyes, dazzled daily by studio luminaries like Mary Pickford, Queen Marie of Roumania, and the Hon. Norman Brokenshire, can no longer perceive twelve-point type; nor have I the patience to track knowledge, what with split sentence change-overs and modern pauseless programs. I'm a martyr and it is unseemly for my friend Bouck to jibe at me.

Anyway, am I *so* dumb? I have, after all, sense enough left to cadge some free advertising in the eminent journal adorned by the great mocker every week, into whose columns I could break my way, otherwise, only by committing a murder, marrying a lady of sixteen or sixty, or turning Mohammedan.

Technical Operation of Broadcasting Stations

14. Studio-Field Change-overs

THE broadcast listeners hear a "change-over" as the transition from a studio program to one picked up in the field, or vice-versa. One announcer is heard to stop talking, and the other takes up the new program. To the broadcast operator the "change-over" involves a switching operation. There are a number of ways, differing both in program effect and technical methods, of swinging a change-over. The discussion here will deal principally with the technical aspects.

Fig. 1 shows a simple layout for affecting change-over operations between field and studio. The studio microphone, M_s, feeds its own amplifier, A_s the output of which is connected to the first of succeeding stages of amplification leading up to the modulators. A line amplifier, A_L, similar to the studio amplifier, but taking its input from a wire line, has its plate tied to that of the studio amplifier, so that the output of either amplifier goes to the modulators. At the far end of the line there is a microphone M_f, a remote control amplifier of from two to six stages, and auxiliary equipment. The object of the field amplifier is to permit riding over line noise, but the audio energy reaching the station is, as a result, much in excess of the output of the studio microphone, so that an artificial line or "pad" is required ahead of the station equipment to cut down the level coming in on the line to the necessary degree. Switching facilities are also required, so that any one of a number of pairs may be connected to the line amplifier stage in the control, but these are represented in Fig. 1 merely by a double-pole double-throw switch between the line and

"RECENTLY I HAD MY BRAIN TAKEN OUT AND EXAMINED" the pad at the station end. Gain controls, in the diagram, Fig. 1, are represented by diagonal arrows indicating variable amplification of those stages through which they are drawn.

The normal course of a change-over may now be outlined. We start with a performance in the studio. The microphone M_s is feeding the amplifier designed for its output. The studio announcer finishes his program with a prearranged cue sentence, and shuts off his microphone. During or at the end of this sentence, the control operator, who hears everything radiated by means of a monitoring receiver or other facilities, says to the remote control operator, "You're on the air." He does this by means of a telephone set which may be connected, by means of the double-pole double-throw switch, on the blades of which the line terminates, to that line. The field man, talking into the microphone M_f, answers, "Right!" Then, and not until then, the control operator flips the D. P. D. T. switch to the "Air" side, connecting the line to its amplifier. The remote control technician, after his "Right!" has turned the microphone M_f over to his announcer, or has made the announcement himself, if he combines the two functions, as is not unusual in small stations. What is spoken to M_f now goes out on the air, while M_s is dead. The change-over has been accomplished. At the same time, the telephone set, it should be noted, is disconnected, so that if someone talks to it accidentally, the speech will not go out on the air.

The connections and procedure outlined above are of a primitive type compared to the methods actually used in most up-to-date stations. With thirty or forty pairs of wires coming into the control room, the D. P. D. T. switch becomes a regulation telephone switchboard, with keys, jacks, plugs; ringing, talking, and monitoring facilities are there in abundance. The board should preferably be built with two positions, so that one side may be used independently for testing with one outside point while another is on the air, with less of the ever-present danger of creating a mix-up on the air. The single microphone, M_f, provided at the field point, is usually only one of a number, since otherwise there will be a delay while it is transferred from the operator, who must use it to get on the air, to the concert position. The principle of the operation of changing over remains the same, however.

The process of switching back to the studio is simpler than the reverse operation. It is merely necessary for the studio announcer to be given listening facilities, say in the form of a high-impedance headphone paralleling the loud speaker in the control room. When the field announcer finishes up with the cue sentence, the studio announcer switches on his microphone and begins to talk; the control operator, at the same time, disconnects the field point from the air, exchanging a few words of summing-up conversation with the field men before they take down their apparatus and leave for the next job.

It is considered a mark of finesse in broadcasting to make the change-overs "snappy," leaving scarcely a pause between one event and the next. This idea is carried to an extreme in what is known as the "split-sentence change-over," in which one announcer finishes a sentence begun by the preceding announcer. In going back to the studio from the field, the procedure is, on the technical end, the same as outlined above. The sentence must be agreed upon beforehand. For example, it is understood that the field announcer will say, "We shall now return to our studio, where . . . ." And there he stops. The studio man, with his microphone already cut-in, remains silent till he hears "where," then, without a pause, finishes the sentence: "The Ritz trio will entertain you for a half hour." The first time one hears this stunt one gets a handsome kick out of it. As far as I know, the credit for introducing it around New York goes to WHN although several other stations have used it since.

It is somewhat more complicated in the other direction (from studio to field). In this case it is necessary to provide listening facilities for the field announcer. This is done readily on a telephone switchboard by sending the monitoring signal to the field point over the line for some minutes before the end of the studio program, and letting the field announcer listen on a pair of headphones across the line, in parallel with those of the field operator. This monitoring signal may be secured by taking a tap across the loud speaker in the control room, which, however, it is essential to keep going with adequate volume. When the studio announcer comes to the cue word of the split sentence, the control operator flips a key which disconnects the monitoring signal from the line and connects the line to the air. This requires accurate timing, and a slip on the part of the control operator messes up the change-over. He needs to be sober, to be sure. An experienced man, however, will have surprisingly few failures, and a well-conducted station can be run for weeks without making an error on split sentence change-overs.

One other detail must be looked out for, particularly if one essays split-sentence virtuosity—accurate control of field and studio levels, so that the volume of the two announcers is substantially the same. This equality may be attained by providing listening facilities in the outputs of the first-stage amplifiers, A_s and A_L, with means, also, for disconnecting either from the succeeding stages of amplification. With one of the two on the air, the control operator listens in its output, then lets the announcer who is to take the air next say a few words, while a suitable level is set by adjustment of the amplification of the first control stage, or the artificial line (if this is variable) or the output of the remote control amplifier. The control operator listens for this in the output of the first stage, *not* on the air. When the latter is put on the air, some adjustment may be necessary during the first word or two, but if the preliminary setting has been carefully made the inaccuracy will be slight and hardly noticeable.

Split sentence change-overs, while striking and worth trying, have something exhibitionistic about them which makes them unsuitable for dignified or highly artistic events. They are excellent for ordinary and jazzy programs, but one does not introduce a Philharmonic concert with them. In fact, the speed of the switch-over should be somewhat reduced in such a case, not only to lower the risk of a mix-up but because a few seconds of silence add impressiveness to the entrance of a queen, a president, or a $50,000 radio program.

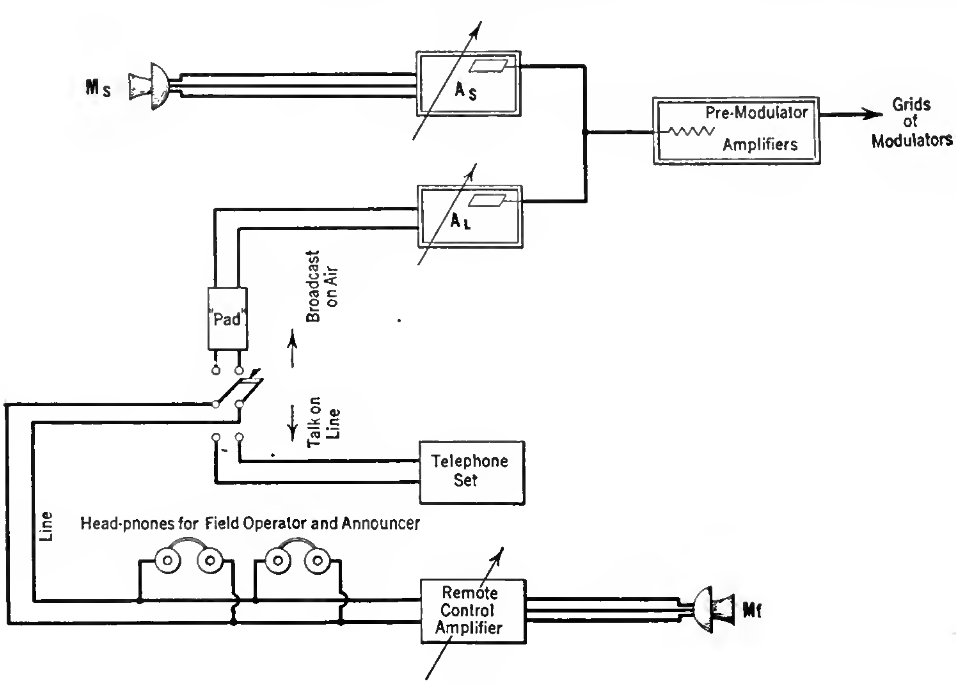


FIG. 1

A. C. As a Filament Supply Source

The Problems of Filament Heating With Alternating Current—Determining the Cause of and Remedying Undesirable Hum—The Best Tubes to Use

By B. F. MIESSNER

Chief Engineer, Garod Corporation

RADIO receivers and tubes have, since the beginning, been designed and developed for operation on absolutely steady direct current, such as that delivered by batteries. To operate a receiver from machine-generated direct current presents some problems, and to operate it from alternating current presents problems of a much higher order. Because operation from direct-current mains was easier, direct-current receivers of this type were the first to make their appearance in spite of the fact that fully 90 per cent. of electrically wired homes are provided with alternating current, and only between 5 and 10 per cent. with direct current suitable for use with radio receivers, that is, 110-volt current.

With battery operation, it is customary to connect filaments in parallel with a heavy-current A-battery source. When, however, the direct current lighting mains are used it has been found necessary to connect the filaments in series and to add resistance to this series circuit which, when connected across the 110-volt circuit, would provide a current of proper value for the filaments of the tubes. A simplified circuit arrangement of the general type used for this purpose is shown in Fig. 1.

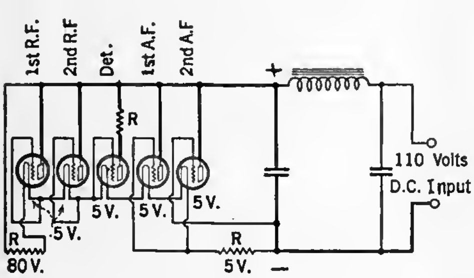


FIG. 1

The next step in electric power receiver development was the substitution, in a circuit of this type, of an a. c. line with a suitable rectifier for supplying the direct current.

In Fig. 2, it will be noted that the vacuum-tube supply circuits are preceded by a filter device, that the vacuum tube filaments are connected in series with a resistance across the rectified current line, and that the grids are biased by voltage drops in filaments more negative than the filament of the tube whose grid requires a negative bias. The first receivers of this type were designed for 201-A tubes requiring 250 milliamperes in the filament and an additional plate load of perhaps 25 milliamperes. To provide this rectified power output of 250 milliamperes at approximately 100 volts, a full-wave rectifier consisting of two Tungar gas type rectifier tubes was used together with a heavy-duty filter, consisting of very large inductances and very large capacities.

With the introduction of 60-milliampere filament tubes and also 60-milliampere rectifier tubes of the Kenotron type, by the Radio Corporation of America, came the possibility of using the same general receiver scheme with such rectifier and radio tubes. This is shown in Fig. 3. A simplification in the power conversion system was made possible with such a scheme because the output load of the converter was reduced to approximately 30 per cent. of that required by 201-A tubes. Even then, two such rectifier tubes were required to take care of the filament and plate current loads unless a single rectifier tube were to be considerably overloaded.

The ideal scheme for eliminating batteries in receivers is one which will use standard tubes of the larger types, without the necessity of developing rectified current specially for the heating of their filaments, and one which will also provide the large power so necessary for the development of high quality and plenty of volume.

A receiver which will operate satisfactorily with raw a. c. filament supply will require less than half the rectified current required when rectified current is applied throughout. For example, if the small dry-cell tubes are used with filaments in series across the rectified current output, their filament supply will be 60 milliamperes, which is more than the necessary plate supply.

If 201-A type tubes are used, the filament consumption is 250 milliamperes in excess of the plate current load. If still larger tubes, such as the 112, are used, the rectified power must necessarily be still further increased to provide the additional filament heating current. The cost of current-supply devices of this type varies nearly in proportion with the rectified output power for which they are designed; their size, weight, complexity and upkeep cost vary in like proportion.

It will be understood, therefore, that a receiver so designed as to permit the use of standard tubes of proved design with a. c. current excitation of their filaments represents probably the ultimate and ideal type of design for operation from home lighting circuits. The only rectified power required in such a receiver is that used for the plate circuits of the receiver, and the alter-

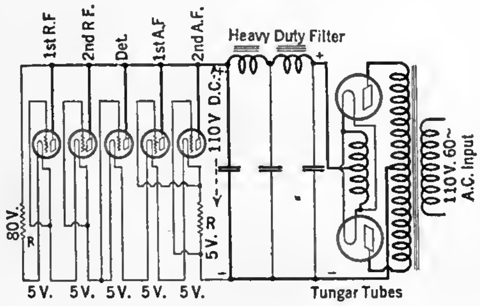


FIG. 2

nating current required for the filament lighting is obtained from a single winding of a few turns of wire on the power transformer used with the B power rectifier. The A power, therefore, requires none of the complex, costly, and bulky elimination apparatus, and the B power requirements are such that the rectifier and filter apparatus is small and inexpensive.

In the author's receiver plan, the filaments of the amplifier tubes are heated by a. c., and the plate circuits are energized by rectified a. c. The filament of the detector tube is lighted by the B current of all the other tubes which is regulated to the 60 milliamperes required by this filament. By the use of this scheme, therefore, a single 216-B rectifier tube provides ample plate power for all of the tubes, including the powerful 210 second audio tube. The filament power for the detector tube, and the C voltage for all the tubes requiring a grid bias, are also supplied from the 216-B rectifier tube.

AN INTERESTING EXPERIMENT

LET us now consider a two-element vacuum tube connected as shown in Fig. 4. The filament of the tube is excited by a. c. The plate is connected through a telephone or other indicating device to one leg of the filament without any external source of potential included in its path. If we listen at the telephone in this circuit, we will hear a humming noise in which a trained hear can discern a mixture of tone frequencies including 60 cycles, 120 cycles, and

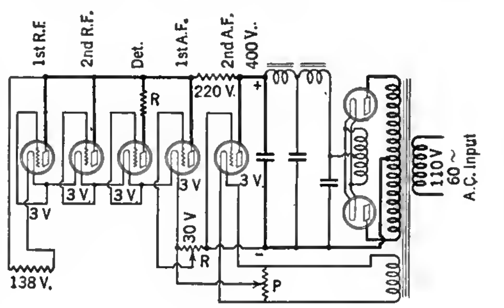


FIG. 3

some other higher harmonic frequencies. This may appear strange, inasmuch as the plate circuit is not provided with any source of potential for attracting the electrons emitted by the filament.

We realize, however, on examination of the diagram, that the plate is connected to the filament at a point of potential variation. The plate itself has at all times the same potential with respect to the rest of the filament as the leg to which it is connected. It is clear that, when the plate and its leg of the filament is positive with respect to the other leg, the plate and this leg both may, by virtue of this positive potential, attract electrons emitted from the negative leg of the filament. In fact, we may conceive of the negative leg as repelling electrons from it while the positive leg is not only holding within it the electrons attempting to escape, by virtue of the releasing effect of the filament temperature, but in addition, this positive leg, along with the plate electrode connected to it, is attracting some of the electrons liberated from the negative leg. Thus we have impressed upon the plate electrode a 60-cycle voltage variation by its connection to the filament circuit, and it functions as a single-wave rectifier under these conditions.

If now we change the connection of the plate

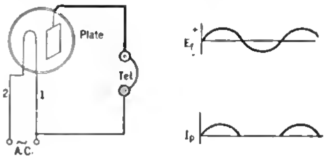


FIG. 4

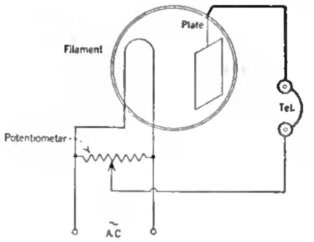


FIG. 5

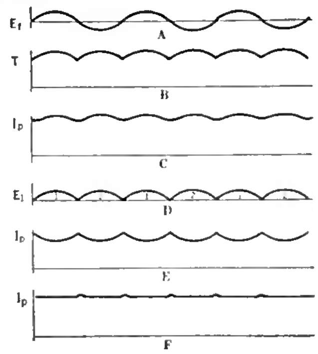


FIG. 6

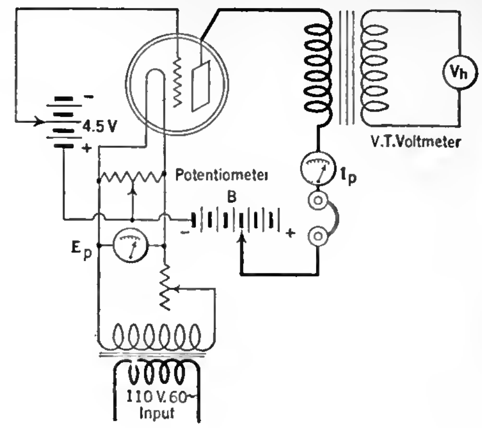


FIG. 7

circuit to the filament circuit as indicated in Fig. 5, so as to reach a point which is neither positive nor negative with respect to the two ends of the filament, the plate will never be positive or negative with respect to the filament as a whole, and it will, therefore, not have the positive potentials applied to it as in the preceding case. If we listen, however, with such an arrangement, we will still hear a humming signal in the telephone. This signal is of a 120-cycle frequency, or in general terms, double that of the exciting frequency. If we include a battery in the plate circuit so connected as to make the plate negative with respect to the filament, we will find that a potential of several volts is required to stop the hum signal. With the 201-A type tube, a negative plate voltage of about 9 volts is necessary to stop this signal. With the 199 type tube, a negative voltage of about 3 volts on the plate will accomplish the same result. One might ask many questions concerning the cause of this phenomenon. It might be due to a bicyclic thermo electromotive force set up between plate and filament by a bicyclic temperature variation of the latter; it might be a bicyclic contact electromotive force; it might be photoelectromotive force, or a magnet electromotive force emanating from the filament current.

Possibly the best explanation is that there is a bicyclic variation in initial emission velocity. We know that when a cathode is heated, it allows a freer swing to the natural vibration of the electrons within it and we know that the higher the temperature of the cathode, the greater the velocity of emergence of the electrons liberated by the heating. If then the temperature of the cathode is varying under the varying heat-producing electric current, the velocity of emergence will vary. Consequently the plate electrode, with no attractive force of its own for these electrons, will receive a mild bombardment of them which varies (in number of electrons striking it) with their emission velocity. We see, therefore, according to this explanation, that electrons reach the plate through no attractive force of its own and with a bicyclic variation following the temperature variations of the filament itself. This temperature effect, along with the effects of the voltage on the plate due to the latter's connection with one side of the filament, as shown in Fig. 4, occur simultaneously. We should not forget in this connection that the positive voltage of one leg of the filament is attempting to equalize the emission reaching the plate by stealing from the negative leg a portion of the excess electrons liberated at the periods of higher temperature. That is, while the negative leg tends to emit more electrons, due both to its rising temperature and to its rising repulsive negative potential, the potential of the positive leg is rising also and attracting to it an increasing number of freed electrons. Thus, the effect of the positive leg which we shall call "voltage effect," is in direct opposition to the "temperature effect" and tends therefore to stabilize the electron flow to the plate electrode. These effects are shown in Fig. 6. In this diagram, curve A represents the exciting voltage applied to the filament of the tube. Curve B indicates the temperature of the filament and shows that the temperature variation is bicyclic with reference to the exciting current. Curve C indicates that the plate current also is bicyclic although the definite relation between temperature and emission is not indicated in this curve. Curve D indicates the voltage variation on the positive leg of the filament insofar as its action as a plate electrode is concerned. The numerals 1 and 2 indicate that during the first cycle one leg of the filament is the positive leg and that during the other half cycle the second leg acts as the positive plate electrode, so that, irrespective of the fact that a given leg of the filament is alternately positive and negative, one or the other of the legs is positive during all periods except when the exciting voltage passes through the zero point, and therefore one or the other leg is constantly acting as a plate electrode of variable potential. The effect upon an otherwise steady emission to the plate electrode of the vacuum tube is shown in curve E, which indicates that the voltage effect of the filament causes a periodic decrease in the electron flow to the plate. When the two effects shown in curve C and E are present simultaneously in the same tube, one tending to increase the emission to the plate and the other tending to decrease it, both of these effects are constantly opposed and a neutralization results which has the effect of stabilizing the plate current, as shown in curve F.

While these curves indicate the tendencies toward plate current stabilization, they are not meant to represent exactly the effects found experimentally. To determine exactly the precise amount of hum signal developed in the plate circuit of various types of vacuum tubes under more normal operating conditions, a series of measurements have been made upon different types of tubes under different operating conditions. In order to obtain this information, a vacuum tube with direct current plate potential and with steady grid bias was set up for alternating current filament excitation.

FURTHER EXPERIMENTS

IN FIG. 7, the circuit arrangement employed for making these measurements is shown. It will be noticed that the filament of the vacuum tube is energized from a 110-volt 60-cycle lighting circuit through a step-down transformer and controlling resistance. A voltmeter across the terminals of the filament indicates the voltage impressed thereon. A milliameter in series with the plate circuit indicates the plate current therein, while a telephone in the same circuit serves as an aural indicator of hum signals. An output transformer primary is also connected in this plate circuit and its secondary is connected to the terminals of a vacuum tube voltmeter, whose function it is to measure the peak voltage of the alternating currents produced by hum causes within the vacuum tube. There is no input to the grid circuit other than the grid biasing C battery. The grid- and plate-circuit filament returns are made to the central point of the potentiometer shown connected across the filament terminals. The plan of measurement here is to fix the grid and plate voltages at some definite values and then to vary the filament voltage through definite steps and to measure the hum signal as well as the plate current for each such filament voltage.

Curves are then drawn with the filament voltage as abcissae and the hum signals as ordinates for one curve and the plate current as ordinates for another curve. These two curves are plotted together and various sets of this type are obtained under varying plate and grid voltage conditions. In Fig. 8 are shown two such curves obtained with an UX-112 type tube with a plate voltage of 135 and a grid voltage of 4.5 volts. The filament voltage was varied from approximately two to six volts and the plate current and hum voltage curves were obtained as indicated. We are impressed at once with the unexpected fact that the hum does not increase uniformly with the filament voltage as would a grid impressed signal voltage under the same conditions. There is, strangely, a rather pro-

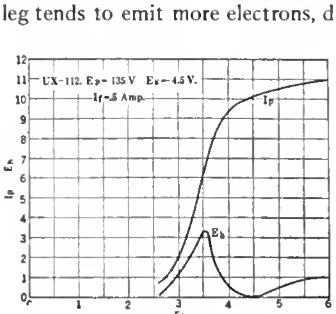


FIG. 8

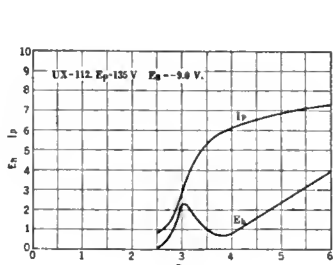


FIG. 9

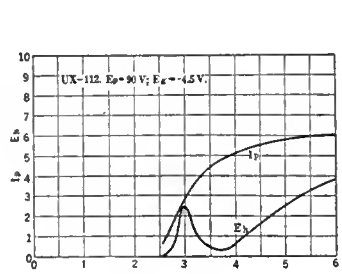


FIG. 10

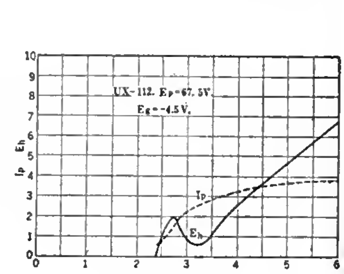


FIG. 11

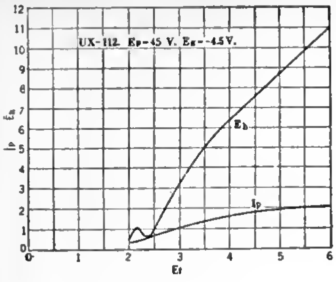


FIG. 12

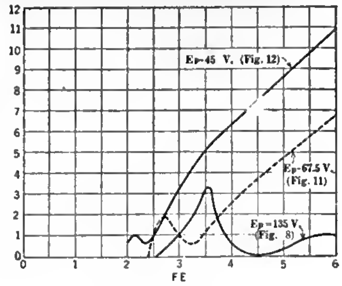


FIG. 13

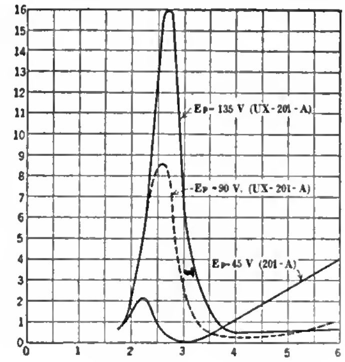


FIG. 14

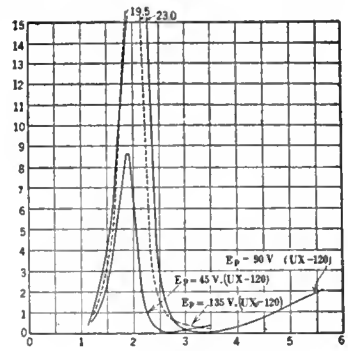


FIG. 15

nounced peak in the hum voltage at a point of about half the normal filament voltage, and there is a very definite minimum at a voltage of about 15 per cent. below the normal voltage of 5 for this tube, and again a definite rise as the normal voltage is approached and exceeded.

If now we change the operating conditions only by doubling the grid voltage, we obtain the curve shown in Fig. 9. Here we note that the hum peak has remained about the same, that the minimum point has risen to a considerable value, and that the upper maximum has increased about four times. If, instead of doubling the grid voltage, we leave the grid voltage at 4.5 volts and decrease the plate voltage to 90, we obtain a curve, shown in Fig. 10, similar to that for the nine-volt grid bias and 135-volt plate voltage. If we now reduce the plate voltage still further, to 67.5 volts (see Fig. 11), we notice a slight decrease in the lower peak, a further rise in the minimum portion, and a decided rise in the maximum portion. Going down to 45 volts we note in Fig. 12 that the lower peak has almost disappeared while the upper maximum has risen to a comparatively high value.

If we now compare the hum curves of Figs. 8, 11, and 12, by drawing them together on one curve sheet, as shown in Fig. 13, we can at once see the general nature of the variation in the curves under the changing plate voltage conditions. With high plate voltage, the hum peak is predominant, and as the plate voltage is lowered, this hum peak decreases in amplitude while the upper maximum steadily increases.

It may be observed in these curves that the peak of the hum curve always coincides with the point of maximum steepness in the filament voltage-plate cu re curves drawn with them. This appears to identify definitely this hum peak with a temperature variation cause. Since a given amount of filament voltage variation at the steepest point of this static plate-current curve produces the maximum change of plate current, it is quite reasonable to expect that, under dynamic conditions, the complete change from maximum to zero of the filament voltage would produce a periodic change in plate current whose frequency is double that of the filament exciting current frequency. And, since the greatest variation in plate current is produced at this filament voltage, it is obvious that the greatest amount of hum disturbance would occur also at this point. We have, therefore, rather definitely identified the lower voltage peak with the temperature variation of the filament. This identification is still further strengthened by the fact that this hum peak corresponds fairly well in amplitude with the slope of the filament voltage plate-current curve.

The filament voltage of the 201-A type tube is the same as that of the 112, whose characteristics have just been shown. However, its filament is made of thoriated tungsten designed for a 0.25-ampere operating current, while the 112 tube has an oxide coated platinum filament designed for an operating current of 0.5 ampere.

HUM CURVES

IN FIG. 14 are plotted three hum curves of the UV-201-A representing the two extremes and middle conditions as far as plate voltage is concerned. By an inspection of the curves it is easy to visualize very clearly the changes in hum characteristics with variations in plate voltage, and again indentify this hum with the filament temperature variation cause. It will also be noticed that the hum peaks are much higher than those obtained for the 112 type of tube. Similar curves for the 120 tube are given in Fig. 15.

Proceeding now to the UV-199 tube with a three-volt filament, taking only 60 milliamperes, we obtain curves such as shown in Fig. 16 and Fig. 17. With 90 volts on the plate and a negative grid voltage of 4.5 (Fig. 16), the plate current characteristic is comparatively flat, while curiously enough the hum peak is very pronounced at the normal operating voltage of the filament. If we decrease the plate voltage to 45 and maintain the same grid voltage as before, we get an extremely flat plate-current characteristic, a very low hum peak, and a definite indication of a minimum point at about 2.5 volts on the filament. See Fig. 17.

Finally, we have two curves for the WD-12 type of tube. This tube has the lowest operating voltage of all, while the filament current is the same as for the 201-A, or 0.25 ampere. It has, however, an oxide-coated platinum filament as has the 112 tube, and operates at comparatively low temperatures. The first curve taken on this tube is shown in Fig. 18, with a plate voltage of 135, and 9 volts negative bias on the grid. The plate current curve is much steeper than any we have yet considered, while the hum peak is about the same as for the 201-A. At a point near or beyond the normal filament voltage, the hum curve is still quite high and there is little indication of a minimum point. In Fig. 19 a curve is given with a plate voltage of 90 and a negative grid voltage of 4.5. A reduced hum peak is obtained, but in general the same hum and plate current characteristics are present. Curiously, there is a steep bulge in about the middle of the plate current characteristic that has not been noted on any of the other tubes under discussion.

If we consider the grid and voltage ratings of the filament as indications of the thickness of the filaments, and consider that a thick filament will not fluctuate in temperature so much as a thin filament, we may compare filaments so far as their temperature variation hum characteristics are concerned on a basis which we may call the "thermal inertia" of the filament itself. This is a time temperature factor which is determined by the thermal characteristics of the filament. The cubical contents of the filament, its specific heat, its radiation constant, the conduction effects through lead-in wires, and some other factors, determine the value of this thermal inertia factor for any given filament. With a given material it is, of course, highest for a cylindrical type of filament, as compared for example, with a flat strip type of filament. It is greater for a material with high specific heat than it is for one with a lower value. It is greater for a filament having a surface with low radiation constant than it is for one having high radiation properties. It is greater for a filament of low temperature than it is for one of high temperature, because the radiation factor increases rapidly with high temperatures. If, therefore, we classify the various tubes we have thus far studied with reference to their filaments and select two extremes and a medium, we will have the 112 tube at the one extreme with highest thermal inertia, the 201-A with medium thermal inertia, and the 199 with the smallest thermal inertia.

THERMAL INERTIA

IF WE plot the hum curves of these three tubes for the same plate and grid voltages, that is, 90 volts plate and negative 4.5 grid volts, as shown in Fig. 20, we may compare their hum characteristics directly as a function of the ther-

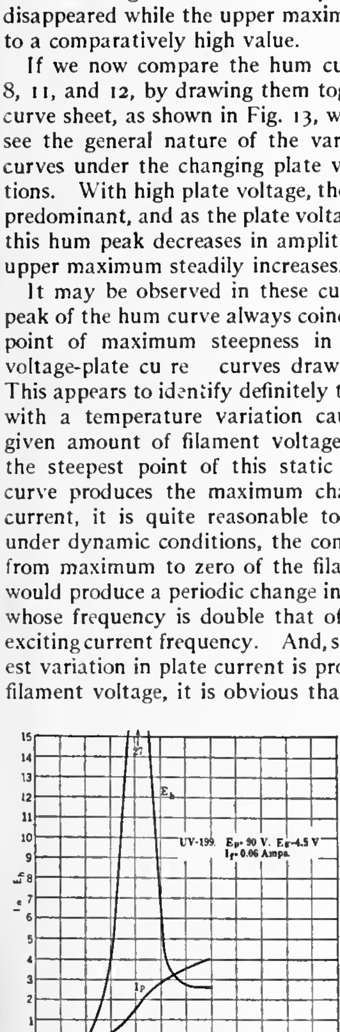


FIG. 16

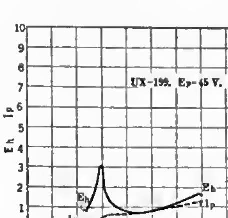


FIG. 17

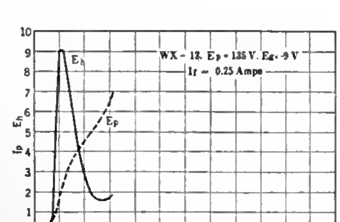


FIG. 18

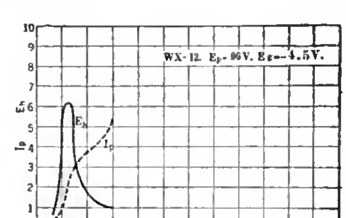


FIG. 19

mal inertia of the filament itself. This comparison indicates very clearly that the hum peak is always found below normal filament voltage, and has a very definite relation in its magnitude to the thickness and thermal characteristics of the filament.

From the preceding data the fact is well established that one very prominent kind of hum in tubes is due to the temperature variation of the filament. It has been further established that there is usually to be found a filament voltage within the operating characteristics of the tube at which the total hum from whatever cause developed by the tube is at a minimum. It has been shown that at voltages near, and in excess of the normal operating voltages, there is usually a considerable rise in hum output of the tube.

We will now endeavor to explain the cause of these phenomena. If we go back to our discussion on the two-element tube, wherein we indicated that there was present within a tube a voltage effect and a temperature effect, which tend to neutralize each other so as to cause a stabilization of the plate current under varying filament emission, the explanation of these hum effects will be made clear.

Let us consider for a moment a tube which, with normal filament, grid, and plate voltages, has a filament sufficiently thick to prevent any appreciable temperature variations due to its high thermal inertia. With such a tube, we will have no hum peak due to temperature variations, but we will have a hum of another type due to the voltage effect previously discussed.

Remembering that the positive leg of the filament is acting as a plate electrode and attracting electrons from the negative leg, we can understand that, irrespective of the fact that the emission from the filament is constant, due to constant temperature, there is still a hum due to the "stealing" effect, which causes a hum of double the frequency of the exciting current, because of this periodic subtraction from the flow to the plate by the periodic flow to the filament legs. With such a tube we will secure a hum characteristic such as that shown in Fig. 21. We can see therefore, that by merely increasing the thickness of the filament we have not eliminated all of the hum causes within a tube.

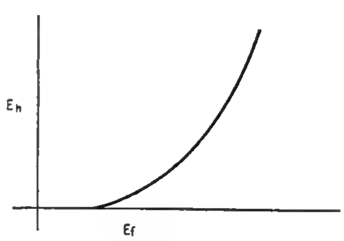


FIG. 21

If now we consider another type of tube in which the filament has a very low thermal inertia and a negligible voltage effect, so that a strong variation of temperature and plate current results, we will obtain a curve of the type shown in Fig. 22, in which the voltage effect is absent.

The 199 type of tube, with but three volts across its filament and the ends far spaced in this straight filament form, is almost a perfect example of this type of tube, as you may remember from the appearance of the hum characteristic which showed a very high temperature peak and no appreciable voltage effect.

In Fig. 22, it will be noted that the hum curve does not drop to zero, at the higher filament voltages, but that it retains a fairly uniform value which, from a comparison of all the curves so far presented, indicates that its value at this point bears a definite relation to the slope of the plate current characteristic in the same filament voltage region. The hum curve, therefore, should never drop to zero unless the plate current curve is parallel to the filament voltage axis.

If we now combine the temperature effect and the voltage effect in a single tube, we may expect a neutralizing action between them, which, under suitable conditions, may make it possible to operate a tube with alternating current on the filament and with a stable plate current. By combining the pure voltage hum characteristic of Fig. 21 with the pure temperature characteristic of Fig. 22, we can understand how this neutralization takes place and what should be the form of the resultant hum curve.

This combination is shown in Fig. 23, wherein the upper curve represents the temperature characteristic and the lower curve the voltage characteristic. The algebraic addition of these two factors, Eht and Ehv, gives the resultant curve shown in the dotted line. This dotted curve shows that, at the point where the two neutralizing effects are equal, zero hum results, and that where the temperature effect is predominant, that is, at voltages below this zero point, we have a temperature type of hum, and at voltages above this point, where the voltage effect becomes predominant, we have a voltage type of hum.

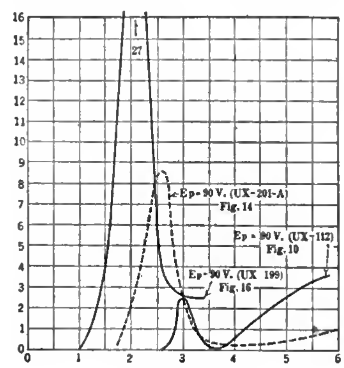


FIG. 20

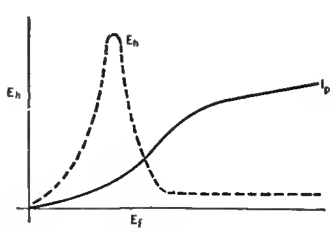


FIG. 22

Of course, in the measuring apparatus used for taking the hum curves previously shown, this reversal in the nature of the two types of hums on the two sides of the minimum point, does not appear, with the result that the portion of the dotted curve below the filament voltage axis turns upward instead of downward in the curves shown. It is necessary to show it as it is indicated in Fig. 23 to arrive at the algebraic sum of the curves, and this form is more exact.

112 TUBE BEST

THE 112 type of tube has been found best for use in audio and radio frequency amplifying circuits because there is more complete neutralization of the two hum causes within this tube than there is in other tubes. Again, while some of the other tubes show quite low minimum hums, at operative filament voltages there are nevertheless, present within the tube, hum causes of the two types of considerable magnitude. These, while they almost completely stabilize the plate current, nevertheless introduce other effects. A tube of the 199 type, while its hum output at about 3.5 volts is quite low, is practically useless for radio frequency amplification when its filament is excited by alternating current, due to the fact that its filament temperature is varying considerably. The amplification constant of the tube is varying with the temperature variations of the filament irrespective of the fact that the plate current is very nearly stable so that, as a result, a constant amplitude radio frequency voltage impressed upon the grid circuit of such a tube will possess a strong 120-cycle modulation frequency in its plate circuit. A receiver using such tubes may be made to operate very quietly so long as signals are not received, but when signals, especially strong ones, are received, this modulation effect introduces a strong 120-cycle hum which completely ruins reception.

The 112 type of tube, because of its very heavy filament, introduces only a very slight hum of this modulation type and, in addition, its plate current is practically without ripple, due to the very close neutralization of the temperature and voltage effect hums. The ideal type of tube, should have an oxide-coated low-temperature filament of the straight type operating with perhaps one volt and two amperes. The filament should be round so as to provide the greatest thermal inertia with a given mass of filament material. It should be straight, and the voltage across its ends should be low so that the voltage effect is reduced to a negligible factor.

It should be possible, as the writer's experiments with special tubes have shown, to use such tubes indiscriminately for radio frequency amplification, detection, and audio amplification with the introduction of no objectional hum in the loud speaker output.

In receivers deriving filament, plate, and grid voltages from alternating-current sources, there are other forms of hum than those introduced by the filament excitation within the tubes themselves. A certain amount of ripple is always present in B-supply rectifiers, and this will introduce a hum, particularly if any considerable amount of it is present in the detector or first audio stages, with subsequent amplification behind it. Instead of the usual procedure in bringing the grid and plate circuit returns to the filament at the center of a potentiometer connected across the filament, some of the B ripple hum can be eliminated by introducing a ripple into the grid circuit of one or more of the vacuum tubes in a receiver by displacing the potentiometer from its usual central position. In this way a 60-cycle grid voltage of very small magnitude is made to neutralize a 60-cycle plate voltage variation of larger magnitude.

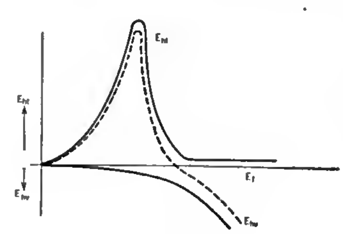


FIG. 23

Another method of eliminating B ripple consists in utilizing, for the grid bias of the vacuum tubes in the receiver, a voltage drop through a resistance carrying some or all of the B current in the receiver. In this way the grid has applied to it a somewhat unsteady biasing voltage with variations of correct phase and amplitude for neutralizing, at least in part, the plate voltage variations from the B supply.

An article in next month's RADIO BROADCAST will give a description of a commercial broadcast receiver in which the principles of hum elimination herein described are employed. This receiver was introduced to the public in May, 1926, and has thus far enjoyed a very successful commercial exploitation.

The *Radio Broadcast* LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of RADIO BROADCAST *have until recently been answered either by letter or in "The Grid." The latter department has been discontinued, and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," appears this series of Laboratory Information Sheets. These sheets contain much the same type of information as formerly appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* RADIO BROADCAST *of much greater interest to our readers.*

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department. The first index appeared in November.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are requested to send their questions to the Technical Information Service of the Laboratory, using the coupon which appears on page 434 of this issue. Some of the former issues of RADIO BROADCAST, *in which appeared the first sets of Laboratory Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company at Garden City, New York.*

No. 65 RADIO BROADCAST Laboratory Information Sheet February, 1927

The Vacuum-Tube Voltmeter

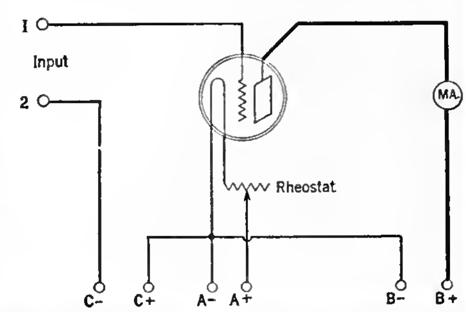
HOW IT FUNCTIONS

THE vacuum-tube voltmeter is a very useful instrument and it finds wide use in an electrical laboratory. The simpler type is not at all difficult to make up, and with it some interesting measurements can be made. For best results it should be calibrated, but even without calibration it is still possible to make many measurements with it that will give a general indication of the comparative merits of different coils, amplifiers, and other units, etc.

The circuit diagram of a vacuum-tube voltmeter is given on this Sheet. The B-battery voltage need not be more than $22\frac{1}{2}$ volts, and the indicating instrument in the plate circuit should have a maximum scale reading of not more than $1\frac{1}{2}$ milliamperes. The C-battery voltage should be adjusted until the meter reads about $\frac{1}{10}$th of a milliampere when the terminals 1 and 2 are short-circuited.

The tube is now being operated on the lower bend of its characteristic curve, similar to the condition under which a C-battery detector operates. Now, if any voltage, whether it be direct or alternating, is impressed across the input terminals, the plate current will change. If a calibration is to be carried out, it is accomplished by impressing various known values of voltage across the input terminals and reading the corresponding deflections of the plate milliameter. Then, if the input terminals are connected across any unknown voltage it is possible to determine the value of this voltage by noting the deflection of the plate milliameter. The actual voltage is obtained from the previously made calibration curve.

As mentioned, even if instruments are not available with which a calibration can be made, it is possible to make comparative tests. For instance, by placing the same input on two amplifiers under test and then connecting the vacuum-tube voltmeter across the output of each, readings may be obtained. Obviously, the amplifier which produces the greatest deflection has the greatest amplification.



No. 66 RADIO BROADCAST Laboratory Information Sheet February, 1927

A Radio Frequency Oscillator

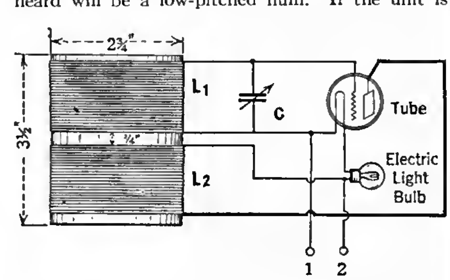
ITS USE AND CONSTRUCTION

A DIAGRAM of a simple oscillator that takes all of its energy from the power mains is given on this Laboratory Sheet. A unit such as this is quite useful to the home-constructor in making many tests on receivers. It sends out energy in much the same way as any broadcasting station, and it can be tuned to deliver this energy at any frequency between 500 and 1500 kc. (600 and 200 meters). It makes use of a 201-A tube and will operate on either 110 volts a.c. or d.c. If the latter is used, the device will only function when terminal No.2 is connected to the positive side of the line.

The coils, L_1 and L_2 may be wound on a single piece of tubing $3\frac{1}{2}$ inches long, having an outside diameter of $2\frac{3}{4}$ inches. L_1 consists of 50 turns of No. 26 d.c.c. wire, and L_2, spaced $\frac{1}{4}$ inch from L_1, consists of 40 turns of the same size wire. Both coils are wound in the same direction.

The condenser, C, should have a maximum capacity of 0.0005 mfd. An ordinary electric light bulb of 25 watts rating is shown in the circuit. If by any chance the oscillator is to be used on a 220-volt circuit, the electric light bulb should be replaced by one suitable for use on this voltage, and should be rated at 50 watts.

If this oscillator is supplied with alternating current and is placed within a few feet of a receiver, it will be possible to tune-in the signal generated by it if the receiver is in good condition. The note heard will be a low-pitched hum. If the unit is supplied with direct current it will not be directly audible. However, if the receiver is of the regenerative type it will be possible to produce a heterodyne whistle, when the set is oscillating.



Attach this marvelous amplifier

$25 ready to attach

to your set in less than 5 minutes — and get the biggest thrill out of radio you have ever had

Any radio set—no matter what type, make, or age—can instantly be transformed to give you such rich and clear and natural reproduction of music and speech that you will be absolutely astounded. You cannot duplicate Truphonic amplification, *no matter how much you can afford to pay.* At the low price of $25, the Truphonic brings a thrilling new enjoyment of radio within the reach of all.

Truphonic Amplification is not surpassed—at any price

If you want this new thrill in radio, do this:

Get the Truphonic amplifier at your radio dealer's. Place it alongside, or behind your set. Make one simple connection to your set. (A clip goes over one prong of the detector tube—done in 10 seconds). Connect the battery cable. Take the regular standard audio tubes from your set. Insert them in the Truphonic, along with an extra tube (either 201A or power tube). Plug loudspeaker into Truphonic. That is all. The rest is a song of praise from you, and from all of your friends who hear it.

The Truphonic employs an audio coupling system that is definitely superior to transformers, resistance coupling, or impedance. Three stages of this advanced coupling give much greater distortionless volume than is possible by any other method.

A power tube can be used, and in fact is recommended for the very best results, owing to the fact that for great volume a power tube has a much greater undistorted output capacity than a 201A.

We recommend using a UX 171 tube. (The wiring to extra B and C batteries is provided for in the Truphonic cable). This combination gives exceptional volume, with an unapproached faithfulness. But in any case, whether you use a power tube or not, the Truphonic will vastly improve upon your present reproduction. (Truphonic Amplification is also to be had in single coupler units described on the next page.)

Don't let another night go by without getting all that radio can give in beautiful reproduction. Attach a Truphonic to that set of yours and expect the biggest radio thrill you have ever had.

If your dealer has not yet stocked the Truphonic Amplifier, we will send you one direct C. O. D. on a 5-day money back trial. Be sure to mention your dealer's name and address.

ALDEN MANUFACTURING CO.

Dept. B.22 Springfield, Mass.

NA-ALD

TRUPHONIC

POWER AMPLIFIER

NA-ALD

No. 67 RADIO BROADCAST Laboratory Information Sheet February, 1927

171 Tube Characteristics

PLATE IMPEDANCE

THIS Laboratory Sheet will explain how to determine the plate impedance, or output resistance, of a tube by using figures that can be obtained from the static characteristics. Specifically does it deal with the 171 type tube. The plate impedance is equal to the change in plate voltage divided by the corresponding change in plate current. We will calculate the plate impedance of a 171 tube using the static characteristic curves given on Laboratory Sheet No. 68.

EXAMPLES:

No. 1. What is the plate impedance of a 171 tube with 180 volts on the plate and a negative grid bias of 40.5 volts?

See curve 5 on Sheet No. 68. The X indicates that point on the curve corresponding to the condition given in the example (*i. e.*, 180 volts on the plate). The impedance is determined by first of all reading from the curve two different plate currents corresponding to two different plate potentials, with the same grid bias in each case. Any plate voltages may be taken provided we stay on the straight portion of the curve. Therefore, we might take plate voltages of 170 volts and 190 volts, corresponding to plate currents of 15.8 mA. and 26 mA. The change in plate voltage is 190–170 = 20 volts, and the change in plate current is 26 – 15.8 = 10.2 mA. Therefore, the plate impedance of the 171 is equal to the change in plate voltage (20), divided by the change in plate current (10.2 mA., or .0102 amperes) which equals 1961 ohms. This value corresponds very closely to that given for the UX-171 (2000 ohms) in Laboratory Sheet No. 58, in the January issue.

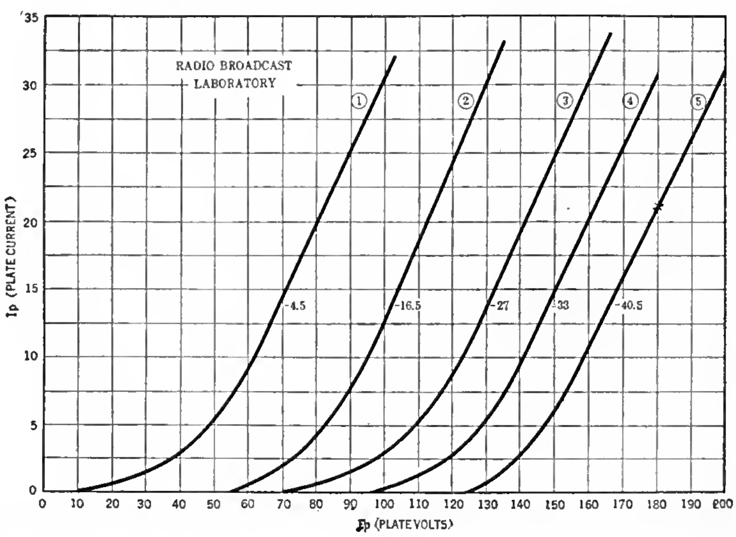
No. 2. What is the plate impedance of a 171 tube with 135 volts of B battery and a grid bias of minus 27 volts?

Refer to curve No. 3 and take any two plate voltages in the straight position of the curve, say 130 and 160 volts. The corresponding plate currents are 13.8 mA. and 30.3 mA. The plate-voltage change is 160 – 130 = 30 volts, and the plate-current change is 30.3 – 13.8 = 16.5 mA. Therefore, the plate impedance is 30 volts divided by 16.5 mA., or 0.0165 amperes, which gives 1818 ohms as the plate impedance.

Mathematically, it is evident that what we are determining is the reciprocal of the slope of the curve. The plate impedance is constant over the straight position of the curve. It is also apparent from an inspection of the curves that the output resistance or plate impedance is practically the same for all values of plate voltage, the slope of the curves being nearly the same.

No. 68 RADIO BROADCAST Laboratory Information Sheet February, 1927

Curves for the UX-171 Tube



No. 69 RADIO BROADCAST Laboratory Information Sheet February, 1927

Sources of Electrons

THE HEATED FILAMENT

THE commonest source of electrons with which the home-constructor is familiar is the filament of an ordinary vacuum tube. Present theory regarding metals indicates that they are made up of atoms, which are, in turn, composed of electrons. These electrons are in violent motion and it might be expected that some of them would leave the metal, but there is an opposing force which holds them in position at ordinary temperatures. If the metal is made hot, however, the velocity of the electrons increases to a very great extent, and some of them do leave the metal. The easiest way to heat the metal is to make it in the form of a wire and send an electric current through it. This creates an excellent source of electrons. It is unquestionable that, by far the most important way, of obtaining electrons commercially, is through the heating of a wire. This method is used to obtain a source of electrons in vacuum tubes.

The vacuum tube was not a very useful instrument at first until it was found that by placing a metal grid between the filament and the plate, the number of electrons passing to the plate could be controlled. Some years after this first discovery, it was found that the vacuum tube would act as an amplifier of weak electric impulses, such as telephone currents. The three-element tube, as it is called, has opened up an entirely new field of research and is doubtlessly one of the most important tools in the hands of science.

There are, however, other sources of electrons which are used to a considerable extent in scientific practice. It has been found that some metals will give off electrons if they are placed in a strong light. This is true of zinc, as an example. Under ordinary light zinc does not give off many electrons, but under the influence of light of very short wavelength, such as ultra violet light, it will give off electrons quite rapidly. This effect is known as the photo-electric effect. Other metals, such as potassium, are very sensitive to light in the visible part of the spectrum. Potassium is, therefore, used in some photo-electric cells where its function is to control electric currents in proportion to the amount of light that is permitted to fall on it. The photo-electric cell is one of the most important units used in a picture transmitting system. The effect produced in the cell is of interest to physicists because of the information it can give them regarding the nature of the electron.

BROWNING-DRAKE RADIO

TESTED . . . Then Highly ENDORSED

SINCE its introduction several years ago, Browning-Drake Radio has been TESTED by thousands of radio experts throughout the world . . . then wholeheartedly ENDORSED for dependable radio reception. This unusual endorsement has put Browning-Drake into a hundred thousand homes where Browning-Drake performance is giving permanent satisfaction to its owners.

During the summer of 1923, at Cruft Laboratory of Harvard University, Glenn H. Browning and Frederick H. Drake set a mathematical standard of design for radio frequency transformers. This scientific achievement resulted in the Browning-Drake slot wound radio frequency transformer. By using one stage of scientifically designed radio frequency, incorporating the Browning-Drake transformer, together with the flexibility of dual-control tuning, a combination was found that has never been surpassed for all around radio reception.

Browning-Drake produces only one model . . . the Browning-Drake Five which is completely assembled at its Brighton laboratories. Every set is unconditionally guaranteed. You will find the price of only $95.00 as amazing as its performance. Ask the nearest Browning-Drake dealer to demonstrate it for you TODAY.

[*DEALERS: No reputable dealer can afford to overlook the Browning-Drake opportunity. Every Browning-Drake dealer has made money and every customer has been permanently pleased. Write or wire TODAY for proposition.*]

BROWNING-DRAKE CORPORATION, Brighton, Mass.

No. 70 RADIO BROADCAST Laboratory Information Sheet February, 1927

Soldering

ESSENTIALS FOR GOOD WORK

IF A receiver is to operate efficiently and quietly it is essential that all of the soldered joints be securely made. Soldering is an exceedingly important operation in wiring a receiver and poor soldering is doubtlessly a frequent cause of trouble.

The ordinary solder consists of a combination of lead and tin, the percentages generally being 50 per cent. lead and 50 per cent. tin. In order to make a good joint, the surfaces to be soldered should be entirely free from oxides. Soldering flux will prevent the formation of oxides while the heat is being applied. The metal parts which are to be soldered should be scraped clean before the flux is applied and, under proper conditions, the solder will flow very easily around the joint when the parts have been heated sufficiently.

If the soldering is correctly done, the solder will appear bright after the joint is made, but a poor joint made with a cold iron will generally leave the solder with a somewhat crystaline structure. Some fluxes should be used very sparingly in making the joint, as they will conduct electric currents and will also have a very detrimental effect on any insulation with which they come in contact. Rosin is a very excellent flux to use, although it is somewhat more difficult to work with than the ordinary soldering paste. It is standard practice in most large electrical companies to use rosin flux almost exclusively, since it has no bad effects on insulation. When rosin is the flux it is important that a very hot iron be used, otherwise, what is called a rosin joint may be produced, in which case there is a thin layer of rosin left between the two metal surfaces. This makes the electrical conductivity of the joint very poor if it does not completely prevent the flow of current.

As mentioned above, it is essential that the iron be sufficiently hot if a good job is to be done. A hot iron will also, in many cases, prevent other troubles. If soldering is attempted with an iron that is not hot enough, it is necessary to hold the iron on the metal for a long time before the solder becomes sufficiently hot to melt and, during this procedure, much of the heat energy is wasted. With a hot iron, the heat, although more intense, is confined to a smaller space because the job is completed quickly. This is important when we are, as an example, soldering a lead to a lug on a transformer. In such a case it is essential that the job be done quickly so as to prevent heating the lug to such an extent that the lead from the winding which connects internally to the other end of the lug will not come unsoldered and thus cause the circuit to be broken.

No. 71 RADIO BROADCAST Laboratory Information Sheet February, 1927

Push-Pull Amplification

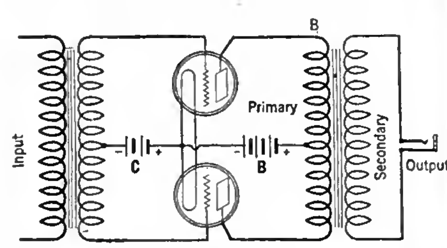
WHY IT IS USED

TRANSFORMERS are not the only source of loss of quality in audio amplifiers. The tube itself can introduce a certain amount of distortion, although this distortion is generally quite small.

The effect of the curvature of the tube characteristic is to introduce in the plate circuit, for each frequency applied to the grid, a new current of twice that frequency. The relative strength of these double frequency currents must be kept small, otherwise the quality will suffer. In order to keep them small, a large impedance must be used in the plate circuit, which will tend to straighten out the tube characteristic. It is also essential that there be enough C battery always to keep the grid negative, and then again, enough B battery must be used to permit operation on that portion of the characteristic curve which has the least curvature. It should be obvious that, as each successive tube in an amplifier has to handle more current than the one before it, the tubes in the last stage must be rated at, or must be capable of, handling greater power than the earlier stages of amplification.

The effect of the curvature of the plate characteristic can be canceled out by using the so-called push-pull transformers. The sketch on this Sheet indicates the scheme of connections of a push-pull amplifier. Briefly, its usefulness is due to the fact that the phase relations of the double frequency currents produced by the tube characteristic are such as to cause them to cancel out in the transformer primary and not to appear across the transformer secondary.

The design of a push-pull transformer is impor-



tant, and unless the same care is taken in designing as with an ordinary transformer, the actual results obtained will not make the push-pull arrangement worth while. It is essential that a push-pull transformer have a very high impedance primary and that the frequency characteristic of the transformer be reasonably flat.

No. 72 RADIO BROADCAST Laboratory Information Sheet February, 1927

A. C. Operated Power-Supply Devices

TROUBLE SHOOTING

THIS Laboratory Sheet will give briefly possible sources of trouble in line power-supply devices (B-battery eliminators).

Quite frequently it is found that a hum is audible in the output of the receiver when it is operated from a power device. This hum need not necessarily indicate poor design, and may be due entirely to mechanical vibration. It can be eliminated by moving the device further from the receiver, or by placing the receiver on top of several layers of soft cloth.

Trouble in the power-supply unit may be the result of breakdown of one of the filter condensers, the breakdown of one of the resistances controlling the intermediate voltage taps, a defective rectifier, or to open connections. In testing the device, a voltmeter is essential. It should be connected between the negative post and the various taps, and if one of the taps gives no reading, the trouble is probably due to a defect in the resistance unit supplying that tap. This is not an uncommon cause of trouble and, therefore, good resistances, capable of carrying the required current without excessive heating, must be used.

Defective resistances are also capable of creating home-made "static." If reception is accompanied by considerable noise when using the power-supply device, the antenna should be disconnected and, if the noise persists, all of the connections and joints should be carefully examined. Be sure that the A-battery terminals are not corroded. If possible, substitute for the power unit good dry B batteries, and if there is no noise, it is a good indication that the line power-supply device is causing the trouble. Defective resistances are the commonest cause of this noise and they should be carefully examined.

If no voltage readings can be obtained on any terminals, the rectifier tube should be examined. Make sure that the filament has not burned out, or, if the rectifier is of the electrolytic type, be sure that it contains sufficient solution. The filter condensers, if possible, should be tested with phones and B battery to make sure they have not broken down. The same test can also be made on the choke coils to be sure that they have not been burned out, and in this way an open circuit created.

If all the connections appear to be complete and the apparatus in good condition, it will be best to try a new rectifier tube in the correct socket. Rectifiers in which a filament is used are constructed in the same manner as are ordinary receiving tubes, and the fact that they light does not necessarily indicate that they are functioning in a satisfactory manner. Rectifier tubes are counted upon to supply comparatively large currents and must be extremely well made with very sturdy filaments if they are to last any great length of time.

The fact that we are powering our receiver from a line power-supply device does not mean that it does not require attention, or that the parts are going to last forever. The rectifier device may wear out after considerable use, and the condensers will sometimes break down as they become old.

Sign off to sweet dreams

You enjoy radio like a gentleman—if you can get the best out of your set and forget all worry and bother. That's your happy frame of mind when you keep your batteries full of pep with a Rectigon. The most absent-minded dial twister snaps on a Rectigon without a qualm. What if you do tune in while you're still charging your battery? There's no harm done, not the slightest. What if the current does go wrong in the dead of night? Your batteries will not be discharged with a Rectigon attached.

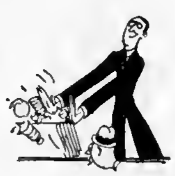
when you keep power in your set with

The Westinghouse Rectigon Battery Charger

©, 1926, W. E. & M. Co.

No noise as it charges—not a bit of fuss. Not even a murmur that would disturb the mildest slumber.

No acids, no chemicals—no moving parts—nothing to spill or burn. No muss, no worry. You'll have no spoiled rugs, no ruined clothing.



Saves its cost in short order—Count the dollars spent in a few trips to the service station and you'll hotfoot it for a Rectigon, for the good it does your pocketbook as well as your batteries.

Snaps on in an instant—Just plug into the light socket, snap on the terminals. Saves service station bother. Spares interruptions caused by absent batteries.

Charges both "A" and "B" batteries—Keeps both packed with power. Bulb is used for "B" battery charging and it is enclosed, like all other parts, in metal, safe from accident. (Rectigon charges automobile batteries, too.)

No Storage Battery Radio is Complete Without a Rectigon

THE RECTIGON is a superb Westinghouse product. Things you *can't* see, like extra heavy insulation, things you *can* see, like the durably enameled case—all are of highest quality. Westinghouse also manufactures a complete line of radio instruments, and Micarta panels and tubes.

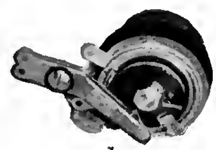
WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

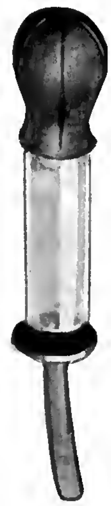
Tune in on KDKA - KYW WBZ - KFKX

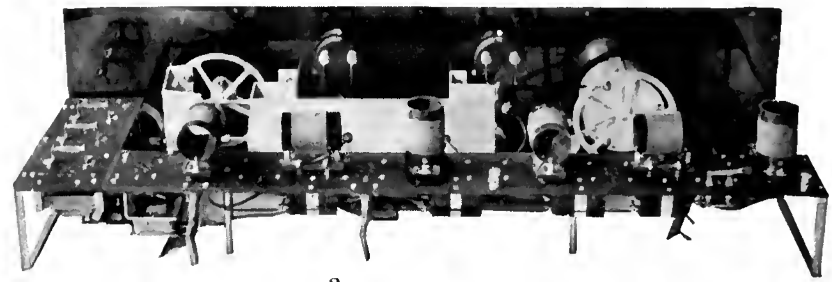
NEW APPARATUS

Equipment of the Radio Industry Submitted to the Radio Broadcast Laboratory for Test and Inspection

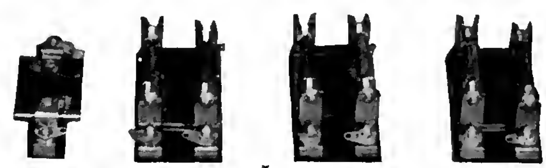
RADIO BROADCAST Photographs

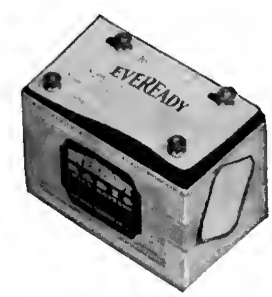

1


2


3

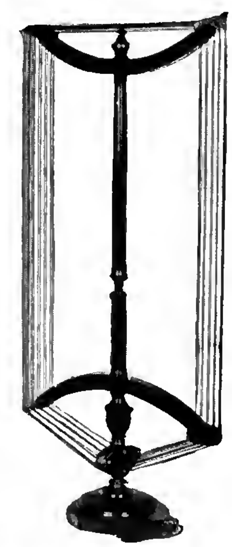

4

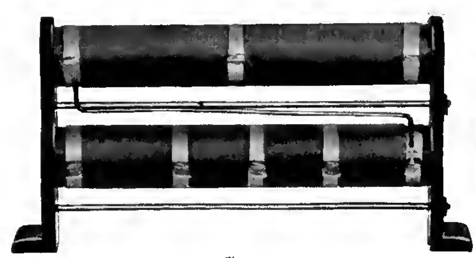

5

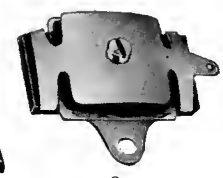


10


6


8


7


9


11

1. RHEOSTAT: The new Carter Radio Company's combined rheostat and filament switch is a novel addition to the long list of this company's products. The unit retails for $1.00

2. HYDROMETER: This hydrometer is manufactured by the Chaslyn Company of Chicago, Illinois. It retails for 75c.

3. RECEIVER: A ten-tube receiver which consists of five stages of tuned radio frequency amplification, a detector, and four audio stages. The receiver may be obtained in kit form from Norden-Hauck, Incorporated, Philadelphia, Pennsylvania, for $291.40

4. POWER SUPPLY UNIT: This B power supply employs a Raytheon tube as a rectifier. The detector and intermediate tap voltages are variable. Manufactured in three models by the Grigsby, Grunow, Hinds Company. Price $32 50, $35.00, and $42.50.

5. AMPLIFIER KIT: A complete three-stage resistance-coupled amplifier kit which comprises grid and plate resistance units, bases, isolating condensers, etc. Manufactured by the Polymet Manufacturing Co., New York City and sold for $5.00.

6. LOUD SPEAKER: The Armstrong Company, Chicago, Illinois, manufactures the Armstrong loud speaker shown above. This instrument sells for $35.00.

7. RESISTANCE: Hardwick, Field. Leeb, Incorporated, Newark, New Jersey, manufactures the tapped resistor which is a standard piece of apparatus of the Amer-Tran power supply kit. Price $7.50.

8. LOOP: The Fiat loop, manufactured by the Radio Appliance Corporation, of Chicago, Illinois, is a fine bit of workmanship. Price $12.50.

9. NEUTRALIZING CONDENSER: The Hammarlund Manufacturing Company, of New York City, manufactures this equalizing condenser which has a maximum capacity of 50 mmfd. The minimum capacity is 2 mmfd. Price 50c.

10. C BATTERY: A new product of the National Carbon Company is the $22\frac{1}{2}$-volt C battery. There are two other taps which provide lower values of C bias. The battery, No. 768, retails for $1.75.

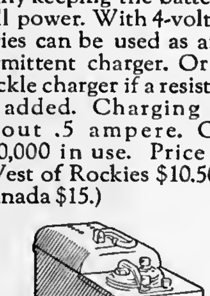
11. POWER SUPPLY UNIT: Another B power supply employing the Raytheon tube as a rectifier is the Greene-Brown Company unit. Price $39.50.

Make *your* radio set *a light socket receiver now*

with Balkite "B" *and the new* Balkite *Trickle and High-Rate Charger*

Balkite Trickle Charger $10

With 6-volt "A" batteries can be left on continuous or trickle charge thus automatically keeping the battery at full power. With 4-volt batteries can be used as an intermittent charger. Or as a trickle charger if a resistance is added. Charging rate about .5 ampere. Over 300,000 in use. Price $10. (West of Rockies $10.50. In Canada $15.)



Balkite Combination

Supplies automatic power to both "A" and "B" circuits. Controlled by the filament switch on your set. Entirely automatic in operation. Serves any set now using either 4 or 6-volt "A" batteries and requiring not more than 30 milliamperes at 135 volts of "B" current—practically all sets of up to 8 tubes. Price $59.50. (In Canada $83.)

All Balkite Radio Power Units operate from 110-120 volts AC current with models for both 60 and 50 cycles. The new Balkite Charger is also made in a special model for 25-40 cycles.

Now, with the best portion of the radio season before you, make your radio set a light socket receiver by adding Balkite "B" and the new Balkite Charger.

Balkite "B"—the proved "B" power supply—eliminates "B" batteries entirely and supplies "B" current from the light socket. The new Balkite "B"-W serves any set of 5 tubes or less requiring 67 to 90 volts; Balkite "B"-X sets of up to 135 volts and 8 tubes (illustrated); Balkite "B"-Y any standard set. Most owners of even small sets will buy Balkite "B-X" which will take care of nearly any set you buy in the future.

The new Balkite Charger with both high and low charging rates, combines the advantages of both trickle and rapid charging. At the low rate, on trickle charge, it automatically keeps your "A" battery fully charged, and in effect converts it into a light socket "A" power supply. Its high rate provides an ample reserve of power for the largest sets.

Both Balkite "B" and the Balkite Charger are entirely noiseless in operation. *Both are permanent pieces of equipment, with no bulbs and nothing to wear out or replace.* Other than a slight consumption of household current, their first cost is the last. Both are built to conform with the standards of the Underwriters' Laboratories. Add these two Balkite Units to your receiver now. Then you too will know the pleasure of owning a radio set always ready to operate at peak power. Ask your dealer. *Fansteel Products Company, Inc., North Chicago, Illinois.*

Balkite Charger $19.50. (*West of Rockies* $20. *In Canada* $27.50.) *Balkite* "B"-W $27.50. "B"-X $42. "B"-Y $69. (*In Canada* "B"-W $39. "B"-X $59.50. "B"-Y $96.)

Walter Damrosch and the New York Symphony on the air
Every other Saturday night a symphony concert. On alternate Saturdays one of Mr. Damrosch's famous piano recitals. Over stations: WEAF, WEEI, WGR, WFI, WCAE, WSAI, WTAM, WWJ, WGN, WCCO, KSD, WDAF, WOC. *Balkite Hour* 9 P. M. *Eastern Standard Time.*

FANSTEEL
Balkite
Radio Power Units

THE BALKITE LINE OF ELECTROLYTIC DEVICES IS PROTECTED BY EDGAR W. ENGLE U. S. REISSUE PATENT NO. 16,438, DATED OCT. 12, 1926

Manufacturers' Booklets Available

A Varied List of Books Pertaining to Radio and Allied Subjects Which May Be Obtained Free by Using the Accompanying Coupon

AS AN additional service to RADIO BROADCAST *readers, we print below a list of booklets on radio subjects issued by various manufacturers. With this list appear many additions to that first printed in this magazine for January, 1927. This information supplements the other departments, such as the "Lab," data sheets, and the Periodical surveys, all of which have proved most popular with our readers. The publications listed below cover a wide range of subjects, and offer interesting reading to the radio enthusiast. The manufacturers issuing these publications have made great effort to collect interesting and accurate information.* RADIO BROADCAST *hopes, by listing these publications regularly, to keep its readers in touch with what the manufacturers are doing. Every publication listed below is supplied free. In ordering, the coupon printed on page 414 must be used. Order by number only.*—THE EDITOR.

PARTS

1. FILAMENT CONTROL—Problems of filament supply, voltage, regulation, and effect on various circuits. RADIALL COMPANY.

2. HARD RUBBER PANELS—Characteristics and properties of hard rubber as used in radio, with suggestions on how to "work" it. B. F. GOODRICH RUBBER COMPANY.

3. AUDIO TRANSFORMERS—A booklet giving data on input and output transformers. PACENT ELECTRIC COMPANY.

4. RESISTANCE-COUPLED AMPLIFIERS—A general discussion of resistance coupling with curves and circuit diagrams. COLE RADIO MANUFACTURING COMPANY.

5. CARBORUNDUM IN RADIO—A book giving pertinent data on the crystal as used for detection, with hook-ups, and a section giving information on the use of resistors. THE CARBORUNDUM COMPANY.

6. B-ELIMINATOR CONSTRUCTION—Complete constructional data on how to build. AMERICAN ELECTRIC COMPANY.

7. TRANSFORMER AND CHOKE-COUPLED AMPLIFICATION—Circuit diagrams and discussion. ALL-AMERICAN RADIO CORPORATION.

8. RESISTANCE UNITS—A data sheet of resistance units and their application. WARD-LEONARD ELECTRIC COMPANY.

9. VOLUME CONTROL—A leaflet showing circuits for distortionless control of volume. CENTRAL RADIO LABORATORIES.

10. VARIABLE RESISTANCES—As used in various circuits. CENTRAL RADIO LABORATORIES.

11. RESISTANCE COUPLING—Resistors and their application to audio amplification, with circuit diagrams. DEJUR PRODUCTS COMPANY.

12. DISTORTION AND WHAT CAUSES IT—Hook-ups of resistance-coupled amplifiers with standard circuits. ALLEN-BRADLEY COMPANY.

13. MATERIALS FOR SCREW MACHINE PRODUCTS—Comparative costs of steel and brass with data and actual examples of how to specify. BRIDGEPORT BRASS COMPANY.

14. ORDERING THE RIGHT KIND OF SHEET BRASS—How to specify the proper grades for various purposes. BRIDGEPORT BRASS COMPANY.

15. B-ELIMINATOR AND POWER AMPLIFER—Instructions for assembly and operation using Raytheon tube. GENERAL RADIO COMPANY

15a. B-ELIMINATOR AND POWER AMPLIFIER—Instructions for assembly and operation using an R. C. A. rectifier. GENERAL RADIO COMPANY.

16. VARIABLE CONDENSERS—An ambitious description of the functions and characteristics of variable condensers with curves and specifications for their application to complete receivers. ALLEN D. CARDWELL MANUFACTURING COMPANY.

17. BAKELITE—A description of various uses of bakelite in radio, its manufacture, and its properties. BAKELITE CORPORATION.

18. BRASS RODS—Details of manufacture together with tests and specifications. BRIDGEPORT BRASS COMPANY.

19. POWER SUPPLY—A discussion on power supply with particular reference to lamp-socket operation. Theory and constructional data for building power supply devices. ACME APPARATUS COMPANY.

20. AUDIO AMPLIFICATION—A booklet containing data on audio amplification together with hints to the constructor; also some general radio information. ALL-AMERICAN RADIO CORPORATION.

21. HIGH-FREQUENCY DRIVER AND SHORT-WAVE WAVEMETER—Constructional data and application. BURGESS BATTERY COMPANY.

46. AUDIO FREQUENCY CHOKES—A pamphlet showing positions in the circuit where audio frequency chokes may be used. SAMSON ELECTRIC COMPANY.

47. RADIO FREQUENCY CHOKES—Circuit diagrams illustrating the use of chokes to keep out radio frequency currents from definite points. SAMSON ELECTRIC COMPANY.

48. TRANSFORMER AND IMPEDANCE DATA—Tables giving the mechanical and electrical characteristics of transformers and impedances, together with a short description of their use in the circuit. SAMSON ELECTRIC COMPANY.

49. BYPASS CONDENSERS—A description of the manufacture of bypass and filter condensers. LESLIE F. MUTER COMPANY.

50. AUDIO MANUAL—Fifty questions which are often asked regarding audio amplification, and their answers. AMERTRAN SALES COMPANY, INCORPORATED.

51. SHORT-WAVE RECEIVER—Constructional data on a receiver which, by the substitution of various coils, may be made to tune from a frequency of 16,660 kc. (18 meters) to 1999 kc. (150 meters). SILVER-MARSHALL, INCORPORATED.

52. AUDIO QUALITY—A booklet dealing with audio-frequency amplification of various kinds and the application to well-known circuits. SILVER-MARSHALL, INCORPORATED.

56. VARIABLE CONDENSERS—A bulletin giving an analysis of various condensers together with their characteristics. GENERAL RADIO COMPANY.

57. FILTER DATA—Facts about the filtering of direct current supplied by means of motor-generator outfits used with transmitters. ELECTRIC SPECIALTY COMPANY.

59. RESISTANCE COUPLING—A booklet giving some general information on the subject of radio and the application of resistors to a circuit. DAVEN RADIO CORPORATION.

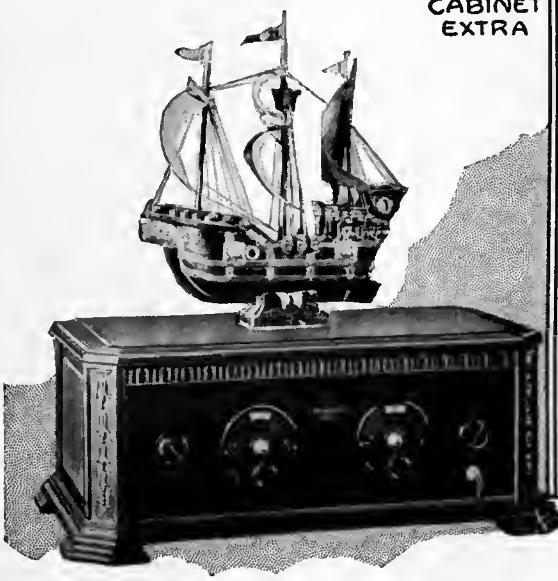
60. RESISTORS—A pamphlet giving some technical data on resistors which are capable of dissipating considerable energy; also data on the ordinary resistors used in resistance-coupled amplification. THE CRESCENT RADIO SUPPLY COMPANY.

62. RADIO-FREQUENCY AMPLIFICATION—Constructional details of a five-tube receiver using a special design of radio-frequency transformer. CAMFIELD RADIO MANUFACTURING COMPANY.

YOU CAN BUILD THE NEW SHIELDED HI-Q*

$63.05

CABINET EXTRA



This Book Tells You How

Written under the supervision of ten of America's leading radio engineers, this remarkable book tells you how to build this wonderful modern radio and save $50 to $100. From your dealer or by mail

25 Cents

Automatic Variable Coupling—a wonderful new feature through which same control operates tuning condenser and primary coil simultaneously. This gives maximum and equal amplification over entire tuning range.

Automatic Variable Coupling in the HI-Q
Supplies that Missing "Something"

The Foundation Unit

In the Hi-Q Foundation Unit, all your thinking has been done for you. Consists of drilled and engraved panel and sub-panel and all the essentials required to start building. Everything plainly marked. Simply put parts together and tune-in. Price complete

$10.50

Associate Manufacturers

Benjamin Electric Mfg. Company
Carter Radio Company
Durham Resistors
Eby Manufacturing Company
Hammarlund Mfg. Company
Martin-Copeland Company
Radiall Company (Amperite)
Samson Electric Company
Sangamo Electric Company
Westinghouse Micarta

UNTIL the arrival of the Hi-Q Receiver there has always been a missing "Something" in radio, the lack of which has caused distortion of signals and either excessive or minus volume on various wave lengths.

This is only one of the features of this wonderful new receiver. In addition the 1927 Hi-Q Receiver has the newest form of Stage Shielding, a factor which prevents coupling between stages and eliminates oscillation.

These two special features, plus self-adjusting filament control and simplicity of operation makes everyone an expert operator. The perfect matching of highest quality parts produce in this instrument a degree of selectivity even in crowded areas which is nothing short of marvelous. Distant stations come in like magic with full volume, and tone has that natural quality you have always hoped for in radio.

Build It Yourself—Save $50 to $100

The wonderful thing about the Hammarlund-Roberts Hi-Q is that, like 70,000 other novices and amateurs, you can build it yourself. Simply get your copy of the "How to Build It" Book and the guaranteed specified parts from your dealer. Follow the crystal-clear instructions and in a few hours have one of the finest receivers available in the radio world.

Hammarlund ROBERTS Hi-Q*

*Hi-Q: High Ratio of Reactance to Resistance. High Ratio—Great Selectivity—Loud Signals

HAMMARLUND-ROBERTS, Inc. - - 1182-A Broadway, New York

63. FIVE-TUBE RECEIVER—Constructional data on building a receiver. AERO PRODUCTS, INCORPORATED.

64. AMPLIFICATION WITHOUT DISTORTION—Data and curves illustrating the use of various methods of amplification. Also data on how to build. ACME APPARATUS COMPANY.

65. RADIO HANDBOOK—A helpful booklet on the functions, selection, and use of radio apparatus for better reception. BENJAMIN ELECTRIC MANUFACTURING COMPANY.

66. SUPER-HETERODYNE—Constructional details of a seven-tube set. G. C. EVANS COMPANY.

ACCESSORIES

22. A PRIMER OF ELECTRICITY—Fundamentals of electricity with special reference to the application of dry cells to radio and other uses. Constructional data on buzzers, automatic switches, alarms, etc. NATIONAL CARBON COMPANY.

23. AUTOMATIC RELAY CONNECTIONS—A data sheet showing how a relay may be used to control A and B circuits. YAXLEY MANUFACTURING COMPANY.

24. DETECTOR TUBES—A brief outline of tube operation. C. E. MANUFACTURING COMPANY.

25. ELECTROLYTIC RECTIFIER—Technical data on a new type of rectifier with operating curves. KODEL RADIO CORPORATION.

26. DRY CELLS FOR TRANSMITTERS—Actual tests given, well illustrated with curves showing exactly what may be expected of this type of B power. BURGESS BATTERY COMPANY.

27. DRY-CELL BATTERY CAPACITIES FOR RADIO TRANSMITTERS—Characteristic curves and data on discharge tests. BURGESS BATTERY COMPANY.

28. B BATTERY LIFE—Battery life curves with general curves on tube characteristics. BURGESS BATTERY COMPANY.

29. HOW TO MAKE YOUR SET WORK BETTER—A non-technical discussion of general radio subjects with hints on how reception may be bettered by using the right tubes. UNITED RADIO AND ELECTRIC CORPORATION.

30. TUBE CHARACTERISTICS—A data sheet giving constants of tubes. C. E. MANUFACTURING COMPANY.

31. FUNCTIONS OF THE LOUD SPEAKER—A short, non-technical general article on loud speakers. AMPLION CORPORATION OF AMERICA.

32. METERS FOR RADIO—A catalogue of meters used in radio with connecting diagrams. BURTON-ROGERS COMPANY.

33. SWITCHBOARD AND PORTABLE METERS—A booklet giving dimensions, specifications, and shunts used with various meters. BURTON-ROGERS COMPANY.

34. COST OF B BATTERIES—An interesting discussion of the relative merits of various sources of B supply. HARTFORD BATTERY MANUFACTURING COMPANY.

35. STORAGE BATTERY OPERATION—An illustrated booklet on the care and operation of the storage battery. GENERAL LEAD BATTERIES COMPANY.

36. CHARGING A AND B BATTERIES—Various ways of connecting up batteries for charging purposes. WESTINGHOUSE UNION BATTERY COMPANY.

37. CHOOSING THE RIGHT RADIO BATTERY—Advice on what dry cell battery to use; their application to radio, with wiring diagrams. NATIONAL CARBON COMPANY.

53. TUBE REACTIVATOR—Information on the care of vacuum tubes, with notes on how and when they should be reactivated. THE STERLING MANUFACTURING COMPANY.

54. ARRESTERS—Mechanical details and principles of the vacuum type of arrester. NATIONAL ELECTRIC SPECIALTY COMPANY.

55. CAPACITY CONNECTOR—A new device which simplifies the connecting up of the various parts of a receiving set, and at the same time provides bypass condensers between the leads. KURZ-KASCH COMPANY.

61. DRY CELLS—Information on the construction and operation of dry cells with a description of the methods used in testing them. THE CARBON PRODUCTS COMPANY.

68. CHEMICAL RECTIFIER—Details of assembly, with wiring diagrams, showing how to use a chemical rectifier for charging batteries. CLEVELAND ENGINEERING LABORATORIES COMPANY.

MISCELLANEOUS

38. LOG SHEET—A list of broadcasting stations with columns for marking down dial settings. U. S. L. RADIO, INCORPORATED.

39. BEHIND THE SCENES IN A BROADCASTING STATION—Operation in general, and specific facts about WKRC. KODEL RADIO CORPORATION.

40. STATIC—A brief discussion of the disturbances which may cause trouble in a receiver. SUN MANUFACTURING COMPANY.

41. BABY RADIO TRANSMITTER OF 9XH-9EK—Description and circuit diagrams of dry-cell operated transmitter. BURGESS BATTERY COMPANY.

42. ARCTIC RADIO EQUIPMENT—Description and circuit details of short-wave receiver and transmitter used in Arctic exploration. BURGESS BATTERY COMPANY.

43. SHORT-WAVE RECEIVER OF 9XH-9EK—Complete directions for assembly and operation of the receiver. BURGESS BATTERY COMPANY.

44. ALUMINUM FOR RADIO—A booklet containing much radio information with hook-ups of basic circuits, with inductance-capacity tables and other pertinent data. ALUMINUM COMPANY OF AMERICA.

45. SHIELDING—A discussion on the application of shielding in radio circuits with special data on aluminum shields. ALUMINUM COMPANY OF AMERICA.

58. HOW TO SELECT A RECEIVER—A common sense booklet describing what a radio set is, and what you should expect from it, in language that any one can understand. DAY-FAN ELECTRIC COMPANY.

67. WEATHER FOR RADIO—A very interesting booklet on the relationship between weather and radio reception, with maps and data on forecasting the probable results. TAYLOR INSTRUMENT COMPANIES.

USE THIS COUPON

RADIO BROADCAST SERVICE DEPARTMENT
RADIO BROADCAST, *Garden City, New York.*
Please send me (at no expense) the following booklets indicated by numbers in the published list

....
....
....
....

Name ....

Address ....
(Number) *(Street)*

....
(City) *(State)*

ORDER BY NUMBER ONLY
This coupon must accompany every order.
RB 227

Another Step Forward in Transformer Design Means Better Results for You!

Since The FIRST *Totally Shielded Air Core Transformers Were Designed By Us Some Time Ago, We Have Continued To Develop This Field*

UNTIL

Now Our SECOND, *Vastly Superior To The First, Is Ready For Those Who Want The Ultimate Benefits That Have Been Obtained From Modern Radio Research.*

Such unbelievable results have been reported from those using our old transformers from all sections of this and other countries, that we do not hesitate to say that

Real Radio Reception Can Be Yours

The Utmost In Electrical Skill and Mechanical Design Is Embodied In Our New Transformers

1—Entirely new principles are utilized in these transformers which give absolute separation of stations, a thing which has for a long time troubled all set owners. As a precaution we have used a special insulator to protect the windings from atmospheric conditions.

2—The size has been decreased, with an increase of efficiency so that a cumbersome set is no longer a necessity, the entire set with 2 audio now being easily built behind a 10″ x 17″ panel—8½″ deep.

3—More positive contacts in the nature of soldering lugs have taken the place of the inefficient machine screw behind which corrosion always takes place.

Better design and an infallible method of testing these kits has enabled us to reduce the cost so that it comes within the range of most radio users. We guarantee these kits for an indefinite period to retain their efficiency and electrical characteristics.

If you cannot get these from you dealer—order direct from us. Descriptive literature on request

INDEPENDENT RADIO CORP.

PRECISION APPARATUS

TRADE MARK

1516 Summer Street Philadelphia, Pa.

THE HARBOR AT CONSTANTINOPLE

Radio in Turkey

A Short Recital of the Trials and Tribulations Incident to the Birth of Amateur Radio in Constantinople, Which Thrived Through Much Government Interference

By M. MAZLOUM

ROBERT COLLEGE is an American institution in Turkey. It was founded by Americans and is backed up by American funds. It must be interesting, therefore, to many Americans to know what Robert College has done for radio here in Constantinople.

Early in 1922 Professor Dyke, then head of the physics department, managed to buy some wireless apparatus from a Russian officer, and had it installed in the laboratory. With its help it was possible to receive most of the European stations and under favorable conditions, Arlington. Unfortunately, however, there was no course in radio, and only a very limited number of students had access to the set. Thus passed the year 1922-23.

In the fall, Henri Moreau, a student of Electrical Engineering, took the set to pieces and built it up anew. This arrangement consisted of two radio frequency stages, one detector and one audio frequency stage. It was a vast improvement over the old hook-up. Let me mention that Mr. Moreau was one of the first amateurs in Constantinople, and had already built a number of reliable sets which could be operated on a loop.

The antenna at the Laboratory was changed to a longer and higher one, and experiments were started, with the result that one day a voice giving a lecture in Berlin was heard over the ether. This started the craze going. Heretofore only the students who actually had sets in their homes took an interest in radio. Now practically everybody was bitten by the bug. It is one thing to hear meaningless "dit-dah-dits" in the phones but quite another to receive intelligible words.

There was a rush for information concerning radio. The library was invaded, but unfortunately the knowledge gained from that source proved inadequate. The books on the subject were few and old, some dating even as far back as the commencement of the century. Finally, the students had to fall back on those who had had experience of their own. Of course, being amateurs we did our best, but also, being very few, we did not get along very rapidly.

One day in the spring of 1924, when we thought that everything had started to go all right, down came the thunderbolt. The government made an announcement stating that all illegal owners of radio sets would have their apparatus confiscated, and would be, moreover, subjected to a heavy fine, and possibly imprisonment. We could have wept as we saw our work come tottering down. We knew Doctor Gates, the president, too well to think that he would risk getting into difficulties with the government over such an unimportant thing as a radio set. The next day when we came to college the antenna was down and the apparatus had been taken to pieces.

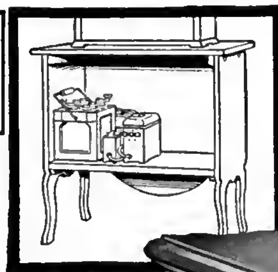
This had exactly the same effect upon us as a bucket of cold water. At first we were shocked but afterwards, when the reaction set in, we glowed all over with impatience, and vowed that since we could not continue working publicly in college, that we would work secretly in our own homes. We used our loops and continued as before in perfect security. There was nothing to attract attention outside the building and therefore nobody ever dreamt of troubling us. Thus passed the year 1923-24.

Professor Tubini, acting dean of the Engineering College, and head of the electrical department, now came to our aid. He was interested in radio, and besides, he was a business man. He went to England, made a special study of radio conditions there, and returned. He brought back a very expensive and modern three-tube set purchased from the Marconi Company. It is one thing, however, to buy a set, and quite another to get it into Constantinople. Professor Tubini went to Angora to get the necessary permission. If I am not mistaken it took him three months to get it, but it was well worth the trouble for he not only got permission to use

Winsdor Wall or Table Type Cone Speaker Amazes Radio World

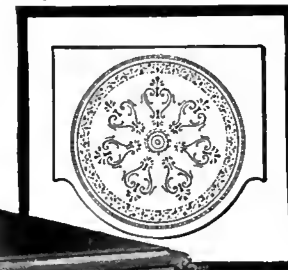
Model 210
(Pat. Applied For)

The latest model Windsor Cone Loudspeaker has astonished the world of radio. In convenience, quality of reception, and extremely low price, it far surpasses anything yet offered. The cone is 22 inches in diameter and is supported by an easel back. It can be hung up on the wall, as in the picture above, or stood upon any flat surface as shown in the picture below. It contains the famous Windsor loudspeaker unit noted for its extreme clarity and fidelity of reproduction.



Rear view at left shows large compartment with ample space for batteries, battery charger, or battery eliminator, which are entirely concealed from view. Back is open for ventilation of batteries.

At right is shown the Cone Loudspeaker, with its panel, which is quickly and easily removable, allowing instant access to all batteries, battery charger, battery eliminator or other equipment and wiring.



Model 200

$29

Console with Cone Loudspeaker Ready for Set and Batteries

(West of Rockies, $35)

(Pat. Applied For)

Model 200—with 22-inch Cone Loudspeaker

This Windsor Cone Loudspeaker Console is equipped with a 22-inch Windsor Cone Loudspeaker. Its top is 30" x 17" and is 29" high. The battery shelf provides ample space for batteries, charger, battery eliminator and other equipment. Beautifully finished in either Mahogany or Walnut.

Model 210
22-inch Cone Loudspeaker with easel back

$15.00

(West of Rockies $18)
(Pat. Applied For)

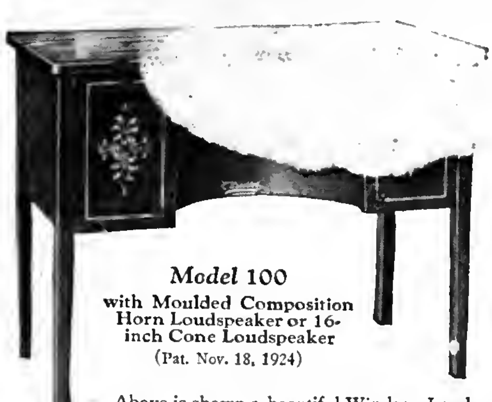
This is the Fastest Selling Line of *Loudspeakers and Loudspeaker Consoles* in the Radio World Today

The quality of radio reception made possible by Windsor Cone and Horn Loudspeakers and Loudspeaker Consoles so far surpasses anything heard heretofore that it amazes and delights every radio enthusiast. The Windsor Line is so complete that everyone can find in it a loudspeaker, loudspeaker table, or loudspeaker console exactly to fit their particular needs.

Model 302 (Shown below)
With Moulded Composition Horn Loudspeaker and 18-inch Cone Loudspeaker.

(Pat. Applied For)

In this Windsor Console is combined both the Windsor Moulded Composition Horn Loudspeaker and the 18-in. Windsor Cone Loudspeaker. The top is 30 in. x 17 in. and stands 29 in. high. Plenty of battery and equipment space is provided by large shelf in rear. Price, finished in Mahogany or Walnut **$48.00**
(West of Rockies, $55)



Model 100
with Moulded Composition Horn Loudspeaker or 16-inch Cone Loudspeaker
(Pat. Nov. 18, 1924)

Above is shown a beautiful Windsor Loudspeaker Console, finished in either Walnut or Mahogany, which provides ample space on top for any radio set. The battery shelf beneath will accommodate all necessary equipment. Equipped with either Moulded Composition Horn or 16-inch Cone Loudspeaker. Size: 38 in. x 18 in., and 29 in. high. Price **$40.00**
(West of Rockies, $42.50)

To the right is shown the newest Windsor Loudspeaker Console. It is equipped with a 22-inch Cone Loudspeaker and cabinet suitable for 7-inch radio panels up to 26 inches in length. Battery shelf provides ample space for all equipment. Beautifully finished in either Walnut or Mahogany. Price (without receiving set) . . **$44.00**
(West of Rockies, $52.00)

(Pat. Applied For)
Model 1000
with 22-inch Cone Loudspeaker

Note to Dealers: Write or wire today for details of the highly profitable Windsor line.

Electrical Department

WINDSOR FURNITURE COMPANY

1412 Carroll Avenue • CHICAGO, ILLINOIS

Los Angeles Branch—917 Maple Avenue

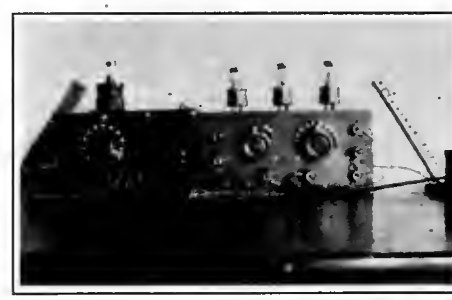
the set, but also to install a laboratory and give courses in radio.

When we heard the glad news we could hardly contain ourselves. There was something doing at last. With the governmental permit in our hands we were established forever, free to carry out our experiments with lots of apparatus and information at our service.

The Marconi set was installed in the chapel, which is our assembly hall, chiefly for recreation purposes. The first night the hall was crowded. Even the cooks and the servants came to hear this wonderful new "voice out of the sky." The people were lucky, indeed, because the program came in beautifully, without a trace of static, which is quite unusual for Constantinople.

Had it not been for the ships in the harbor, which continue until 10:30 p. m., reception might have been said to have been perfect. You should have seen the Russian servants stare when they heard the "International" come booming in through the loud speaker from Moscow. They are all Czarists. Rome and Paris came in very loudly and so did Germany. England, although quite clear, did not have so much volume.

Practically all went home that night interested. Many new devotees to the cause of radio had been made, and when, at the beginning of the second semester, a course in wireless was started, Professor Tubini did not find an empty class room.



THE AUTHOR'S FIRST VALVE SET

The valves (vacuum tubes) employed are of English manufacture. The pick-up device is a loop antenna nailed to the wall behind the receiver

The laboratory equipment was of English make, and was received at the beginning of the second semester just in time for the classes.

Professor Tubini did much to encourage the amateurs. He imported apparatus for them at a very low price, and also arranged it so that goods could be sold in town at a reasonable cost. In short, he facilitated the task of the amateur a great deal. Heretofore the radio fan had to depend on second-class equipment, often unreliable, bought from soldiers or sailors, or else had to import it and this took a considerable time.

It took three years to establish a wireless set in Robert College. It took three years to obtain permission to teach and install a radio laboratory. Had it taken ten years, again I would affirm that the time spent was not in vain. Robert College graduates have a high social position throughout the Near East. Many statesmen and persons of influence have come up from her ranks. To have such men interested in radio means the spreading of the art in their respective countries. It means that the government regulations will become more liberal and that restrictions will no longer exist. It means that everybody will be able to make use of a great art and stretch out into foreign countries and glean information and entertainment which they otherwise could never have afforded. In short, it is the opening of a new world to the war-tired people of the Near East and perhaps is one way of helping to solve the problem of international peace.

A KEY TO RECENT RADIO ARTICLES

By E. G. SHALKHAUSER

THIS is the sixteenth installment of references to articles which have appeared recently in various radio periodicals. Each separate reference should be cut out and pasted on cards for filing, or pasted in a scrap book either alphabetically or numerically. An outline of the Dewey Decimal System (employed here) appeared last in the January, Radio Broadcast, *and will be reprinted in an early number.*

R343. Electron-Tube Receiving Sets. Receiver, *Infrodyne.*
Radio News. Oct., 1926. Pp. 356-ff.
"The Infradyne," H. Green.
The principles upon which this receiver is built are not unlike those of the common and well-known super-heterodyne, differing only in the method in which the intermediate stages deliver the energy to the detector tube. This intermediate stage does not tune to the difference of frequencies of the local oscillator and the incoming signal but to the sum frequency, thus utilizing the very short wavelengths for amplification. This eliminates interference from long-wave stations, stray heterodyning, and all harmonics, so that stations are tuned-in on only one point of the dial setting. A description of this receiver is given in detail.

R347.7 Patent Practice. Patents.
Popular Radio. Nov., 1926. Pp. 651ff.
"How to Patent Your Radio Invention," E. H. Felix.
The writer gives pertinent advice to radio experimenters on the subject of patents and patent practice. Every inventor should ask himself the following questions before applying for a patent:
(1). Does the device perform a service so useful that a sufficient number of people will pay enough for it to yield you a substantial profit?
(2). Is the service performed by the device a new one, or is it accomplished by your device much more economically, efficiently, and satisfactorily than by other existing devices?
(3). Is it sufficiently simple of manufacture to permit it to be made in quantity at a profit?
(4). Does it fill a need sufficiently obvious to its prospective users that it can be sold to them without excessive advertising and promotion cost?
What to patent and what not to patent, how to proceed with a patent application, and the rules of patent practice in general, are discussed.

R553. Meteorological Signals. Meteorological Signals.
Popular Radio. Nov., 1926. Pp. 656ff.
"Radio Transmits Weather Maps to Ships," S. C. Hooper.
The Jenkins system of picture transmission is described as being used for broadcasting the daily weather maps to ships. A photograph of a transmitted map is shown.

R343. Electron-Tube Receiving Sets. Receivers, *Crosley, Murad, Freshman.*
Popular Radio. Nov., 1926. Pp. 656ff.
"Inside Information on New Radio Receivers."
In this third series of articles on new receiving sets, the following receivers are discussed in detail. The New Model Crosley 5-50 receiver: The Murad Super-Six receiver; The New Model Freshman Console.

R281.71. Quartz. Quartz Crystals.
Radio. Nov. 1926. Pp. 27ff.
"The Operation and Construction of Quartz Crystals," J. B. Dow.
A theoretical discussion on the properties of quartz crystals is presented. A quartz crystal has three axes spoken of as the optical, the electrical, and the third axis. The laws pertaining to such a crystal are determined by applying pressures or stretching forces along these three axes. These laws are explained. The operation of such a crystal, when placed in the grid of a vacuum tube, is to set up continuous oscillations when the plate circuit has the same resonant frequency as the mechanical vibrations of the crystal. Details are given on the relation of a good crystal, the cutting, grinding, and polishing.

R343.7. Alternating-Current Supply. Power-Pack, *the LC.*
Popular Radio. Nov., 1926, Pp. 638-642.
"How to Build the LC Senior Power Pack," L. M. Cockaday.
A "power pack" unit which supplies the A, B, and C voltages for a 210 tube, B voltage for all the tubes in a receiver, and C voltage, is described. Diagrams on construction and assembly, as well as operating instructions, are given.

R110. Radio Waves. Waves, Radio.
Popular Radio. Nov., 1926. Pp. 643ff.
"Waves and Wavelengths," Sir. Oliver Lodge.
A simple explanation of sound and light vibrations, and their effects upon our senses, is given. Sound waves are said to be compressions and rarefactions in the air, whereas light waves are thought of as waves in a subtle medium called the ether. The properties of light waves and their characteristics are presented.

R582. Transmission of Photographs. Televisor.
Popular Radio. Nov., 1926. Pp. 649ff.
"The 'Televisor'," O. E. Dunlap.
The transmission of moving pictures by the Baird system has been perfected to such an extent that licenses have been granted in Great Britain for purposes of transmitting and receiving by this system. The details of the method are clearly outlined, only one photo-electric cell being necessary at the transmitting end.

(Continued on page 426)

Build as You Buy!

It goes without saying that you'd like to own the best of radio receivers. You know that the S-M Shielded Six, approved by Radio Broadcast, is just about as good a set as you can buy or build, for it incorporates the very latest engineering ideas you'll find in two to five hundred dollar factory built sets.

Take for example the tone quality, guaranteed to be the most satisfying you've ever heard. Then there's the complete individual shielding of each of the three radio frequency and the detector circuits, so equalized that uniform amplification is obtained at all wavelengths. And you know what the special sensitivity control means—the little knob that lets you go the limit on distance, with only two station selector dials.

You'd like to build the "Six" and feel you had the very best, wouldn't you? And maybe you haven't got $95.00 for the complete kit handy right after Christmas? All right—S-M has made it possible for you to buy just what you can afford—begin your Shielded Six as a one tube set, a three tuber; or better yet, let your dealer show you how you can commence with four tubes for less than $53.00, and have a set to start with that will give you volume and quality on local and medium distant stations.

Then as you want to, you can add to your initial investment little by little, knowing that at each step you discard nothing, buy nothing that you won't use when your Shielded Six finally has the last tube installed and you're confident you've got the best of sets.

Ask your dealer about this new "installment building" idea that lets you buy the finest of sets as you can afford to.

Do you know the secret of quality reproduction?

Have you your copy of "The Secret of Quality"? It tells you simply how to get the most out of your audio amplifier—how to get real quality. It contains laboratory data never before available even to many manufacturers. It is the only authoritative treatise of all types of audio amplification written in non-technical language ever published.

It's free! Ask your dealer for a copy.

Prices 10% higher west of the Rockies.

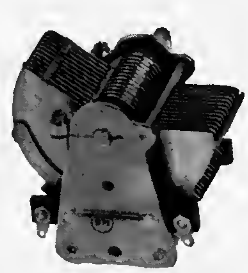
The best recommendation of S-M parts is the circuits for which they have been specified. Here are but a few of the more recent ones.

Infradyne (Improved model)
Shielded Six
Silver-Cockaday
Best's A. C. Browning Drake
Best's A. C. Diamond of the Air
Radio News Batteryless Receiver
Radio Broadcast Super
Radio Age Super
Radio Broadcast Local
LC-27 Junior Power Pack
Citizens Call Book Monotune Receiver
Call Book Power Pack
Callies Super
Radio Mechanics "A", "B" and "C" Eliminator
Radio Engineering "A", "B" and "C" Eliminator
Radio Mechanics Man-O-War Super
Lincoln Super
Best's Short Wave Set
Hush-Hush 11 Short Wave Set
Popular Mechanics Super
Christian Science Monitor 6 tube Browning-Drake
Radio Engineering Short Wave Set
New York Sun "B" and "C" Eliminator for Resistance Amplifier
Chicago American Short Wave Set
Chicago Post Power Amplifier
Best's new Super
Radio News Power Amplifier
Loftin-White
Popular Radio Town and Country Receiver
Radio News Super

SILVER-MARSHALL, INC.

838 West Jackson Blvd.
Chicago U. S. A.

210 Long Wave Transformer $6.00
211 Filter.......... 6.00



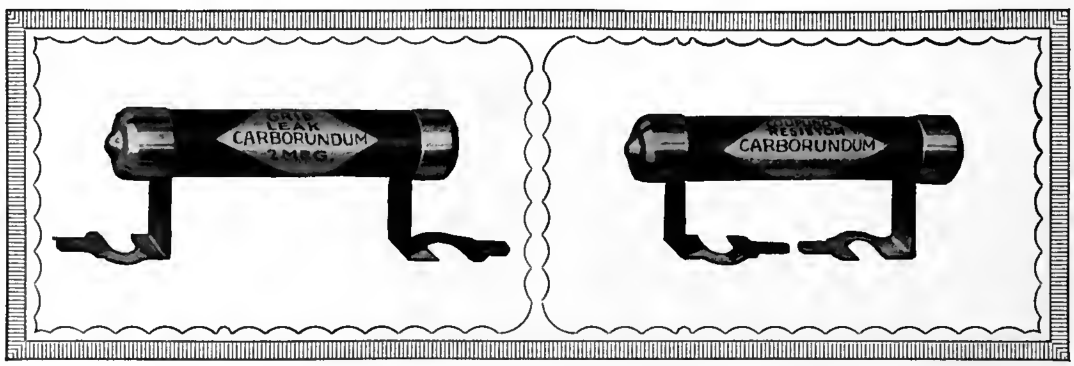
316-A and 316-B Variable Condensers, 00035, $4.50

220 Audio Transformer $6.00
221 Output Transformer 6.00

And Now Announcing!

CARBORUNDUM GRID LEAKS AND COUPLING RESISTORS

REG. U. S. PAT. OFF.



Send for the new Carborundum Hook-Up Book D-2

ABSOLUTELY noiseless—
Do not disintegrate with use or time—
No metallic film but instead a solid rod of dense unbreakable Carborundum—one of the greatest of all electrical resisting materials.
Made in all standard values and tested under actual operating conditions.

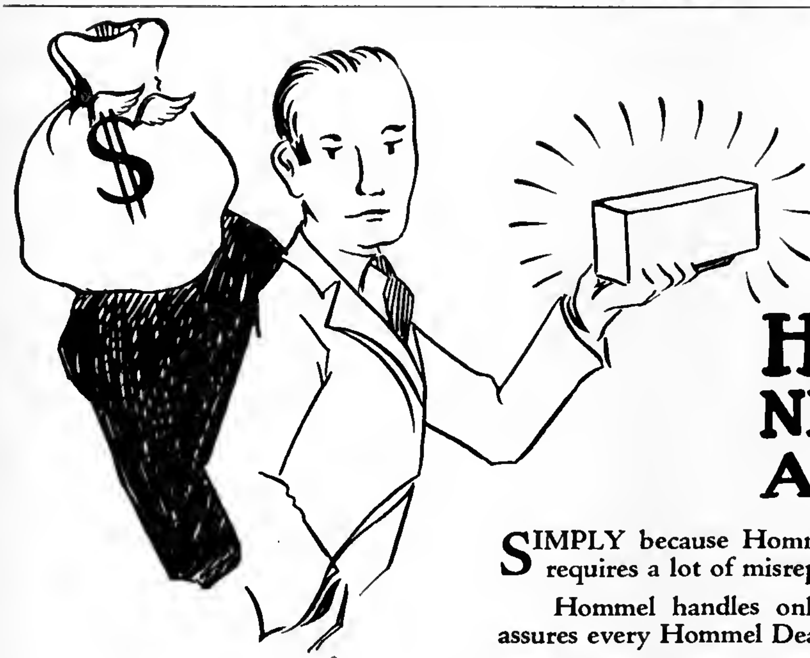
Grid Leaks or Resistors from your dealer or direct, 35c. each

IN ORDERING PLEASE STATE VALUES REQUIRED

THE CARBORUNDUM COMPANY, NIAGARA FALLS, N. Y.

SALES OFFICES AND WAREHOUSES IN

New York : Chicago : Boston : Philadelphia : Cleveland : Detroit : Cincinnati : Pittsburgh : Milwaukee : Grand Rapids
The Carborundum Co., Ltd., Manchester, Eng.



HOMMEL NEVER GOLDBRICKED A DEALER

SIMPLY because Hommel does not buy goldbricked merchandise that requires a lot of misrepresentation to sell.

Hommel handles only the best selling merchandise—the kind that assures every Hommel Dealer a quick turnover.

Hommel's many years of merchandising experience has given him a keen discernment of good and bad selling lines—a good judgment that has built a national reputation for standard and reliable dealer's supplies.

Send for the Hommel Catalogue No. 27-B to-day—and tie up with Hommel—the wholesaler who never retails

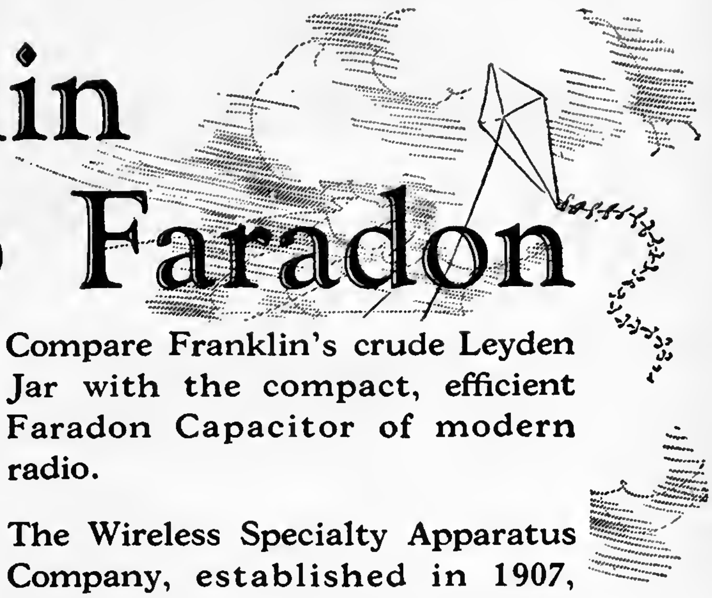
WHOLESALE EXCLUSIVELY

LUDWIG HOMMEL & CO

929 PENN AVENUE PITTSBURGH, PA.

from Franklin

to Faradon



Compare Franklin's crude Leyden Jar with the compact, efficient Faradon Capacitor of modern radio.

The Wireless Specialty Apparatus Company, established in 1907, manufacturers of Faradon, specializes in electrostatic condensers for all purposes.

Model WS By-Pass Unit

Made in
½ M F D
1 M F D
and 2 M F D
Units

For Dependability

insist upon Faradon equipment for your radio set and battery eliminator.

Wireless Specialty Apparatus Company

Jamaica Plain, Boston, Mass., U. S. A.

Made in U. S. A.

Price $10.50

Model WS-3750 "Universal" Filter Capacitor Block

Other models in blocks or individual units with any desired capacities and voltage ratings.

Faradon By-Pass and Filter Capacitors

RECEPTION AT ONE POINT *only* ON THE DIAL

At
ONE POINT
only

Think of It!

There is no reappearance of stations with the *New*

MADISON-MOORE
ONE • SPOT
TRANSFORMER

With this new, improved instrument you log the desired station at ONE particular point on the dial and always bring in that same station at that identical point---not in a half dozen or more places. The intermediate frequency of the MADISON-MOORE *One • Spot* Transformer is of such high value that reappearance of any station in the entire broadcast range is eliminated.

In addition to this fixed *One • Spot* reception, you get Positive Selectivity, Higher Quality and Greater Distance. Yet, the price of this latest model is less than for the former one!

To know the joy of exact selectivity without duplication, and to get a world of Radio Satisfaction, install MADISON-MOORE *One • Spot* TRANSFORMERS.

[*If your dealer can't supply you, write us.*]

MADISON-MOORE RADIO CORPORATION
2524 E Federal Boulevard
Denver, Colorado, U. S. A.

MADISON~MOORE
The Finest* RADIO APPARATUS *in the World!

Insist on hearing RGS this receiver

42 Stations

The R·G·S

Is Your Answer to Present

What the Authorities Say:

ARTHUR H. LYNCH
Former Editor Radio Broadcast
President, Arthur H. Lynch, Inc.

"For practical all round operation it is difficult to find a Receiver which is in any way superior to the National Grimes which was recently demonstrated to me in my home."

* * *

R. W. COTTON
Designer and Inventor of Cotton Super Sales Manager Samson Electric Co.

"I have tested the R. G. S. Receiver thoroughly and it has all the attributes of what I consider to be an exceptional receiver. It has tone quality, selectivity, and sensivity and is one of the few receivers I know of which has been designed for present day broadcast conditions. It will prove particularly satisfactory for broadcast listeners in the Metropolitan areas.

"The R. G. S. Receiver is its own best advertisement."

* * *

VOLNEY HURD
Radio Editor Christian Science Monitor

"Uncramped by former commercial pressure, David Grimes has brought forth a Receiver which has justified his engineering ability. His radio frequency system gives great sensitivity in addition to selectivity that we have seldom seen equaled with six tube circuits let alone four. In his audio frequency he puts his finger right on the source of most transformer coupled difficulties. Radio has need of a set like this this year. Thank you, Mr. Grimes."

Forty-two stations in 30 minutes—each station as clear as a bell—absolutely no "cross talk"—these are the highlights in a simple test made at Boston a few days ago with an assembled R. G. S. Receiver. During the same time and under identical conditions, a receiver conceded to be one of the finest standard instruments on the market was tried. With difficulty, ten stations were brought in. Even some of these interfered with each other. The R. G. S. Receiver meets the challenge of modern broadcast conditions—*conclusively*.

Miami beach at 5:30 in the afternoon from within one half mile of Station WBBR, New York City. Chicago at 6:15 in the afternoon without an antenna! The chaotic condition of metropolitan area broadcasting is eliminated with one gesture. The R. G. S. embodies a design that insures the ability to pick-up stations without "cross talk" not only on the lower half of the dial but on the upper half with equal ease and facility. And most important of all, the R. G. S. Receiver is not critical at any point on the dial. The irksome task of obtaining extremely critical adjustments is abolished.

The R. G. S. does more than raise the standards of selectivity. TONE QUALITY, DISTANCE, SENSITIVITY, VOLUME—they are all there to respond the moment your hand touches the dial.

The R. G. S. receiver, employing a new application of the Inverse Duplex System, is presented, unassembled. It is offered thus to give the radio world immediate advantage of the startling improvements it effects and also in order

DEALERS: ***Write for complete merchandising information***

Built For Modern THESE TOOLS ONLY Broadcast Conditions

Insist on hearing RGS *this receiver*

in 30 Minutes!

RECEIVER

BROADCAST CONDITIONS

to keep the price down to "rock bottom." This kit contains the complete receiver—there is nothing more to buy as far as the instrument itself is concerned. Blueprints and complete instructions for assembling are included.

NO MATTER HOW MUCH advertising is done, the strongest advertisement will be the performance of the instrument itself. The R. G. S. was developed with scientifically selected apparatus. It was not designed to meet a price level, although it is lower in price, with one or two exceptions than any receiver on the market. The R. G. S. was specifically designed, however, to meet (and it does meet) the chaotic conditions that exist in present day broadcast conditions. The new principles of the R. G. S. are not to be found in any other amplifier-receiver equipment.

ALL WE ASK AT PRESENT is that you insist on hearing an R. G. S. Receiver in actual operation. Through our jobbers and dealers we can arrange for a demonstration of an assembled R. G. S. for your particular benefit. Turn the dial of the R. G. S. Receiver with your own fingers, make your own test, draw your own conclusions. As the real authorities in the industry, such as Wing, Cotton, Bouck, Kruse, Lynch, Hurd, etc., have discovered, you will find that every claim we have made is based on real performance. Fill out the coupon below and mail to us.

THE R. G. S. RECEIVER is fully covered and protected by U. S. Patents Nos. 1,517,057 and 1,517,058; by Canadian Patents Nos. 241,602 and 260,787; by British Patents Nos. 204,301 and 225,579; and Australian Patent No. 20,813.

DEALERS: *Write for complete merchandising information*

What the Authorities Say:

WILLIS KINGSLEY WING

Editor of Radio Broadcast

"The new Grimes receiver recommends itself to me because it embodies sound design and some very neat principles. The receiver is 'new' without being 'new and revolutionary' in the unfortunate sense of that term. It is particularly pleasing to see that the excellent and appealingly economic idea of the Inverse Duplex System—deservedly popular for a long time—has been improved and refined, and the result crystallized in this model."

* *

Robert S. Kruse, Technical Editor of Q S T, has operated this Receiver in his home for an extended period of time and approves of its performances and selectivity.

* * *

ZEH BOUCK

Consulting Radio Engineer

" . . . I particularly like the idea of reflexing with resistance coupling.

"We have long lamented the general poor performance of manufactured receivers. It is indeed refreshing to find a designing engineer of commercial equipment, not merely endowed with intelligence himself, but permitted to give full rope to it unhampered by suicidal sales and production departments.

Mr. Grimes's new set is several steps in the right direction."

R. G. S. Sales Division
Grimes Radio Engineering Co., Inc.
285 Madison Ave., New York City

Your R. G. S. Receiver sounds good to me. Please arrange with my dealer, whose address I have given below, for a demonstration at his shop. There is no obligation attached to this demonstration. I am interested in testing for myself if your claims are just claims or if they are founded on fact.

Your Name..............................

Street..............................

City.............................. *State*..............................

Dealer's Name..............................

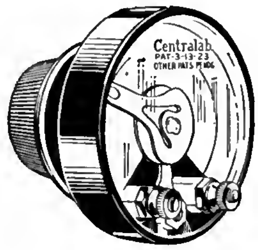
Dealer's Address..............................

BUILT FOR MODERN THESE TOOLS ONLY BROADCAST CONDITIONS

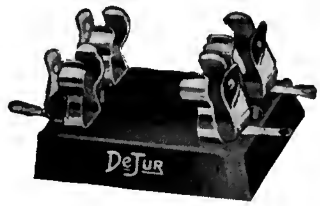
Insist on hearing R·G·S this receiver

"My selection of the recommended apparatus in the R. G. S. Receiver was based on the special scientific requirements of the circuit."—DAVID GRIMES.

Samson Transformer



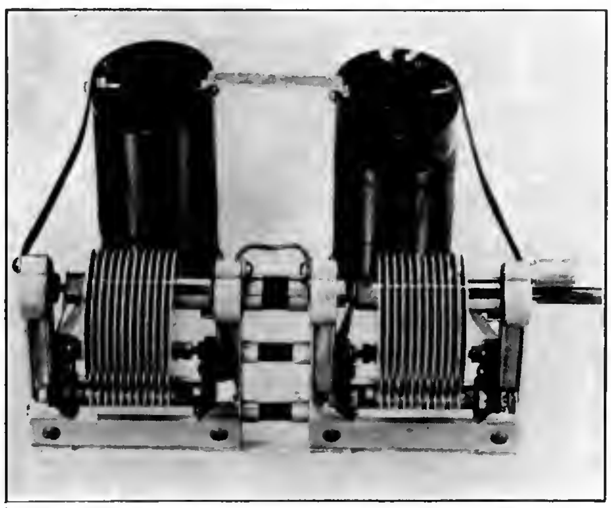
Centralab Potentiometer



DeJur Resistance Mounting

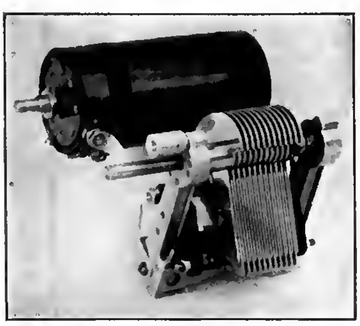
Grimes R. F. Filter Coil and R. F. Choke

Benjamin Socket



[National-Grimes R. F. Tuning Coils—National Condenser]

Sangamo Condensers

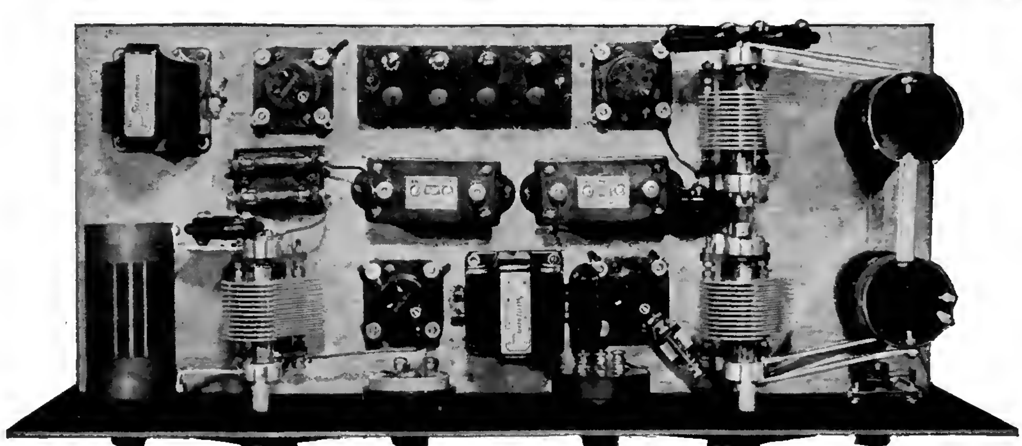


National-Grimes R. F. Tuning Coils
National Condenser

Lynch Resistors

DeJur Variable Resistance

Price
$69.70



Without Accessories or Cabinet

Westinghouse Micarta Panel

R·G·S RECEIVER

DEALERS: *Write for Complete Merchandising Information*

BUILT FOR MODERN BROADCAST CONDITIONS

THESE TOOLS ONLY

NATIONAL
POWER AMPLIFIER

Lynch Resistors, TOBE Condensers Electrad Royalty Resistances, all play their essential part in the excellence of the NATIONAL Power Amplifier

MOST good Radio sets today are sensitive and selective, but many have lagged behind in audio quality. The NATIONAL Power Amplifier brings your present set up-to-date, and makes its performance an unqualified pleasure. Designed in collaboration with Arthur H. Lynch and James Millen, it omits nothing to give quality reproduction.

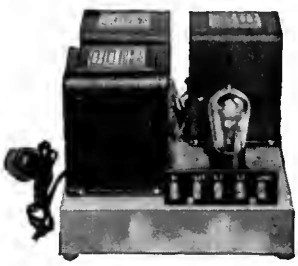
This new instrument contains a complete audio amplifier of a design not hitherto offered to the public, which is arranged to be coupled directly to the detector tube of any receiver. The audio tubes are removed from the receiver and in their place the NATIONAL Power Amplifier passes the detected signal to the loud speaker at any desired volume, which may be sufficient to fill a large hall, still without any impairment of tone or quality.

The amplifier uses one stage of impedance and two of resistance coupling, with an impedance leak on the power tube. High-mu tubes are used for the first two stages and a UX-171 semi-power tube for the output, which passes through a NATIONAL Tone Filter to the loudspeaker. Exceptionally good results have been secured with CeCo Tubes in the amplifier, although other standard makes of high-mu and power tubes give excellent performance, providing their characteristics are approximately the same.

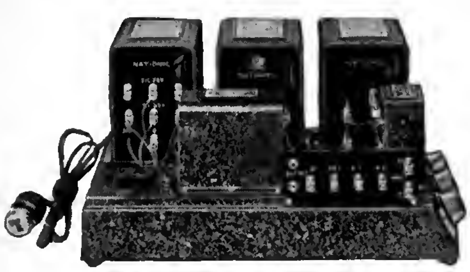
In addition to the audio amplifier, this new NATIONAL Power Amplifier has a complete B-supply for the entire set and the C-voltage for the power tube. Once adjusted it requires no further attention and may be placed in a cabinet beneath the Radio set.

The B-supply portion of the NATIONAL Power Amplifier is designed to be used either with filamentless full-wave rectifier tubes, preferably those which will supply from 80 to 85 mils—or the UX-213 or CX-313 fullwave Rectron Tube. All of the parts whether made by NATIONAL COMPANY or other manufacturers, have been selected only after careful investigation—so as to maintain NATIONAL standards of excellence in this sturdy and thoroughly well designed piece of apparatus.

B-POWER SUPPLY KITS NATIONAL POWER AMPLIFIER KITS



NATIONAL B-Power Unit
Type M



NATIONAL One-Stage Amplifier
Type E-1

NATIONAL Power-Amplifier
Type L-3

In the NATIONAL Power-Amplifier, the Power Units are mounted on a cored and drilled cast metal base with the amplifier. The NATIONAL Power-Transformer carries windings suitable for use either with the new Raytheon BH 80-mil tube or the Rectron UX-213. It also carries a winding for lighting the filament of the power-tube direct from A.C. The Special NATIONAL TOBE B-BLOCK employs extra high-voltage short-path condensers, necessary when so much voltage is being handled. The Filter-Chokes are wound with large wire,—and the iron cores are exceptionally heavy. These power-units will carry 80 mils continuously without heating or damage,—a very high rating. TOBE Buffer Condensers are used. Variable C-voltage for the power tube bias and variable B-voltage for detector and R.F. tubes is supplied at the terminal strip, through Variable Resistances. There is a solidity and excellence of appearance in these B-Supply Units which is a true reflection of the careful engineering design and quality of materials packed within them.

NATIONAL Power Amplifier Kit (Type L-3)

The NATIONAL Power Amplifier is put up in complete kit form by the National Company, except audio tubes. Including the wire and full instructions. The unit may be easily assembled in one evening.

Price—NATIONAL Power Amplifier Type L-3 completely assembled and tested, without tubes; state whether BH type or Rectron 213 type tube is to be used $89.00
BH type tube extra 6.00
Price, NATIONAL Power Amplifier Type L-3 in kit form with full instructions for assembling, complete with BH tube $84.00

The NATIONAL B Power-Unit Kit (Type M)

To meet the large demand for a reliable and rugged B-Power Supply unit, free from difficulties associated in so many minds with such devices, National Company also offers a complete kit with Raytheon BH Tube. This is also provided with a cored and drilled metal base, all necessary wire, and can be assembled in a few hours. It employs the same fine units as the NATIONAL Power Amplifier,—Power Transformer, NATIONAL Special TOBE B BLOCK and Filter Chokes.

Price, NATIONAL B-Power Supply Type M, completely assembled and tested, without tubes; state whether BH or UX-213 type rectifier tube is to be used $60.00
BH Tube extra 6.00

NATIONAL One-Stage Amplifier Kit (Type E-1)

In many cases the Radio owner desires a combined B Eliminator and one-stage power amplifier which can be plugged directly into the output of his present set. The NATIONAL one-stage Power Amplifier meets this need. It contains the same B-Power Units as the NATIONAL B-Power Supply and in addition, one stage of NATIONAL Impedaformer Power Amplification for use with Type 171 Semi-Power Tube,—an adjustable C bias is also included and a NATIONAL Tone Filter.

Price, NATIONAL one-stage Amplifier Type E-1, completely assembled and tested, without tubes; state whether BH or UX-213 type rectifier tube is to be used $68.00
BH Tube extra 6.00

NATIONAL

B-POWER AND AMPLIFIER KITS

B-POWER SUPPLY KITS NATIONAL POWER AMPLIFIER KITS

NATIONAL Equipment for B-Eliminators and Power Amplifiers
NATIONAL Power Transformer

This Transformer, for the construction of Power Units, is designed for use with either Raytheon or Rectron Tubes. The secondary carries sufficient voltage to operate the new Raytheon BH 80-mil Tube and the wire is of sufficient size to permit continuous operation for long periods without heating or damage. The transformer has center-tapped 7.5 volt and 5.5 volt secondaries, for heating the filaments of rectifier tubes or of power tubes, whether of the UX-210, UX-112, or UX-171 type. This makes the transformer adaptable without change to a number of different rectifier and amplifier circuits.

The unit is cased in a heavy pressed metal box, attractively finished in black crackle. The terminal panel is of Bakelite with special NATIONAL screw-type terminals.

Dimensions: $4\frac{1}{8}''$ wide x $4''$ deep x $4\frac{3}{4}''$ high. Built to NATIONAL standards.

Price—with Raytheon BH Tube..................$22.50 each

Price—without Raytheon BH Tube............... 16.50 each

NATIONAL Power Transformer

NATIONAL Filter Chokes (Types No. 35 and No. 80)

These Filter Chokes are made for use in Filter Circuits of plate-supply units.

Type No. 35 contains two iron core inductances and is designed for a maximum continuous output of 35 mils. This is sufficient for the average 5 tube set, with or without one power-tube.

Dimensions: $2\frac{5}{8}''$ x $4''$ x $3\frac{1}{4}''$, finish and type of case to match the NATIONAL Power Transformer.

Price—Type No. 35.................................$7.00

The NATIONAL Filter Choke Type No. 80 is a larger unit containing two iron core inductances wound with larger wire than the Type No. 35 and with larger cores, and capable of handling up to 80 mils continuously, as with the new Raytheon BH Tube.

Dimension: $4\frac{1}{8}''$ x $4''$ x $4\frac{3}{4}''$. Cased to match the NATIONAL Power Transformer.

Price—NATIONAL Filter Choke No. 80 .... $10.00

NATIONAL Filter-Chokes

Tobe Special B Block
built for use with NATIONAL B Eliminators and Amplifiers

This Special TOBE B BLOCK, designed expressly for the NATIONAL B Eliminators and Amplifiers, contains TOBE High-Voltage *short-path* Type Condensers, suitable for working voltages up to 400-volts D.C. It is not guaranteed for use with UX-216-B tube when more than 400 volts is being rectified with it (*a higher voltage condenser block is required for this purpose; prices sent on request*).

Dimensions: NATIONAL $4\frac{1}{8}''$ x $4''$ x $4\frac{3}{4}''$.

Price—TOBE SPECIAL B BLOCK..............$17.50 each

NATIONAL Special Tobe B Block

NATIONAL Tone Filter

The plate voltages now required with either the UX-171, UX-112 or UX-210 Power Tubes, for fine quality of reproduction, range from 180 volts upward. The makers of the tubes recommend passing the output to the loud speaker through a Tone Filter. The NATIONAL Tone Filter is designed for this purpose. It contains an impedance of the proper value through which the plate of the Power Tube is supplied, a 2 Mfd. TOBE Filter Condenser, through which the A. C. com ponent of the power tube output passes to the speaker. With this NATIONAL Tone Filter all D.C. is kept out of the speaker windings, thus preventing them from burning out, and at the same time the quality of the output is greatly improved, because no force is exerted on the speaker armature, except that due to the signal. Cased to match the other NATIONAL B-Power units, supplied with 5-foot phone cord, for instant attachment to any existing set.

To install put the tips on the end of the phone-cord plug in speaker jack on the set and insert speaker cord into the two tip-jacks marked LS on the panel of the Tone Filter.

Dimensions: $2\frac{5}{8}''$ x $4''$ x $3\frac{1}{4}''$ high.

Price—NATIONAL Tone Filter.................$8.00 each

NATIONAL Tone Filter

NATIONAL products are built to engineering standards of excellence. Anyone who has ever built a set using NATIONAL BROWNING-DRAKE Coils and Transformers knows what that means. Send for Bulletin 116-RB.

National Co., Inc., Engineers and Manufacturers—W. A. Ready, Pres., Cambridge, Mass., Makers of NATIONAL BROWNING-DRAKE Coils and R. F. Transformers, Impedaformers, Condensers, Power Transformers, etc., for Radio.

NATIONAL
B-POWER AND AMPLIFIER UNITS

B-POWER SUPPLY KITS NATIONAL POWER AMPLIFIER KITS

CLAROSTAT

Scores again!

Isn't it significant to users of variable resistances that the NATIONAL-LYNCH Power Amplifier and B eliminator—the quality job of the year—is equipped with CLAROSTAT.

CLAROSTAT, the greatest variable resistor, is standard equipment not only in the apparatus of the National Co., but in the products of 90% of the B eliminator manufacturers of the country.

Have you sent for your copy of "THE GATEWAY TO BETTER RADIO"? The edition is limited and you can't afford to be without it. 32 pages covering everything. Send 25c to Dept. R. B.

American Mechanical Labs. 285 N. 6th St., B'klyn

Endorsed by Leading Radio Authorities and Specified by Arthur H. Lynch for the

National Power Amplifier

See Specifications

Two CeCo Type "G"

HIGH MU TUBES

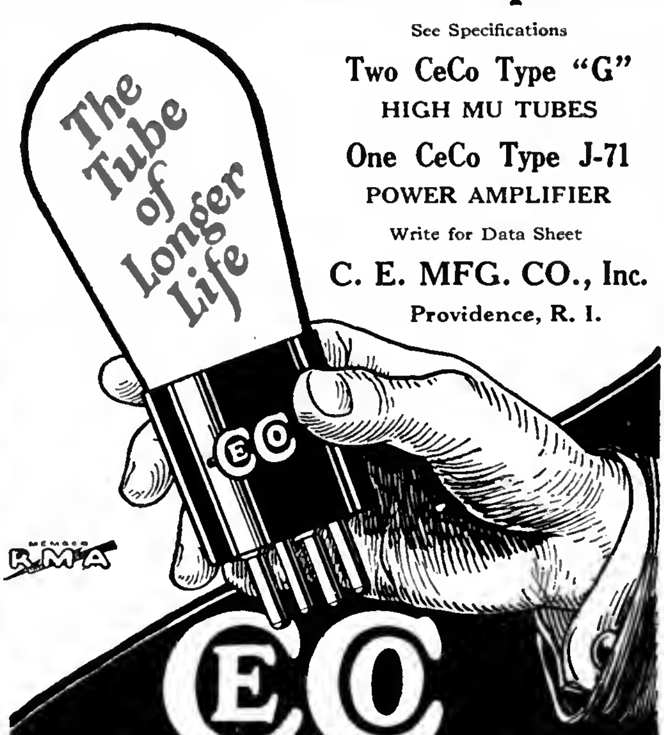
One CeCo Type J-71

POWER AMPLIFIER

Write for Data Sheet

C. E. MFG. CO., Inc.

Providence, R. I.



A Type for Every Radio Need

Chosen by EXPERTS

JAMES MILLEN, Lawrence M. Cockaday, Gerald M. Best, and many other eminent radio designers use the Lynch Metallized Resistor in their experimental circuits and receivers. These men *know* radio; they have laboratory and testing equipment with which quickly to make accurate comparisons. There could be no better proof of the true merit of the Lynch Metallized Resistor than the endorsement of these experts.

Comprising a concentrated metallized deposit one-thousandth of an inch thick upon a rigid core, sealed forever within a glass tube, the Lynch Metallized Resistor gives *conductive*, non-arcing resistance that remains silent, accurate!

Guaranteed accuracy—10%; in production they average 5%. .25; 5; 1; 2; 3; 4; 5; 6; 7; 8; 9; 10 Meg., 50c. .025; .09; .1 Meg., 75c. Single mounting 35c; Double, 50c. If your dealer cannot supply you, send stamps, check, or money order. We ship postpaid same day order is received.

PRICES:

.25 to 10 Megohms .50. Above .01 to .24 Megohms .75
.001 to .01 Megohms $1.00.

Write us for complete list of ranges

Dealers all over the country and abroad are concentrating on dependable Lynch Metallized Resistors—"the line of least resistance," no "grief," and steady turnover—due to adequate advertising.

Get on our mailing list: we keep you posted on new developments. Write us to-day!

ARTHUR H. LYNCH, Inc., Fisk Bldg., Broadway & 57th Street, New York

LYNCH METALLIZED FIXED RESISTORS

TOBE

A Special TOBE B-BLOCK with hi-voltage condensers was chosen for use in the NATIONAL POWER AMPLIFIER. TOBE Buffer Condensers are used in the B-Supply Units also, and each audio-coupling condenser is a 0.1 Mfd. TOBE. The NATIONAL Tone-Filter uses a big TOBE, too.

TOBE Condensers are used because they are good condensers. Ask your dealer for TOBES and TOBE B-BLOCKS.

Tobe Deutschmann Co.

Engineers, Manufacturers, Importers of Technical Apparatus

CAMBRIDGE - - - MASS.

QUALITY DONGAN PRODUCTS

No. 3527 Unit

Increase the Volume of Your Present Set

It is easy now to get much greater undistorted power from your present radio receiver whether it has 2 tubes or 8 tubes. At the same time and at little additional expense you eliminate the need of B-Batteries.

No. 3527 Unit. Full Wave Rectifier for use with one UX 213 tube and power amplifier UX No. 171 tube. This unit includes one No. 2505 transformer and two No. 514 chokes. Full Power and B-Battery Eliminator. No. 3527—$15.00 List.

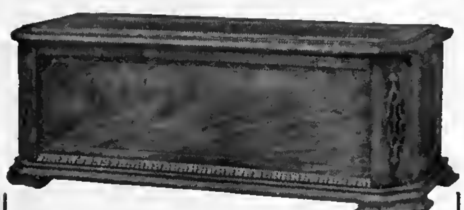
No. 3516. Full Wave Rectifier for use with one Raytheon Bll tube and one UX No. 171 tube. This unit includes one No. 2593 transformer and two No. 514 chokes built into substantial metal case. Exceptional power for all purposes. Eliminates B-Batteries. No. 3516—$13.00 List.

Fans—Send check or money order to factory if your dealer cannot supply you. Deliveries are prompt.

Manufacturers—As exclusive parts manufacturers Dongan offers the receiver and battery eliminator manufacturer a reliable source of supply. Our engineering department will co-operate with you in effecting the proper designs of the latest types for your requirements. Ask for a representative or send your specifications.

DONGAN ELECTRIC MFG. CO.
2991-3001 Franklin St. Detroit, Mich.

TRANSFORMERS of MERIT for FIFTEEN YEARS



MODEL "C" CHEST

Cabinets in stock—have piano hinge and are 10" deep — grooved front top rail being removable. Illustration shows gold line wood panel to match.

Sizes	Walnut Only	Panel to Match
7x18-10	$15.00	$1.26
7x21-10	17.00	1.47
†7x21-12	17.50	
7x24-10	19.00	1.68
*7x26-10	21.00	1.82
7x30-10	23.00	2.10
**7x28-11	23.00	1.96

*For Madison Moore Receiver.
**For Victoreen Receiver.
†For Hammarlund Roberts Hi Q Receiver.

Walnut Infradyne Cabinet
$26.00

LC-27 Cabinets

Mahogany or Walnut with Baseboard

$18.00

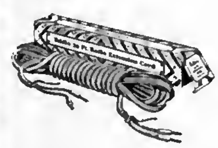
The LC-27 cabinets have 25° slope and take 8x26 panel. They are full 10" deep back of the panel. WRITE FOR folder showing complete LC-27 Line, special Infradyne cabinets, and other Radio Furniture.

CORBETT CABINET MFG. COMPANY
St. Marys - - Pennsylvania

Inside Aerial and Loop Wire

Beldenamel Aerial Wire

Lead-In and Ground Wire



Belden 20-Ft. Radio Extension Cord

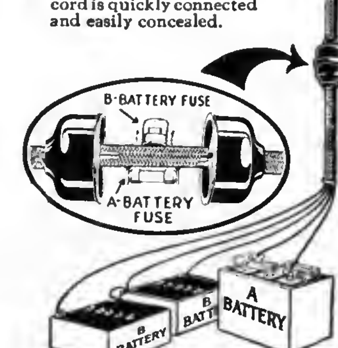
Belden Accessories that *Improve Your Set*

FOR an outdoor aerial, use a Beldenamel Aerial. It cannot corrode or deteriorate. For indoor aerials, use the Belden Indoor Aerial Wire. And do not forget Belden Lead-In and Ground Wire to finish the job. All of these items are included, if you wish, in the new Belden Superadio Antenna Kit.

The Belden 20-foot Loudspeaker Extension Cord brings the loudspeaker where you want it. For safety to tubes and batteries, and protection against fire, use a Belden Fused Radio Battery Cord.

The Belden Fused Battery Cord provides:

1—An A-battery fuse.
2—A B-battery fuse.
3—A polished bakelite cover for the battery fuses.
4—A compact connecting cable that dispenses with loose wires.
5—A color-code on each wire for identifying each circuit.
6—A time saver, because the cord is quickly connected and easily concealed.



Ask your nearest dealer to explain how Belden Radio Accessories help you get better results from your set.

BELDEN MANUFACTURING COMPANY
2312A South Western Avenue Chicago, Illinois

(Continued from page 420)

R 385.5 MICROPHONE. MICROPHONE,
RADIO BROADCAST. Dec., 1926. Pp. 183-184. *Condenser.*
"THE CONDENSER TRANSMITTER,"
A discussion concerning the condenser microphone, its characteristics and peculiarities, is presented. It is compared to the carbon microphone, the latter having certain advantages over the condenser type, although both are used in broadcasting stations.

R582. TRANSMISSION OF PHOTOGRAPHS. TELEVISION.
RADIO BROADCAST. Dec., 1926. Pp. 139-143.
"And Now, We See by Radio!" A. Dinsdale.
A new system of transmission of motion pictures, called the Baird system, is discussed, and details relative to its operation and development are outlined. A comparison is made between the comparative effectiveness of the selenium cell and the photo-electric cell. The system is spoken of in the highest terms and said to be the only real practical system developed to date. Its accuracy in reproducing images and objects is considered to be far greater than that of any other system, this having been shown by actual demonstrations to others. Commercially, it is considered by many to be the only apparatus available at present.

R402. SHORT-WAVE SYSTEMS. SHORT-WAVE
QST. Nov., 1926, Pp. 9-13. TRANSMISSION.
"General Electric Short-Wave Test Results," M. L. Prescott.
In a summary article, the results of the General Electric Company's short-wave transmissions, covering a period of eighteen months, are closely compared. Six stations were operating at frequencies from 20,000 to 2750 kilocycles, at various times during the intensive test period of April, 1926. Experimenters of the A.R.R.L. made observations and these are shown plotted as audibility curves. The curves show decided variations when comparing day and night transmission.

R132. AMPLIFYING ACTION. AMPLIFICATION,
QST. Nov. 1926 Pp. 14-18. *R.F.*
"R. F. Amplification—A Re-Hash," E. B. Lyford.
The problem of controlling oscillations in r.f. stages is summed up, four general methods of stabilizing being enumerated. (1) The potentiometer in the grid return, or in the plate circuit. (2). The losser method in the tube circuits. (3). Hazeltine neutralization method. (4). Reversed tickler method or the bridge compensation method.
A variation of the Rice circuit of neutralization is shown and explained. Dimensional data are given for those who desire to experiment with this method of neutralization.

R330. ELECTRON TUBES. RELAYS,
QST. Nov., 1926. Pp. 20—21. *Electron.*
"A Sensitive Vacuum-Tube Relay," W. H. Hoffman and F. H. Schnell.
A relay used in conjunction with a receiving set to operate sounders, bells, buzzers, etc., is outlined. A signal audibility of R-5, or better, will cause the relay to function. The parts required to build the relay, together with the circuit diagram, serve as a guide to the builder.

R3 4.3. TRANSMITTING SETS. TRANSMITTER,
QST. Nov., 1926. Pp. 22-25. *Crystal-controlled.*
"A Shielded Crystal-Controlled Unit," J. M. Clayton.
A crystal-controlled transmitter, with separate stages of a three-stage oscillator-amplifier circuit shielded, here described, is said to have solved several difficulties experienced in unshielded sets. Tubes of the UX-210 type are used throughout, a maximum of 500 volts being available for the plate potential. Two tubes operate in parallel in the last stage. Complete data on construction and operation, including the circuit diagram, are given.

R220. CAPACITY. CAPACITY
QST. Nov., 1926. Pp. 28-31. STANDARDS.
"The Uses of a Calibrated Variable Condenser," R. B. Roof.
With a well calibrated variable condenser, seven possible uses for it are described: (1). To find the distributed capacity of a coil. (2). To find the inductance of a coil. (3). To match two dissimilar coils so that they may both be tuned by the sections of the same tandem condenser. (4). To find the capacity of fixed condensers. (5). To calibrate other variable condensers. (6). As a wavemeter in conjunction with an inductance. To measure decrement and r.f. resistance. (7). Various uses in oscillating vacuum-tube circuits.
A vacuum-tube driver is needed for the first five uses. In order to indicate resonance several methods, as outlined, may be used.

R113. TRANSMISSION PHENOMENA. TRANSMISSION
QST. Nov., 1926. Pp. 32-33. PHENOMENA.
"Horizontal Wave Experiments at 2AER," J. M. Hollywood.
Data obtained and conclusions arrived at during a series of tests on horizontally and vertically transmitted and received waves on 40 meters (7496 kc.), indicate that a number of theories may be looked upon as supplying information concerning wave propagation. The author speaks of the "pebble in the pond theory," "the radiant ray theory," and the "lines of force theory," all of them being illustrated.

R124. COIL ANTENNAS. LOOP EXPERIMENTS.
QST. Nov., 1926. Pp. 36-40.
Considerable experimental data obtained with a loop receiver-transmitter using tubes no larger than the UX-210, are presented. The circuit diagram of the set itself is shown, together with constructional and operating data, and photographs. The outfit was used mainly for portable work in cars and planes. A Heising modulating system can be connected to it for phone work, as illustrated.

R120. ANTENNAS. ANTENNAS,
The Transmitter. Oct., 1926. Pp. 7-10. *Hertz Type.*
"Hertz Excitation. Something Different," K. M. Ehret.
Whether an antenna will operate better when radiating on harmonics or on the fundamental depends on location, says the writer. A theoretical as well as practical discussion, pertaining to the Hertz form of oscillators, follows, wherein facts of current and voltage feed to the radiating system are clearly outlined. A "re-radiating" antenna (inductive coupling of the main antenna to a secondary oscillator) is suggested as giving very good results.

IT DELIVERS FULL "B" VOLTAGE

Burns

B-Battery Eliminator

Operates from lighting current like other household appliances. No hum or vibrations. Smooth constant plate supply. Once connected it requires no further attention or adjustment. Remarkable results on local and long distance reception.

Popular Price—Write for Data

American Electric Company
State and 64th Streets **Chicago, U. S. A.**
Makers of Burns Speakers

The New 6-Tube

ELKAY

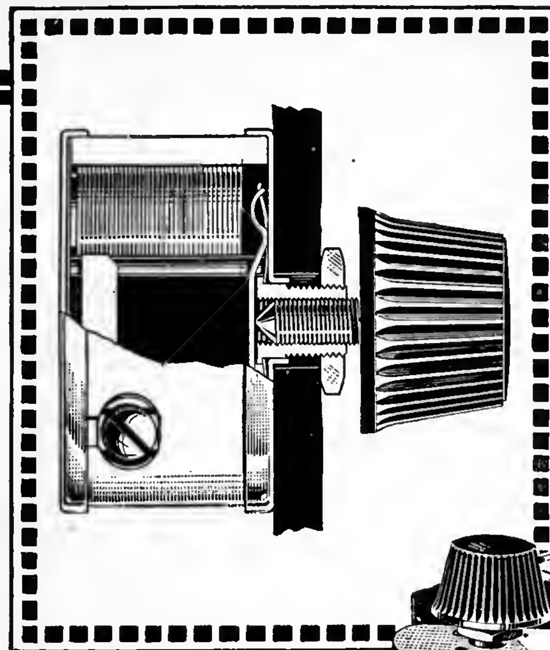
TRADE MARK REG.

With Donle Truphonic Audio Amplification

which delivers pure tone in any volume over the entire tonal scale, and the patented Elkay Synauto R. F., which smoothes out the tuning over the whole dial from 200 to 580 meters—is a receiver that will be modern for years to come.

Completely shielded. Neat Uni-Control—the flexibility of 3 dials at your finger tips. In brown antique. Duco-finished mahogany, $125. (Exclusive franchise to the Trade).

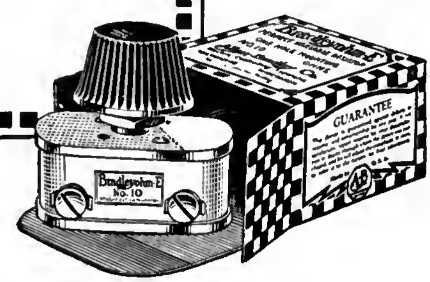
The Langbein-Kaufman Radio Co.
Dept. R
62 Franklin Street, New Haven, Conn.



Bradleyohm-E

PERFECT VARIABLE RESISTOR

This new oversize resistor is used as standard equipment by leading B-Eliminator manufacturers such as Acme, All-American, Majestic, Philadelphia Storage Battery and Willard. The scientifically-treated discs provide stepless, noiseless, plate voltage control, and the setting will be maintained indefinitely.



Use Allen-Bradley Resistors for B-Eliminator Hook-Ups

ALLEN-BRADLEY research engineers have developed a series of variable and fixed resistors especially suited for B-Eliminator hookups. The success of their efforts is indicated by the fact that Allen-Bradley resistors, both variable and fixed, are used by more than fifteen B-Eliminator manufacturers, including European as well as the largest American manufacturers.

Bradleyunit-A

PERFECT FIXED RESISTOR

Another triumph of the Allen-Bradley Research Laboratory is Bradleyunit-A, a perfect fixed resistor that contains no glass, requires no hermetic sealing, and can be soldered into place without the use of clip mountings. Bradleyunit-A is not affected by temperature or moisture.

The silent, smooth control of plate voltage so essential in B-Eliminator service is obtained with Bradleyohm-E. For fixed step adjustment of voltage, Bradleyunit-A is recommended.

Do not experiment with make-shift resistors when these Allen-Bradley units have been pronounced the ideal units for B-Eliminator service.

Ask your dealer for them, today!

ALLEN-BRADLEY COMPANY,
278 Greenfield Avenue,
Milwaukee, Wisconsin

Please send me your literature on Allen-Bradley radio devices and B-Eliminator hookups.

Name ....

Address...

....

R111. ELECTROMAGNETIC THEORY. ETHER WAVES.
Popular Radio. Nov., 1926. Pp. 635ff.
"Are There 'Ether Waves' After All?" E. E. Free.

Experiments conducted by Prof. D. C. Miller, of Cleveland, Ohio, on the problems of the existence of the ether have received considerable attention, due to the claims put forth that a slight ether drift has been detected. The Michelson-Morley experiment showed no ether drift, and Einstein's Theory was based on this evidence. Dr. Miller's experiment consisted in measuring the interference fringes of light passing in different directions. He obtains a variation of speed of light parallel to the axis of the sun of about 6 miles per second, and believes that the whole solar system is falling through space at an actual speed of about 120 miles per second. This coincides remarkably well with astronomical observations.

R120. ANTENNAS. ANTENNAS. *Principles of.*
Proc. I. R. E. Oct., 1926. Pp. 675–688.
"Field Distribution and Radiation Resistance of a Straight Vertical Unloaded Antenna Radiating at One of Its Harmonics," S. A. Levin and C. J. Young.

The operation at the harmonics of the grounded antenna, and of an ungrounded antenna at any distance above ground, has been considered as far as current, voltage and power distribution, electromagnetic field, and radiation resistance, are concerned. The antenna is always assumed to be a straight vertical wire and unloaded. The ground is supposed to be a perfect conductor.

R140. RADIO CIRCUITS. RADIO CIRCUITS, *Calculation of.*
Proc. I. R. E. Oct., 1926. Pp. 689–693.
"A Method for Maximization in Circuit Calculation," W. Van B. Roberts.

Having found the expression for a current (or voltage, or power, etc.) in terms of complex quantities representing the constants of a circuit, it is often desired to determine what value of some one of these complexes makes the absolute magnitude of the current (or voltage, etc.) a maximum or a minimum. Rather than reduce the expression to its absolute value first, and then maximize in the usual way, it is often much less tedious to differentiate the expression while in the complex form. The condition for which the absolute value is an extremum is then not that the derivative is equal to zero, but that the derivative multiplied by a small increment of the independent variable gives to the dependent variable an increment which is at right angles to the vector representing the dependent variable itself. The condition of maximum obtained by this method is often in a form that is more compact and that has obvious physical significance. Two examples of the use of the method are given.

R134. SUPER-HETERODYNE. SUPER-HETERODYNE, *Origin of.*
Proc. I. R. E. Oct., 1926. Pp. 695–698.
"On the Origin of the Super-Heterodyne Method," W. Schottky.

In this discussion the author points out how, in his opinion the super-heterodyne method of ether wave reception was first conceived by himself and others while doing research work in the Siemens Laboratory, Germany, during the war period. This idea was patented in 1917, and another in June, 1918. These are said to be older than the original Armstrong patent, pertaining to the same methods of reception.

R113.4. HEAVISIDE LAYER. HEAVISIDE LAYER.
Wireless World (London). Sept. 8, 1926. Pp. 359–360
"Conditions Under Which Short Waves Penetrate the Heaviside Layer," E. V. Appleton.

The writer discusses the changes that transmitted wireless waves of various wavelengths undergo when meeting the Heaviside Layer. On the longer waves, it is said, the conductivity of the upper atmosphere is equivalent to that of a sheet of copper one meter in thickness. However, the penetrating powers of the shorter waves, their peculiarities as made manifest by the skipped distances, makes it probable that energy penetrates the Heaviside Layer. Somewhere between one and ten meters all of the transmitted rays are said to leave the earth and escape.

R610. STATION DESCRIPTIONS. STATION, *KDKA.*
Wireless World (London). Sept. 22, 1926. Pp. 413–416.
"KDKA, 309.1 Meter Transmitter."

A description of station KDKA, East Pittsburgh, is given. Details relating to construction and the constants of the antenna system, the oscillator, modulator, and amplifier units, the power supply, and the control system, are discussed. Photographs and drawings accompany the article. The station is said to operate at an efficiency of 67 per cent.

R344.5. ALTERNATING CURRENT SUPPLY. RECTIFIER, *Ruben.*
Wireless World (London). Sept. 22, 1926. Pp. 423–424.
"The Ruben Rectifier," A. Dinsdale.

A solutionless electrolytic rectifier, developed by an American named Ruben, and known as the Elkon rectifier, is described. It is composed of two discs between which a film is formed when connected to the circuit. The principle of operation is not disclosed.

R320. ANTENNAS. ANTENNAS, *Resonance.*
Wireless World (London). Sept. 29, 1926. Pp. 451–453.
"Frame Aerial Crystal Reception," W. H. F. Griffiths.

The effects produced when tuning a distant antenna to resonance with a broadcast station are outlined. If the currents induced in this way are appreciable, the receiving antenna will radiate and thus increase the signal strength for a neighboring receiving set, which is also tuned to the same wave. A loop antenna was used to obtain the results outlined and graphed.

R343. ELECTRON-TUBE RECEIVING SET. RECEIVER, *New "Universal."*
RADIO BROADCAST. Dec. 1926. Pp. 154–158.
"The New 'Universal' Receiver," H. E. Rhodes.

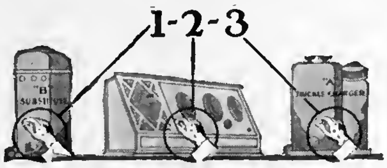
This receiver is a revised model of the R.B. "Universal" described in RADIO BROADCAST for Jan., 1926, pp. 331–336, and uses the Roberts system of neutralization, condenser control of regeneration, and a two-stage transformer-coupled audio frequency amplifier. The article presents the diagrams, the assembly information, and data on construction and testing.

The Old Way

each time you turned your set on or off you had to operate

3 Switches

1-2-3



NOW–

you operate everything with **ONE** switch–the SET SWITCH

BRACH

CONTROLIT

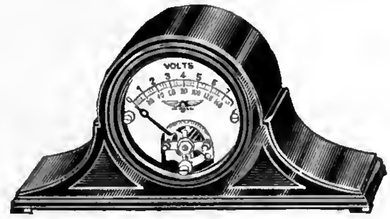
DOES IT –AUTOMATICALLY

Manufactured by the Makers of the Famous BRACH LIGHTNING ARRESTERS

L. S. BRACH Mfg. Co.
NEWARK, N. J.
TORONTO, CAN.

JEWELL

February—



Pattern No. 135-C

Broadcast listeners are now enjoying the best reception conditions of the year. Better radio reception, however, can be had by exact regulation of filament voltage.

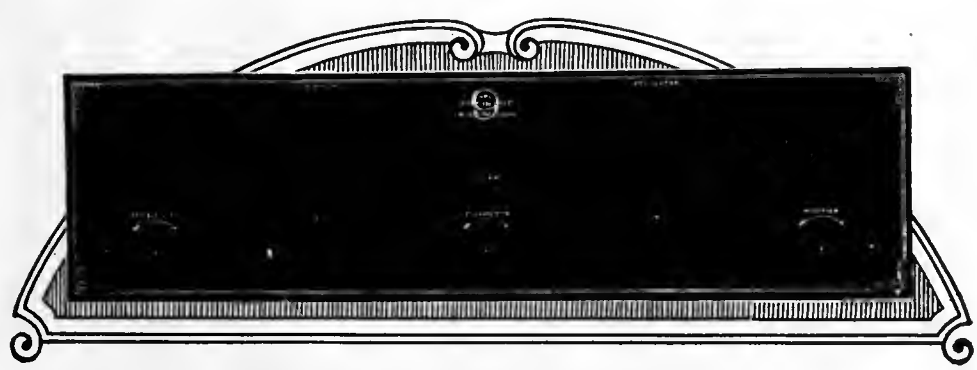
Moving parts are silvered. The double range scale has black characters on a silvered background. The movement is of the D'Arsonval moving coil type, equipped with standard zero adjuster. Enclosing case is of polished black bakelite. It is a very beautiful as well as highly accurate instrument.

Pattern No. 135-C "DeLuxe" Radio Voltmeter is ideal for filament control, A-B and C battery testing, circuit checking and all around radio use. It is much more desirable for radio test work than the ordinary voltmeter, as it can be used for portable test purposes, and also perform all tip jack tests. Its two ranges are ample for all radio check and test work.

Send for our descriptive form No. 1016 and also ask for our catalog No. 15-C

Jewell Electrical Instrument Co.
1650 Walnut St. - - - Chicago
"26 Years Making Good Instruments"

RADIO MANUFACTURERS' ASSOCIATION RMA MEMBER



FORMICA KIT PANELS

FROM one end of the country to the other, home set builders are producing handsome radio sets by the use of Veri Chromed Formica panels for the leading kits.

These panels include the Karas Equamatic, Bremer Tully Power Six, H. F. L. Nine-In-Line Superheterodyne with sub panel, Victoreen single dial and two dial. There is also an Infradyne 7 x 28″ and 7 x 30″ Aerodyne, St. James 8 Tube, Bremer Tully Counterphase, Browning Drake National, Madison Moore Superheterodyne, Camfield Duoformer. They are sold by the leading jobbers and dealers.

Special Panels cut to size and Formica Tubing are also available for Amateurs

The FORMICA INSULATION COMPANY
4616 SPRING GROVE AVENUE CINCINNATI, OHIO

Hear the FORMICA Orchestra Tuesday 9 to 10 over WLW

FORMICA
Made from Anhydrous Bakelite Resins
SHEETS TUBES RODS

Formica has a Complete Service on Insulating Material for Radio Manufacturers

R156. TRANSFORMERS TRANSFORMERS AND CHOKES.
Wireless World (London). Sept. 29, 1926. Pp. 455–458.
"Magnetic Circuits of Choke Coils and Transformers," S. O. Pearson.

In designing choke coils and transformers for radio circuits, it is important to keep in mind that in many parts of these circuits the coil must carry both d.c. and a.c., says the writer. If the d.c. component saturates the iron, practically no choking effect is produced by the coil. The principle is outlined diagrammatically by curves showing the variation of current taking place in the anode circuit and the magnetic flux density. The use of air gaps is supposed to greatly increase the magnetizing current, but, at the same time, reduces the effective inductance of the coil.

R113.6 REFLECTION IN LOUD SPEAKERS. LOUD SPEAKER
Wireless World (London). Oct. 13, 1926. REFLECTION.
Pp. 506–508.
"Acoustic Reflection," N. W. McLachlan.

The discussion concerns the effect of resonance when loud speakers are located in rooms where echos occur. The reflections produced will determine the proper placing of loud speakers for best results on the low as well as the high frequencies.

R005. EXECUTIVE; ADMINISTRATIVE. PROBLEMS OF
RADIO BROADCAST. Dec. 1926. RADIO INDUSTRY.
Pp. 144–145.
"What the Future Holds for the Radio Industry," F. Strother.

In discussing the problems of the radio industry, comparison is made between two companies—the National Cash Register Company and the Radio Corporation of America; the former with one aim, one purpose, the latter with a variety of purposes. The RCA is called an artificial organization, because it lacks the natural foundations of a business enterprise, *i.e.*, a purely commercial origin, singleness of purpose, and positiveness of control. The importance of commercial skill, inventive talent, or manufacturing skill, is considered as valuable as the possession of patents. The final analysis is sketched as resolving itself into a problem of "the survival of the fittest."

R115. METEOROLOGICAL. WEATHER AND RADIO.
RADIO BROADCAST. Dec., 1926. Pp. 152–153.
"How a Low Barometer Affects Radio," E. Van Cleef.

A theory is presented explaining the relation between static formation and atmospheric circulation. In addition to the points discussed by the author in RADIO BROADCAST, May 1925, pp. 90, the following is added: Reception is accompanied by static when transmission crosses any part of a warm humid "low" or when transmission crosses an area adjacent to an intensely developed humid "low" whose surface temperatures are above the freezing point. If the precipitation throughout the "low" is rain, static will be pronounced, while if it be snow or ice, little static will occur. A comparison of the weather conditions for the 1925 season and the 1926 season, when considered with the points mentioned, explains why reception was better in 1925.

R343. ELECTRON-TUBE RECEIVING SET. RECEIVER,
RADIO BROADCAST. Dec., 1926. Pp. 169–173. *Single-Tube.*
"A Single-Tube Receiver That Won't Radiate," Zeh Bouck.

A single-tube three-circuit regenerative receiver, non-oscillating, is presented, using the King Equamatic system. In the author's opinion, the following are the requirements for a good beginner's receiver: (a). Easily wired and mechanically simple. (b). Inexpensive to construct. (c). Non-oscillating. (d). Should be good enough to keep.

Construction and operation details are given for a receiver which fulfills these conditions.

R384.3. FREQUENCY METERS. FREQUENCY METERS.
Bureau of Standards. Letter Circular LC 180.
"Specifications for Frequency Indicator, Type B, for Use in Radio Transmitting Stations."

This circular letter describes in detail the construction of a frequency indicator for use in broadcast transmitting stations, whose frequency falls between the values of 550 and 1500 kilocycles. It consists of a simple capacity and inductance circuit with a thermo-galvanometer coupled inductively to it through one turn. The specifications are very detailed and complete for constructing a precision instrument.

R351. SIMPLE OSCILLATORS. OSCILLATORS.
Bureau of Standards. Letter Circular LC 186. Piezo.
"Specifications for Portable Piezo Oscillator, Bureau of Standards Type N."

A portable piezo-electric oscillator, consisting of a simple electron tube with inductance, shunted by a variable capacity, in the plate circuit, with provision for the crystal in the grid circuit, is described. Together with the drawings, this information is complete concerning construction and operation of a valuable laboratory instrument.

R134. DETECTOR ACTION. DETECTOR
Proc. I. R. E. Oct. 1926. Pp. 649–662. ACTION.
"Theory of Detection in a High-Vacuum Thermionic Tube," L. P. Smith.

In this paper some new ideas have been presented regarding the detector action by means of the high-vacuum tube in connection with a grid leak and condenser, which show the function of the grid leak and condenser as well as their proper values for best detection. It has been shown that three main sources of distortion exist with this method of detection. They may be briefly stated as follows: Two sources from the curvature of the grid characteristic; one of these is frequency distortion due to the harmonics produced, and the other an amplitude distortion arising from the fact that the rectified grid current does not vary linearly with the input voltage. The remaining distortion is produced by the grid leak and the condenser.

R114. STRAYS. STRAYS.
Proc. I. R. E. Oct., 1926. Pp. 663–673.
"Long-Distance Radio Receiving Measurements and Atmospheric Disturbances at the Bureau of Standards in 1925," L. W. Austin.

The article presents a résumé of the long-distance measurements of long-wave stations made by the Bureau of Standards. Conclusions are drawn regarding the possible explanations of the results.

R213. HARMONIC METHODS OF FREQUENCY MEASUREMENTS. — HARMONIC AMPLIFIER

Bureau of Standards Paper No. 530.

"Establishment of Radio Standards of Frequency by the Use of a Harmonic Amplifier," C. B. Jolliffe and Grace Hazen.

A harmonic amplifier is described, together with its application in establishing radio standards of frequency from an audio-frequency source. The results of one-frequency meter standardization are summarized briefly. A sonometer, an auxiliary pitch-measuring device, is described, and the method of using the harmonic amplifier with this auxiliary for the standardization of piezo oscillators and comparison of audio frequencies is given.

The work has shown that radio-frequency meters may be standardized with high precision and ease from a fundamental audio frequency by use of a harmonic amplifier. The accuracy of the standardization is limited only by the accuracy of the fundamental frequency source and the precision and accuracy of the frequency meter. The harmonic amplifier is simple and rapid in operation. Fixed frequency generators, such as piezo oscillators and electron-tube driven tuning forks, may also be accurately and rapidly standardized by the use of the harmonic amplifier and the auxiliary sonometer.

R351. SIMPLE OSCILLATORS. — OSCILLATOR OR DRIVER.

Burgess Engineering Circular No. 12. Part I.

"A High Frequency Driver," W. H. Hoffman.

A vacuum-tube radio frequency oscillator, also called a driver, is described, with detailed constructional information given. It is designed to cover frequencies from 375 kc. (800 meters) to 25,000 kc. (12 meters) for purposes of radio measurements. The indicating instrument used is a milliammeter connected in the grid circuit of the vacuum tube. Five coils cover the frequencies used.

R384.1. WAVEMETERS. — WAVEMETERS, Short-Wave.

Burgess Engineering Circular No. 12, Part II.

"Short-Wave Wavemeters," F. H. Schnell.

Two wavemeters, one calibrated in kilocycles and the other in meters, each having a range of 30,000 kc. (10 meters) to 3000 kc. (100 meters), are described. The instruments serve many uses, as outlined. Curves showing the relation between dial settings and either wavelength or frequency readings for Karas and Cardwell condensers in connection with various sizes of coils, are appended.

R800(621.353). BATTERIES, PRIMARY. — BATTERIES, Primary.

Burgess Engineering Circular No. II.

"Estimating B Battery Service Life," W. B. Schulte.

The paper presents a method of testing B batteries and shows the shelf life, discharge, and capacity characteristics of B, or plate, batteries, classified according to battery weight in pounds. Examples are given showing how approximate service-hours may be computed for all standard combinations of tubes and batteries. Tube plate currents with various grid bias voltages are shown by curves. The effects of the number of tubes, the grid bias voltage, the size of B batteries, and the type of tubes, are clearly shown as a help for the user to figure his own requirements.

R171. INTERFERENCE. — INTERFERENCE.

Proc. I. R. E., Oct., 1926. Pp. 575–603

"Reduction of Interference in Broadcast Reception," A. N. Goldsmith.

The factors in station interference with broadcast reception, namely signal field strength, receiver selectivity, and psychological reactions of the listeners, are analyzed. Statistical data correlating these factors with interference complaints from listeners in the vicinity of the 50-kilowatt broadcasting transmitter at Bound Brook, New Jersey (WJZ), are then presented, these data being the results of a survey by a special interference reduction staff.

The clearing up of the complaints by this service, using simple methods which are described, indicates the feasibility of high-power broadcasting stations, as well as the necessity for them because of the requirement of reliable broadcasting service over large areas. In the appendix, the construction of a series wave trap is outlined.

R113.7. TRANSMISSION FORMULAS. — TRANSMISSION (SHORT-WAVE) *Principles of.*

Proc. I. R. E., Oct. 1926. Pp. 613–647

"Some Measurements of Short-Wave Transmission," R. A. Heising, J. C. Schelleng, G. C. Southworth.

Quantitative data on field strength and telephonic intelligibility are given for transmission at frequencies between 2.7 m gacycles (111 meters) and 18 megacycles (16 meters), and for distances up to 1000 miles, with some data for distances up to 3400 miles. The data are presented in the form of curves and surfaces, the variables being time of day, frequency, and distance. Comparisons are made between transmission over land and over water, between night effects and day effects, and between transmission from horizontal and from vertical antennas. Fading, speech quality, and noise are discussed. The results are briefly interpreted in terms of current short-wave theories.

A Circuit Diagram Correction

AN ERROR crept into the diagram, Fig. 8. on page 288 of the January, 1927, issue. This drawing is a schematic diagram of the power-supply device described by James Millen. A connection between the minus A and the center tap of the transformer filament winding supplying the power tube was shown. This is incorrect. The lead should, instead, be connected from minus A to the center tap of the transformer high-voltage secondary. The ground connection should also be transferred from filament winding to the negative A terminal. The picture diagram given on page 286 is absolutely correct.

The Next Number of RADIO BROADCAST
Will Contain:

- A complete description of the new Alexanderson photograph transmission system.
- The second of James Millen's constructional articles on various models of home-assembled B-power supply devices.
- How to assemble a B-power supply device for the Hammarlund-Roberts "Hi-Qu" receiver.
- Another splendid article on the two- and four-tube R. B. "Lab" receiver.
- Complete constructional details of the new Grimes Inverse Duplex receiver.
- The March of Radio—the review of current thought, opinion and progress.
- The Usual Departments—"The Listeners' Point of View"—"As the Broadcaster Sees It"—The Best In Current Periodicals—The R. B. Laboratory Information Sheets.

March, 1927, RADIO BROADCAST is on sale on the newsstands, February 15th—Four dollars a year by subscription.

THE "RADIO BROADCAST" INFORMATION SERVICE

How to Write for Technical Information—The Scope of This Service

As WAS announced in the June RADIO BROADCAST, all questions which were formerly sent to "The Grid" will now be handled by the Technical Information Service, RADIO BROADCAST Laboratory. That service is maintained under the following rules:

1. All questions from subscribers to RADIO BROADCAST will be answered free of charge.
2. Non-subscribers to RADIO BROADCAST will be charged a fee of One Dollar for the Laboratory Technical Service.
3. All questions will be answered by mail and none will be published in RADIO BROADCAST.

The Technical Information Service of the Laboratory feels that it is important to define the scope of its service to readers. Although the Service is of very general help to our readers, there are certain demands which can not be met.

The Technical Information Service:

1. Cannot make comparisons between various kinds of receivers or manufactured apparatus.
2. Wiring diagrams of manufactured receivers cannot be supplied. This information can be secured from the various manufacturers.
3. Complete information cannot be given about sets described in other publications, but in all cases (wherever possible), inquirers will be referred to a source of information where the data can be obtained. In this connection, the monthly department in RADIO BROADCAST "The Best in Current Radio Publications" should be of great help, and should be consulted. That department records the most important constructional, technical, and general radio articles which appear.
4. Special receivers or circuits cannot be designed by the Technical Service.
5. Those who ask questions which cannot be answered in the scope of a letter will be referred, if possible, to sources where the information can be obtained.

TECHNICAL INFORMATION INQUIRY BLANK

Technical Service,
RADIO BROADCAST Laboratory,
Garden City, New York

GENTLEMEN:

Please give me fullest information on the attached questions. I enclose a stamped addressed envelope.

☐ I am a subscriber to RADIO BROADCAST, and therefore will receive this information free of charge.

☐ I am not a subscriber and enclose $1 to cover cost of the answer.

Name....................................

Address....................................

R. B. F.

"Radio Broadcast" Booklets

HOME constructors who wish to obtain complete blueprints and constructional information on the R. B. Impedance-Coupled Browning-Drake receiver as described in this magazine for September, 1926 can secure a set by fowarding their order, together with remittance for $1 to RADIO BROADCAST, Booklet department, Garden City, New York. Other blueprint sets which are sold at the same price are those on the four-tube Roberts receiver, and the "Aristocrat" receiver.

Why not subscribe to *Radio Broadcast*? By the year only $4.00; or two years $6.00, saving $2.40. Send direct to Doubleday, Page & Company, Garden City, New York.

Vee Dee

ART **Any Metal Form Finish**

Metal Panels

for Kits and Sets

for **Nationally Famed Kits—Drilled and Decorated**

L. M. Cockaday LC-27, **$3.70**
Browning-Drake Improved, **$3.05**
Hammerlund-Roberts Hi-Q, **$2.70**
Silver-Cockaday, Panel and Chassis, **$4.60**
Karas Equamatic, **$3.50**
Infradyne-Remler Type, **$3.75**
Bremer-Tully Power Six, **$3.05**
Citizens Super, Panel and Chassis, **$6.60**
Write for Discounts

Receivers equipped with Vee Dee metal art panels will yield the utmost in efficiency, accuracy, durability, beauty and economy.

Vee Dee Metal Panels are finished in beautiful wood grains, bronze duotones and high lighted novelty effects. Precisely drilled to the thousandth part of an inch. Every special panel includes vulcanized fibre bushings for best insulation.

Vee Dee Metal Panels are being adopted as standard equipment by prominent manufacturers of kits and sets.

STOCK METAL PANELS

In all standard sizes. Easy to drill. Retail prices range from $2.15 to $3.55. Beautifully finished and artistically decorated.

Manufacturers—Jobbers

Save money and improve your sets by adopting Vee Dee Metal Art Panels. We co-operate in working out new panel designs. Lowest prices—liberal terms. Write to

THE VAN DOORN COMPANY
160 North La Salle Street : Chicago, Ill.
Factories, Quincy, Ill.

Order your copy of *Radio Broadcast* from your news dealer or radio store. Make sure that he reserves a copy for you each month. If your favorite radio store does not stock the magazine write us giving name of radio dealer and address

---

FROST-RADIO

Type 880 Super Variable Resistance

These new non-inductive, variable high resistance units are precision instruments which operate smoothly and noiselessly from zero to maximum rating. Have low temperature coefficient. Lever makes positive rolling contact with resistance element with absolutely no wear. Designed for use as tone and volume control, for resistance coupled amplification, to control regeneration, and as a stabilizer. Furnished in following resistances: 50,000, 100,000, 200,000, and 500,000 ohms. List: $1.25.

HERBERT H. FROST, Inc.
160 N. La Salle St., Chicago *New York City* *Los Angeles*

Easy! Just connect Jefferson Tube Charger to the two "A" battery terminals for 10 minutes, once a month, as per directions for large or small tubes.

Keep tubes full of 'pep'

(without removing them from set)

TUBES weaken with use, cut down the sensitivity and power of your set, and consume more current.

To enjoy top-notch programs every night, keep your tubes always like new.

Once a month, for ten minutes, attach a Jefferson Tube Charger to your set. The improved reception—plus longer life of tubes and batteries—are worth many times the small price of $5. Also rejuvenates run-down or paralyzed tubes. Guaranteed, patented, and made ONLY by Jefferson. Get one today—from your dealer.

JEFFERSON ELECTRIC MFG. CO.
Largest manufacturers of small transformers
507 So. Green Street, Chicago
[PATENTED]

Jefferson

No 275 Tube Charger

Beautiful Jacobean design by Conner Finished in Warm Walnut

Put Your Set in a Conner Cabinet

THE MOST interesting—the most *noticed* piece of furniture in your home is your Radio Set—House it in a Conner Convenient Cabinet and it will then be the most attractive. Even the *best* set, with a makeshift mounting, exposed wiring and batteries, misses much in giving you and your friends the pleasure and satisfaction which it should. A Conner Cabinet lends added class and tone to the finest equipment.

A Conner Cabinet assembles every detail of your receiving set, including batteries and tools in a scientifically convenient arrangement and encloses everything in an exceptionally beautiful piece of period furniture. Radio builders know the name "Conner" means *Quality*. Leading Radio dealers show Conner Cabinets.

Write today for illustrations of the entire line of Conner Convenient Cabinets and learn how easily you may own and enjoy one of these beautiful cases.

A Period Design for every plan of Decoration

$35 to $99.50

Jacobean
Renaissance
Sheraton, etc.

Write today for illustrations and details.
We specialize on Cabinets for Radio Builders.
Get our Interesting offer to Radio Dealers in open territory. Write today.

CONNER RADIO CABINET COMPANY New Albany, Indiana

Book Reviews

Audio Amplification Data

AUDIO AMPLIFICATION. *Published by the Samson Electric Company, Canton, Massachusetts. 39 pages and 31 illustrations. Price, 25 cents.*

"AUDIO AMPLIFICATION" is the title of an excellent booklet written for those desiring the best in radio reproduction. There certainly existed a need for such a booklet, describing, as it does, in a non-technical language, the design and characteristics of the different types of audio amplification systems. The many diagrams included will be found invaluable in building audio amplifiers of all sorts, whether resistance-, transformer,- or impedance-coupled.

Our interest in the book was aroused by glancing at the table of contents, which listed such topics as: "Comparisons of Audio Amplifiers," "Transformer Choice," "Amplifier Stability," "B Eliminators," and "Reproducers." Certainly the book is not merely an advertisement of Samson material, but was prepared in an endeavor to give the home-constructor useful and concrete information. The fundamental facts concerning all amplifiers are carefully explained so that an accurate conception of the entire subject can be had.

We casually opened the book to the chapter on "Transformer Choice" and read:

> The question will undoubtedly arise "What transformer should I choose?" This question is no more readily answered than "What automobile should I choose?" All transformers may amplify and all automobiles may run. Many will find just what they want in the cheapest transformer, while others will find what they want in the more expensive one. After one has used a given automobile a while, he is better qualified to judge it and to decide whether his original decision was good or bad.. So it is with transformers.
>
> In the first place there is the question of turns ratio. The designation of a transformer by "ratio" is no more complete than the arbitrary designation of an automobile motor's horse power by its cylinder dimensions. Two transformers may have the same ratio of secondary to primary turns, and yet they may be very different in their operation. For illustration, it would be possible to make a transformer of 3–1 ratio with but one turn for the primary and three turns for the secondary. If this transformer were used, it would give no results (assuming an ordinary core such as used in the regular Samson HW-A3, 3-1 were used). In practice, thousands of turns of wire are used as the primary winding, and thousands as the secondary winding. As a rule, the better transformers have a greater number of primary turns than the cheaper ones. Since copper is expensive, it is, of course, cheaper to use as little as possible. As a consequence one 3–1 transformer may give a high amplification of the lower frequencies and another a very low or poor amplification of these frequencies, depending on the quality of the product.

It is sometimes felt that the size and weight of the transformers are direct indications of its quality. This is not necessarily true at all. One transformer might use a poor grade of iron and therefore require a very large coil in order to obtain the same results as another transformer using a better grade of iron. In other words, we might have two transformers very different in size, both of them being equally good. There are other criterions which must be used to judge transformers, and a curve showing how the amplification varies with frequency is the most trustworthy indication of quality.

A Two Year Subscription Saves You Two Dollars

It saves you the bother of renewing next year.

It is the most economical way to subscribe. You simply write six dollars instead of four when sending your check or money order. Try it for two years. Form the habit!

RADIO BROADCAST Garden City, N. Y.

READ RADIO BROADCAST

Many home-constructors will want to obtain a copy of this booklet as the information contained in it is of such nature as to be very useful both in choosing the method to use in audio amplification and in actually constructing the amplifier.

H. E. R.

Satire from WGN's "Bummin'ham" Boys

SAM 'N' HENRY. *By Correll and Gosden. Published by the Shrewsbury Publishing Company, Chicago, Illinois. 189 pages. Six illustrations. Price $1.00.*

SAM 'n' Henry have compiled and published a book called "Sam 'n' Henry"—and that, to this reviewer's notion, is about all there is to say. The Sam 'n' Henry addicts, once knowing that the book exists, will probably rush out and buy it no matter what our comment; and those who aren't followers of Sam 'n' Henry would never buy it anyway.

Sam and Henry, if you be among the ignorant, are a couple of colored boys from way down "Bummin'ham," Alabama, now working in Chicago, and every night at 10:00 they hold forth over WGN for a large and enthusiastic audience. The rôles were created a year or so ago by Freeman F. Gosden and Charles J. Correll. And the characters *are* creations, broadly drawn, perhaps, but never out of drawing.

Sam is the ignorant, clinging-vine type, but pathetically anxious to improve himself. Henry is pompous, worldly, and smug, actually quite as dumb as Sam but delightfully unaware of the fact. This every-night program, constituting as it does a sort of radio comic strip, is to be judged like Mutt and Jeff, not on its best or worst days but on its average, the which has been consistently fair.

The book has presumably been compiled from the best performances of the past year, about twenty-five of them, embracing such episodes as "Taking a Ride on the 'L,'" "At the Shooting Gallery," "At the Fortune Teller's," "Initiation at the Jewels of the Crown," "Sam Gets a Letter from Liza," "The Quack Doctor," etc. Several of them constitute rather good satire of an obvious sort—the burlesque on fraternal organizations in the "Initiation" episode, for example.

But of course the best thing about the radio "Sam 'n' Henry" has always been, not what they say, which is frequently dull, but the way they say it. Sam has an amusing, high, piping voice, while Henry's is a beautifully resonant bass, so low that you can almost count the vibrations!

The reader who knows the radio characters well enough to reproduce the dialect and intonation as he reads will doubtless have quite a bit of fun out of a perusal of the volume, and if he is sure enough addict, he will probably indulge in reading it aloud to whomever he can persuade to listen. To him we recommend the book.

JOHN WALLACE.

"How Radio Receivers Work"

"HOW Radio Receivers Work" by Walter Van B. Roberts, is obtainable for $1 from RADIO BROADCAST, Booklet Department, Garden City, New York. Doctor Roberts' book is enjoying a wide sale among radio enthusiasts. It provides the novice in radio with a very complete and easily understood discussion of the basic principles involved in modern radio receivers.

Why not subscribe to *Radio Broadcast?* By the year only $4.00; or two years, $6.00, saving $2.40. Send direct to Doubleday, Page & Company, Garden City, New York.


Sylvania
TUBES
SYLVANIA Tubes are preferred by the most critical radio users everywhere.
Radio experts with ears that are trained to catch the most minute flaw in radio reception, like the clearer tone and the keener selectivity of Sylvania Tubes.
Sylvania Tubes are made better, yet they cost no more than the ordinary tubes.
For real radio enjoyment, place a Sylvania Tube in every socket of your set and tune in. The result will reveal to you new possibilities in your set.
for
GREATER VOLUME
BETTER TONE ~
KEENER SELECTIVITY
LONGER LIFE ~
SYLVANIA PRODUCTS CO.
EMPORIUM, PA.

RADIO BROADCAST

MARCH, 1927

Willis K. Wing, Editor

Keith Henney, Director of the Laboratory — John B. Brennan, Technical Editor

Edgar H. Felix, Contributing Editor

Vol. X, No. 5

CONTENTS

AMONG OTHER THINGS. . .

SINCE all of our readers are not privileged to tour through Doctor Alexanderson's fascinating laboratory at Schenectady, the next best thing is to read of what one may see there. Edgar Felix's leading article gives one a very good idea of just what has been done at Schenectady. When a paper was presented at the Institute of Radio Engineers convention in January, there was some bitter discussion, all centering around the fact that the developments chronicled were not new. Into that discussion we have no desire to enter, for the important fact seems to us that a workable system has been presented which may lead to various practical applications in the immediate future.

MORE information about the popular R. B. "Lab." circuit is published on page 467 and an article in April will furnish additional experimental details of this circuit which offers so much of interest to the home constructor. In the "Listeners' Point of View," some of the first results of the readers' questionnaire are detailed. They cast an interesting light on the feeling of radio listeners about radio programs. After reading more than 500 of these replies, we believe that every soprano would be wise to make immediate plans for leaving the country. Our April and May numbers will contain more material from these answers.

THE many users of current-supply devices and the many more who are prospective purchasers will find the article beginning on page 477 of great interest. Our discussion of these devices should also prove of distinct aid to the radio dealer. Our remarks, while somewhat frank, are aimed to help the user and prospective purchaser and should only be interpreted for what they are, a collection of data which should make current-supply devices more satisfactory in actual use. Those who have been waiting for constructional data on the new Grimes R. G. S. receiver will find the long-awaited article on page 480.

THROUGH an omission which we greatly regret, a credit line was omitted from the frontispiece in our February issue. The photograph and the information were kindly supplied by the Westinghouse Electric & Manufacturing Company, some of whose products are used in the installation in the lighthouse mentioned.

PRINTERS' INK for January 13th shows that Radio Broadcast printed in its January number a total of 24,205 lines of advertising, being exceeded in this field only by *Radio News*.

THE April Radio Broadcast will contain an especially interesting article on the R. B. "Lab." circuit, of particular importance to those who have already constructed the two- or four-tube models. There will be another Radio Club of America paper, dealing with loud speakers, another of James Millen's excellent articles on the use and home construction of current-supply devices, and all the usual departments, including a more complete listing of manufacturers' booklets. Ross Gunn of Yale University has submitted an unusually interesting article on coils and coil design, scheduled for April, which is well worth waiting for.

—Willis K. Wing.

Doubleday, Page & Co. *MAGAZINES*
Country Life
World's Work
Garden & Home Builder
Radio Broadcast
Short Stories
Educational Review
Le Petit Journal
El Eco
Frontier Stories
West

Doubleday, Page & Co. *BOOK SHOPS* (*Books of all Publishers*)
New York: Lord & Taylor; Pennsylvania Terminal (2 Shops); Grand Central Terminal; 38 Wall St. and 526 Lexington Ave.; 848 Madison Ave. and 166 West 32nd St.
St. Louis: 223 N. 8th St. and 4914 Maryland Ave.
Kansas City: 920 Grand Ave. and 206 W. 47th St.
Cleveland: Higbee Co.
Springfield, Mass.: Meekins, Packard & Wheat

Doubleday, Page & Co. *OFFICES*
Garden City, N. Y.
New York: 285 Madison Ave.
Boston: Park Square Building
Chicago: Peoples Gas Building
Santa Barbara, Cal.
London: Wm. Heinemann Ltd.
Toronto: Oxford University Press

Doubleday, Page & Co. *OFFICERS*
F. N. Doubleday, *President*
Nelson Doubleday, *Vice-President*
S. A. Everitt, *Vice-President*
Russell Doubleday, *Secretary*
John J. Hessian, *Treasurer*
L. A. Comstock, *Asst. Secretary*
L. J. McNaughton, *Asst. Treasurer*

DOUBLEDAY, PAGE & COMPANY, Garden City, New York

TERMS: $4.00 a year; single copies 35 cents.

A PHOTOGRAPH SENT BY THE ALEXANDERSON METHOD

The system of photograph transmission employed by Dr. E. F. W. Alexanderson is successful in attaining very excellent quality, as this reproduction of a painting by Walter L. Greene shows. The subject was transmitted at the rate of sixteen square inches per minute

RADIO BROADCAST

VOLUME X — NUMBER 5

MARCH, 1927

Television: Europe or America First?

An Account of the Experiments of E. F. W. Alexanderson in the Field of Television and Radio Photography—How the Present System of Radio Photography Has to Be Speeded Up Two Thousand Times to Attain Television

By EDGAR H. FELIX

CONFIDENT predictions of the coming of television have been made so frequently during the last year that even proverbial pessimists must by this time be convinced that we will soon be able to see as well as hear by radio. Research in this field has attracted scientists and experimenters in almost every corner of the world, and numerous systems for the transmission of still photographs are in successful operation.

More, perhaps, has been written about the experiments of European engineers in this branch of science than of Americans. One must not presume, on this account, that America lags behind. There is every reason to suppose that experiments conducted here are as fully advanced as are those of fellow experimenters abroad, and we may, as the era of radio vision fast approaches, be the spectators at a thrilling international neck to neck struggle for priority, the outcome of which will result in the perfection of an economically practicable system of television.

An attempt to predict just how much water will flow under the bridges before the millennium would be futile. There are still many difficulties to be overcome, but, so rapidly has the art progressed to its present high standing, that one cannot doubt but that it will not be many years hence before we shall be able to see as well as talk with our friends in London and Paris as we sit in our homes in America.

Of the several systems of television now being developed abroad, probably the most advanced is that of John L. Baird, a Scotchman. A British company has already been formed to exploit his system of television in England, and plans have been formulated for the marketing there of a combined Televisor, radio receiver, and loud speaker in a cabinet only 24 x 20 x 18 inches, which is to sell for the equivalent of about $250.

A story in the December, 1926, RADIO BROADCAST, explained very fully the Baird system of television, and it will not be further described here.

The obstacles which the amateur experimenter finds in the path of his participation in radio photographic research to-day are the highly complex apparatus required—still far beyond the skill and patience of an average experimenter to build and to manipulate—and the necessity for an investment in equipment which places radio photography out of reach of the casual experimenter. These factors are not insurmountable in the commercial development of picture transmission and, as a consequence, we have several radio and wire news picture channels offering transatlantic or national service.

A RADIOED PICTURE

This photograph of Norma Talmadge is a good example of the wealth of detail which can be transmitted by the Alexanderson system of radio photograph transmission

International radio communication itself was once in this stage. Such communication between the United States and foreign countries was made possible by means of huge, high-power transmitters, involving investments of hundreds of thousands of dollars. Then came short-wave vacuum-tube transmission which brought amateurs in all parts of the world in touch with each other, utilizing transmitting equipment costing less than the average broadcasting receiver. A simplification of equal significance is in prospect for picture transmission.

In the hope of learning how far from the reach of the serious amateur experimenter radio photography lies, the author visited the laboratories of several scientists. In Washington, the Jenkins equipment was seen; in New York, the Bell System's apparatus was viewed; and, in Schenectady, the Alexanderson device was demonstrated to the writer. At each of these laboratories, highly developed apparatus could be seen in action—apparatus capable of excellent photographic reproduction over wires or by radio. Jenkins' work has often been described, in these columns and elsewhere; the Bell System's equipment is too complex and too expensive for consideration as an amateur pastime; last but not least, is Alexanderson's system, which the writer was privileged to examine recently and, for an entire day, to question its inventor as to its functioning.

Dr. E. F. W. Alexanderson, the well-known General Electric research engineer, has concentrated on the problem of picture transmission during the last few months with a view to developing simple apparatus within reach of large numbers, rather than looking toward a revolution of method. Alexanderson's extraordinary record in the radio field is characterized by his ability to get down to simple basic principles. He was the first to apply the vacuum tube to tuned radio-frequency amplification; the first to use it for transmission of radio telephony; the first to develop a practical source of high-frequency energy for radio telegraphy and telephony; and the first to analyze the polarization of short waves.

His recent announcement of his work with radio photography and television came only after a long period of experiment. While chief engineer of the Radio Corporation of America, his attention was focused on the problem by a speech of Owen D. Young, forecasting the transmission of the entire page of a newspaper by radio photography rather than the laborious word by word system. As a result of this remark, Alexanderson concentrated his attention on the subject, and it was he who afterward took steps to organize the development of the transoceanic photoradio service which has since become known through the work of Captain R. H. Ranger.

During the last few months, Doctor Alexanderson has concerned himself with simplification and improvement of the apparatus, and the discovery of newer, simpler, and more rapid instruments of transmission and reception. Some of the photographs reproduced on these pages are samples of the success which has already attended his efforts. It has required twenty minutes heretofore to transmit a good 4 x 5-inch photograph, but those shown herewith were transmitted at the rate of sixteen square inches a minute. The reproducing apparatus used in making these photographs comprises a standard General Electric oscillograph with some adaptations for controlling a beam of light according to the intensity of the received radio signal. This light is flashed upon a revolving cylinder which is synchronized with the transmitting equipment. On the revolving cylinder is a sensitive photographic paper which makes a print according to the intensity of the light flashed upon it.

The design of the receiving apparatus is relatively simple. A synchronous motor, which may be powered from the sixty-cycle power line, revolves a cylinder of a certain diameter which moves, at the same time, from side to side along a threaded shaft. The rotating and side to side motion thus permits a single beam of light, fixed in direction, to cover systematically the entire surface of the paper upon which the print is to be made. This light-sensitive paper is, of course affixed to the revolving drum. The intensity of the beam of light is controlled by a shutter actuated by a received radio signal. An expensive laboratory oscillograph is not essential; a cruder device, consisting essentially of a telephone receiver and simple shutter will serve the experimenter. With apparatus reduced to these simple terms, the amateur experimenter has not long to wait for his embarkation in this new branch of the radio hobby.

ONE OF THE ADVANTAGES OF THE PHOTORADIO SYSTEM

Is its accuracy in the transmission of signatures, as is shown in this example. Reading from top to bottom, the signatures shown in this photograph are of: Edgar H. Felix, the author of this article; Willis K. Wing, editor of RADIO BROADCAST; Carl Dreher, chief engineer of WJZ; W. T. Meenam, W. J. Purcell, Barrington S. Havens, and Guy Bartlett, of the General Electric Company; Kolin Hager, chief announcer of WGY; and Harry Sadenwater, chief engineer of the General Electric Company's broadcasting stations, WGY, KOA, and KGO

ALEXANDERSON'S TELEVISION EXPERIMENTS

THE development of this simplified reproducing equipment is only preliminary to the problem which is engaging Dr. Alexanderson's attention. Instead of producing a photographic print in two minutes, Dr. Alexanderson is seeking to solve the problem of television. Television enables the observer to see what is taking place at the point of transmission without entailing the making of photographic prints. Motion pictures are a form of recording and reproducing motion but, instead of the medium of a film for the purpose, television uses an electric system capable of transmission over long distances. Television has the same relation to radio photography as motion pictures have to still prints.

Transmitting a good 4 x 5-inch still picture in a little more than a minute may seem like a long step toward the attainment of television. With true television, however, sixteen complete pictures must be transmitted a second in order to give the eye the impression of continuous motion. That means speeding up the process very considerably. Doubling the speed of almost any mechanical or electrical system is task enough for any engineer, but to step up a delicate and accurate process almost two thousand times is a problem of tremendous magnitude. Even the feat of tenfolding the earlier speed of transmission, which Doctor Alexanderson has already accomplished, is a remarkable tribute to what may be achieved by ingenious mechanical and electrical refinement. Clearly something radical is necessary to make the system work the two thousand times faster necessary for television. It is recognition of this fact which has led many experimenters in radio photography to await a new and radical invention before pronouncing television as a forthcoming certainty.

Alexanderson works on the theory of using what science has already made available rather than waiting for revolutionary means and methods which may never come. He does not believe in speeding a machine far beyond its normal capacity, for that makes neither for safety nor reliability. Instead, it is characteristic of his research methods to find ways and means of dividing the work involved by new and ingenious methods so that it falls within the capabilities of existing systems. The Alexanderson system of transoceanic telegraphy, for example, was invented on that principle. In order to get the required signal strength, he divided up the antenna in a multiplicity of units with the result that the local losses in the ground were reduced to one-tenth. Thus the high-power telegraph stations of the Radio Corporation, using the Alexanderson 200-kw. alternator, are giving a signal strength that with older methods would have required 2000 kw.

THE REQUIREMENTS FOR TELEVISION

THE essentials in television are light waves which control the current output of photo-electric cells, according to the intensity of the waves submitted to them; vacuum tube amplifiers, which increase these fluctuating currents to a magnitude sufficient to modulate a high-frequency carrier wave; high-frequency radio waves, for transmitting the light-wave modulated signal through space to receiving systems; and amplifiers and selectors that control a local source of light which in its turn is passed and deflected by regulated mirrors so as to cover the surface of a projection screen sixteen times a second. Here we have, in one paragraph, enumerated the essential elements of a television transmitter and receiver, every one of which must be adapted, electrically and mechanically, to work accurately at very high frequencies.

ONE OF THE FAILURES OF RADIO PHOTOGRAPHY

The distortion in this picture, which was transmitted by the Alexanderson system, could have been remedied by proper adjustment of the receiving equipment. This is a good way of visualizing the distortion which is often audibly apparent in an ordinary radio receiver

The minimum requirement for the production of a clearly intelligible and enjoyable moving photograph is the undistorted projection of 300,000 light images per second, each of a correct intensity and properly placed in relation to all the others. No small task. Three-hundred thousand light beams, each of the correct intensity and correctly placed, flashed successively upon the screen!

The transmission of music is possible because of the physiological and psychological ease with which sound impulses are sensed. An eighty-piece symphony orchestra, playing many different notes a second, each with its fundamentals and numerous harmonics in correct balance, blends into a single, though highly complex, sound wave, consisting of variations of air pressure, involving frequencies no higher than ten or fifteen thousand per second. Such sound impulses are not appreciably distorted by the elimination of all those outside the essential frequency range, lying between 100 and 6000. The contributions of all the separate instruments of the orchestra are scrambled into a single air wave and the ear, fed a reproduced duplicate of this air wave, is so trained that it is able to unscramble the work of each instrument and to be conscious of them individually and collectively.

Our receiving apparatus for light waves is somewhat more complex. The eye responds simultaneously to separate impulses from millions of different directions. Look through a tiny pin hole, restricting your vision to one point, and, if it is small enough to actually give you one point in the distance, you will be conscious of only two factors of sight, intensity and color. Eliminating color, the eye, focused on a single point, sees only the degree of light and darkness. Distance, size, and relative position of an object is gained only when the eye sees many different points. Consciousness of length, width, height, spacing, and direction is attained only by response to millions of light rays, reflected from literally millions of points within range of vision. There is no simple blending of light waves into one, as we have with sound waves.

In television, by reflecting a beam of light from the surface of a photograph to a sensitive photo-electric cell, we may convert into an electric current an expression of the intensity of light or darkness of a single point on the photograph. By moving our point of observation, the reflected light beam, up and down and across our picture until its entire area is covered, we transmit our picture by means of the reflected light of varying intensity. This process, speeded up and maintained, would give us television. The light waves, photo-electric cells, radio transmission apparatus, and the very short-wave radio carrier is capable of absorbing and transmitting accurately a sufficient number of impressions to give us television. But the mechanical part of the system is hopelessly inadequate.

The small boy who flashes the sun's rays by his mirror on the schoolroom blackboard simulates the mechanical part of our television apparatus. If he used a little shutter which regulated the intensity of the beam and flexed his wrist rapidly enough to cover an appreciable area of the blackboard, he would perform the mechanical part of the work which is the weak link in the television chain. But there is no wrist, mechanical or physical, sufficiently flexible to direct a single point of light, varying in intensity

TELEVISION PROJECTOR APPARATUS

Doctor Alexanderson is here shown demonstrating the apparatus with which he hopes to be able to transmit moving pictures by radio. The large drum in the left foreground has twenty-four mirrors on its periphery, and, when not revolving, reflects, as shown in this picture, the cluster of seven lights. When revolving at high speed, the whole screen appears to be completely covered with brilliant light according to a pre-arranged succession, so as to make a continuous orderly picture consisting of 300,000 separated or blended light impressions.

In the words of Doctor Alexanderson:

"When we embark on such an ambitious program as television, it behooves us to reason out, as far as it is possible, whether the results we expect to get are going to be worth while even if our most sanguine hopes are fulfilled. We are dealing with the photo-electric cell, the amplifier, the antenna, and the radio wave. The photo-electric cell and the amplifier employ the medium of the electron which is extremely fast, but the use of the radio wave itself imposes certain speed limitations on account of the limited scale of available wavelengths. The question therefore remains what quality of reproduction may we ultimately expect in a television system if we succeed to take full advantage of the ultimate working speed of the radio wave? An experimental study of the problem, and the conclusions, may be illustrated by the comparison, of some pictures made at different speeds.

"The three pictures (shown on this page) were made with the selective shade process under conditions similar in character to that of one of our long-wave transatlantic transmitting stations, with a wavelength of 12,000 meters, or a wave frequency of 25,000 cycles. The picture to the left is the result we get if the time of transmission is two minutes. For the middle picture, the transmission time is four minutes and, for the picture to the right, eight minutes. Everything else in the three cases is identical. Relatively these pictures represent the effect of sluggishness of the tuned antenna upon the sharpness in the reproductions. The two-minute picture is not as sharp as the eight-minute picture.

"By using a wavelength of twelve meters instead of 12,000 meters (a wave frequency of 25,000,000 cycles instead of 25,000 cycles), the sluggishness can be reduced. If now, the photo-electric cell and the amplifier and the light control can keep up with this pace, the radio wave will do its part and transmit a picture in 1-1000th part of two minutes, *i. e.*, in one-eighth of a second. We are thus able to predict that it will be possible to transmit a good picture in a space of time which is of the order of magnitude of the time required for moving picture operation, the exact figure being one-sixteenth of a second."

THE MODEL PROJECTOR

IN DOCTOR Alexanderson's laboratory, there is a model of a television projector, consisting of a source of light, a lens, and a drum carrying a number of mirrors. When the drum is stationary, a spot of light, reflected from one of the mirrors, is focused on a spot on the picture to be transmitted. This spot of light is the brush that paints the picture. When the drum revolves, the spot of light passes across the picture, as a new mirror, which is set at a slightly different angle, comes into line to reflect the beam. Thus the light spot passes over the picture until the whole is covered. If we expect to paint a light picture of fair quality, the least we can be satisfied with is ten thousand separate strokes of the brush. This means that the spot of light should pass over the picture to be transmitted in one hundred parallel paths and that it should be capable of making one hundred separate impressions of light and darkness in each path. If we now repeat this process of painting the picture over and over again sixteen times in a second to obtain satisfactory television, it means that we require 160,000 independent strokes of the brush of light in one second! To work at such a speed seems at first inconceivable; moreover, a really good picture requires that the speed be raised to something like 300,000 picture units per second. Doctor Alexanderson says:

"Besides having the theoretical possibility of employing waves capable of high speed signalling, we must have a light of such brilliancy that it will illuminate the screen effectively, although it stays in one spot only one three-hundred thousandths of a second. This is one of the serious difficulties because, even if we take the most brilliant arc light we know of, and no matter how we design the optical system, we cannot obtain sufficient brilliancy to illuminate a large screen with a single spot of light. The model television projector was built in order to study this problem and to demonstrate the practicability of a new system which promises to give a solution to this difficulty. The result of this study is briefly that, if we employ seven spots of light instead of one, we will get 49 times as much useful illumination. Off hand, it is not so easy to see why we gain in light by the square of the number of light spots used, but this can be explained with reference to the model. The drum has twenty-four mirrors and, in one revolution of the drum, one light spot passes over the picture twenty-four times, once for each mirror; and when we use seven sources of light and seven light spots we have a total of 168 light spot passages over the screen during one revolution of the drum.

SUCCESSFUL TRANSMISSION ON LONG WAVES

Is not so rapid as on the short ones, as far as radio photograph transmission is concerned, due to a lag element which creeps in. These pictures were transmitted with 12,000-meter (25,000-kc.) apparatus. That on the left was sent in two minutes; that in the center, in four minutes; and that on the right, in eight minutes

"The gain in using seven beams of light in multiple is twofold. In the first place, we get the direct increase of illumination of 7 to 1, but we have the further advantage that the speed at which each light beam must travel on the screen has been reduced at a rate of 7 to 1, because each light spot has only 24 tracks to cover instead of 170. While the light itself may travel at any conceivable speed, there are limitations of the speed at which we can operate a mirror drum or any other optical device, and the drum with 24 mirrors has already been designed for the maximum permissible speed. A higher speed of the light spot can therefore be attained only by making the mirrors correspondingly smaller, and a mirror one-seventh as large will reflect only one-seventh as much light. The brilliancy of the light spot would therefore be only one-seventh of what we realize by the multiple beam system, which gives seven light spots seven times as bright, or 49 times as much total light.

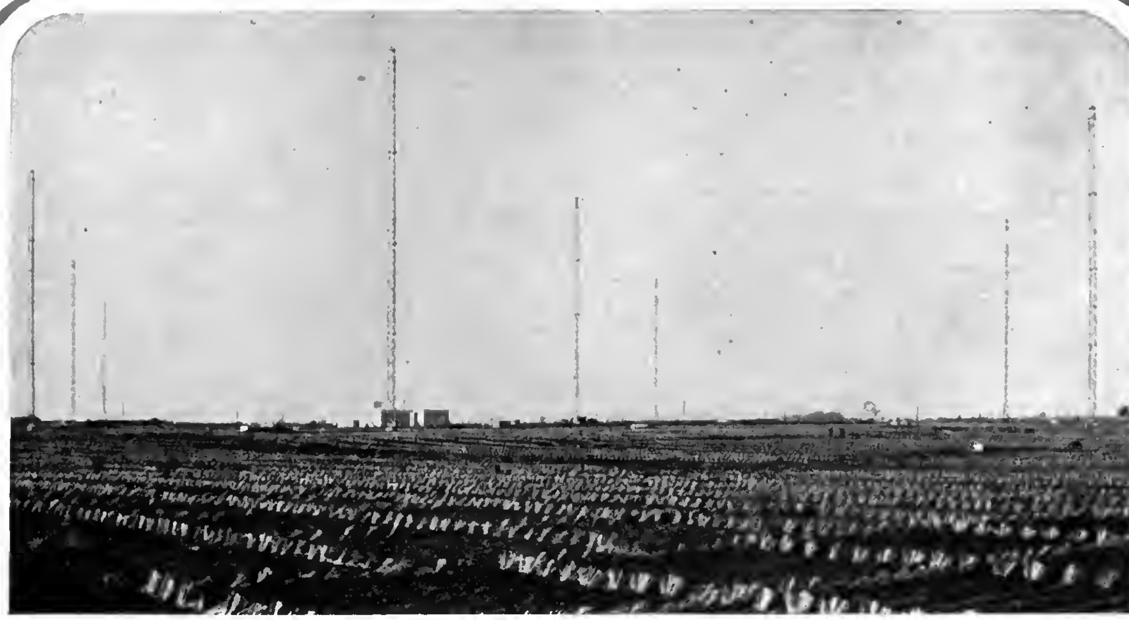
"There is another advantage in the use of the multiple light beam. Each light beam needs to move only one seventh as fast and therefore needs to give only about 43,000 instead of 300,000 independent impressions per second. A modulation speed of 43,000 per second is high with our present radio practice, but yet within reason, being only ten times as high as we use in broadcasting."

There is ample promise in the fruition of Doctor Alexanderson's work. By the use of seven television carrier waves, spaced 100 kilocycles, available, for example, by using the band between 20 and 21 meters (15,000 and 14,284 kc.), and an improvement of existing equipment, television is entirely within reason. How long this process of refinement will require, Doctor Alexanderson is unwilling to predict, but it seems to be in prospect within a relatively short period.

SIMPLE SYSTEM BEING DEVELOPED

ANOTHER line of experiment being carried out by Doctor Alexanderson, dependent not upon accurate modulation and demodulation, is a simple system of radio photography (not television) which promises to bring it soon within reach of amateur experimenters. The system is not subject to the vagaries of fading. It does not depend on accurate modulation as do the transmission of music and full tone radio photography, but upon interruption, as does code radio telegraphy.

The amateur radio photographer—and there will soon be many of his kind—will obtain a permanent proof of the reception every time he uses his photo-receiver. Unlike the broadcast fan, he cannot say that he heard with perfect clarity and comfortable volume a distant station, if he did not do so. The radio photograph gives unmistakable evidence of reception and of the distortion-free operation of the receiver.



THE MARCH OF RADIO

News and Interpretation of Current Radio Events

Radio Regulation in the Great Game of Politics

TWENTY million broadcast listeners are being auctioned in the game of politics. If their fate has not been determined by the time this appears in print, radio might as well be written into the bad debts column of this year's entertainment budget. To the radio industry, Congressional failure to provide sorely needed legislation would be little less than a catastrophe, though, fortunately, one from which eventual recovery is not impossible.

The 1926 season might well have been radio's best and biggest year. Reception conditions have been extraordinarily good; without wavelength tangles, nationwide listening, even during fairly early evening hours, would have been within the capabilities of almost any good five-tube receiver. Instead of rising to new levels, Christmas sales were below normal. The year's loss of sales, resulting from chaotic broadcasting conditions, is not less than $175,000,000. This estimated sales loss is based on the assumption that the number of sets sold this season would have been ten per cent. larger than last year, had there been no wavelength troubles. Owing to higher average *sale price and profit* per set and a reduced number of large producers, most radio set makers, however, are in a stronger position than last year and gross sales figures for the industry will probably equal last year's total. The *number* of sets sold this year is probably twenty per cent. smaller than last year.

The public's apathy to the depreciation of radio entertainment should teach the industry a cruel lesson. Radio, instead of being the most important interest in the life of the broadcast enthusiast, second only to affairs of the heart and to the means of gaining food and shelter, is now apt to be easily displaced and forgotten. If radio reception is not good, the listener now takes to his motor car or to the movies, while the radio industry bites its nails impotently. Those professionally interested in radio have, of course, been much aroused, but the resulting action has been largely confined to optimistic public statements about how good business is or to the general effect that radio reception is not bad. No industry, shivering from a vital blow, has ever demonstrated less ability and less initiative in arousing public support.

On the other hand, radio has held too firm a place in the public estimation to suffer long from its present ills. Regulation is bound to come sooner or later, unless the moguls of radio are willing to go back to hemstitching, running errands, and repairing bicycles. Telephotography as a hobby for the home constructor looms imminent, offering him the trials of experiment and the thrills of true achievement. Radio showmanship improves steadily and quality of reception attainable with modern receivers rises to new heights. The one real cloud on radio's horizon is the overcrowded ether, which can be dispelled only by real leadership on the part of the industry. Had public opinion been aroused by such leadership, radio legislation would not now be settled entirely on political considerations.

Let no one be fooled by the political buncombe emanating from Washington about the "defense of the peepul against monopoly and autocracy." The real issue is that the White Bill is the Administration measure, supporting the successful handling of broadcasting problems by the Secretary of Commerce and proposing to continue it with the aid of an advisory committee, while the Dill Bill is the opposition measure, designed to detract from power of the Secretary of Commerce and to take from him credit for the regulation of radio. To smooth the way for the Dill Bill, its regulating commission provides attractive and comfortable feather beds for political casualties.

The radio industry's Coördinating Com-

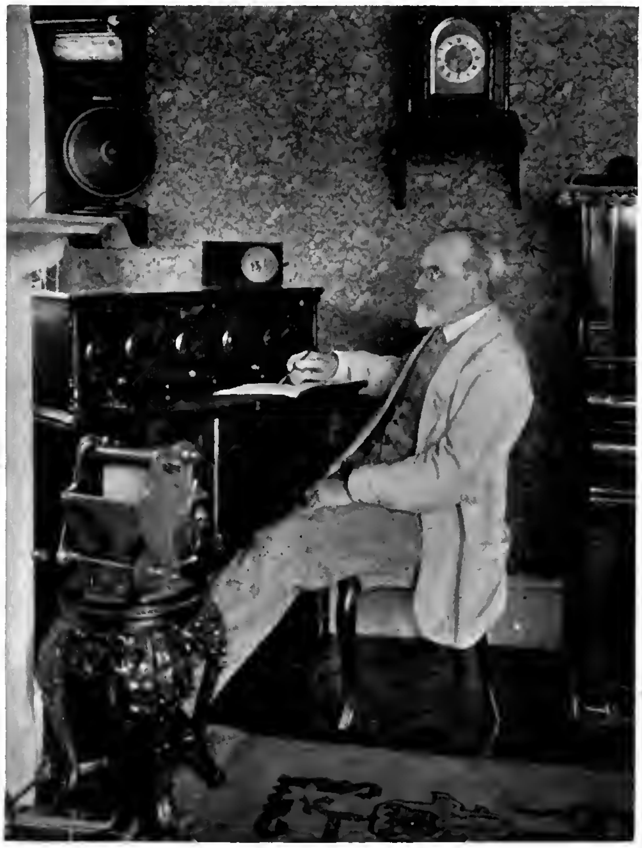
The photograph forming the heading above shows a wireless station among the Japan rice fields. The station is at Keniskawa, eight miles from Tokio.

mittee, lacking the support of broadcast listeners, has done the best possible job it could under the circumstances. To save the industry from a crisis, it undertook to support any legislation which had a chance of being passed, whether it was the best possible law or not. It played the political game astutely and the unfortunate and unavoidable result is that the political game is made a permanent pastime for the radio industry. The members of the Committee could not well afford to antagonize the politicians before whom they must later appear for their private interests.

The Conference Committee's temporizing attitude is well shown by an excerpt from their report to the Congressional Conference Committee:

This Committee is aware of the many interpretations of the effect of the two forms of radio control provided in the Senate and House Bills. It is also aware of the wide difference in the terms of these two forms and the consequent differences of opinion on this subject. From the point of view of legislative expediencies, the Committee would prefer not to pass upon this subject, or make a statement in favor of one of them, but feels obliged in this important matter to express an opinion solely on its idea of the good of the industry and the radio listener.

The Committee urges that, in the discussion of this matter and in the final decision, whether it is a compromise or not, the imperative need of immediate legislation compels the acceptance of some principle of control, if failure to agree will prolong and increase the difficulty of legislation. It is true that any form of control might be made effective, at least until corrective measures can be taken, if experience proves the necessity for a change.

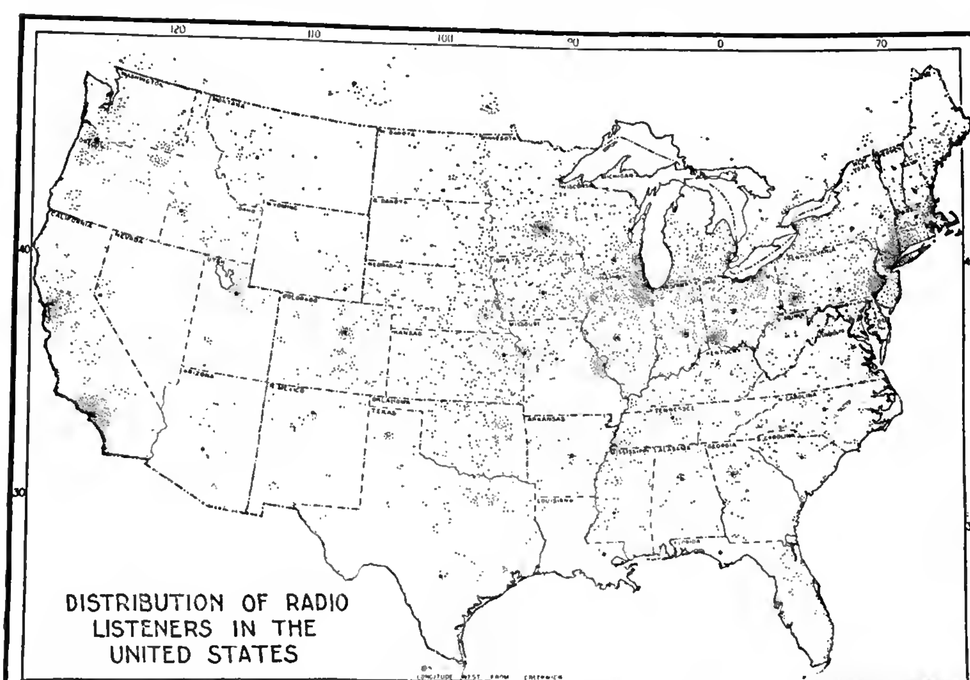


AN ENGLISH RADIO ENTHUSIAST

William Calvert Bramwell of Dingley Dell, Teddington, England, who is said to be one of the oldest radio listeners in England. He is 82. During the 1926 international radio broadcast tests, Mr. Bramwell slept all afternoon in order that he might listen for American stations from one to six A. M. English time

Included among the Committee's nine members are representatives of two wavelength jumpers, an interest which considers radio broadcasting as a potential rival to its business, and a spokesman for the amateurs. Yet the Committee did a most unselfish and constructive job, supporting as it did, priority as the determining factor in assignment of wavelengths, [See "March of Radio," September and November, 1926,] five-year station licenses instead of two-year licenses and urging that distinction be made between the broadcaster's rights with respect to the government and with respect to each other. This latter proposal was stressed by the Air Laws Committee of the American Bar Association in its comprehensive report to the Conference Committee, which came out strongly and fearlessly against an executive commission to handle the issuance of station licenses.

Had the radio industry's Coordinating Committee been solidly backed by twenty million broadcast listeners, it could have dictated the terms of the bill with only radio's best interests in mind. It could have insisted forcefully on maximum power to the Department of Commerce with only advisory and limited appellative powers to the Commission. It could have forced the adoption of definite limitations to the number of licenses issued and to the basis upon which they are to be granted. In absence of widespread listener support, its attitude was wisely one of compromise. The radio industry owes a lasting debt of gratitude to its hard working representatives in Washington. The industry has no one but itself to blame that they could not do more than they did.



WHERE THE RADIO LISTENERS ARE

The dots represent localities from which one or more letters have been received by one of several broadcasting stations on the east or west coast. No inland stations were considered in this particular survey

Danger of Monopoly in Broadcasting

MONOPOLY of broadcasting, which is such delightful music for the politician's song, is most effectively fostered by the fact that there is no incentive to the establishment of rival broadcasting chains. With an excessive number of broadcasters, the listening audience is so divided that the value of individual stations outside of the National Broadcasting chain is too problematical to be saleable on a large scale at the high rates necessary to maintain a truly rival chain. With political management for radio wavelength assignment, the chances of having the number of stations reduced by consolidation or elimination to the small number of 200 or 225 necessary to clear and unimpaired reception are made rather remote. Had the legislators concerned themselves with what is good for broadcasting, they would have set up a definite formula as to the number of stations which the present broadcasting band can accommodate. In the September and October issues, we suggested the division of the broadcast band into two classes, national and local, assigning two thirds of the available channels to about 75 national stations and one third to about 125 stations, serving local interests.

Such a proposal would make it possible for the broadcast listener to tune-in at least 50 of the 75 high grade key stations when reception conditions are favorable and to hear at least twenty of the smaller stations. The number of stations offered the listener decreases proportionately as the allotment of stations is increased over this proposed alignment. By accommodating more stations, service to the listener is decreased instead of increased. The question of how many licenses shall be issued should be considered in the light of service to the largest number of listeners rather than how many of those who desire to broadcast.

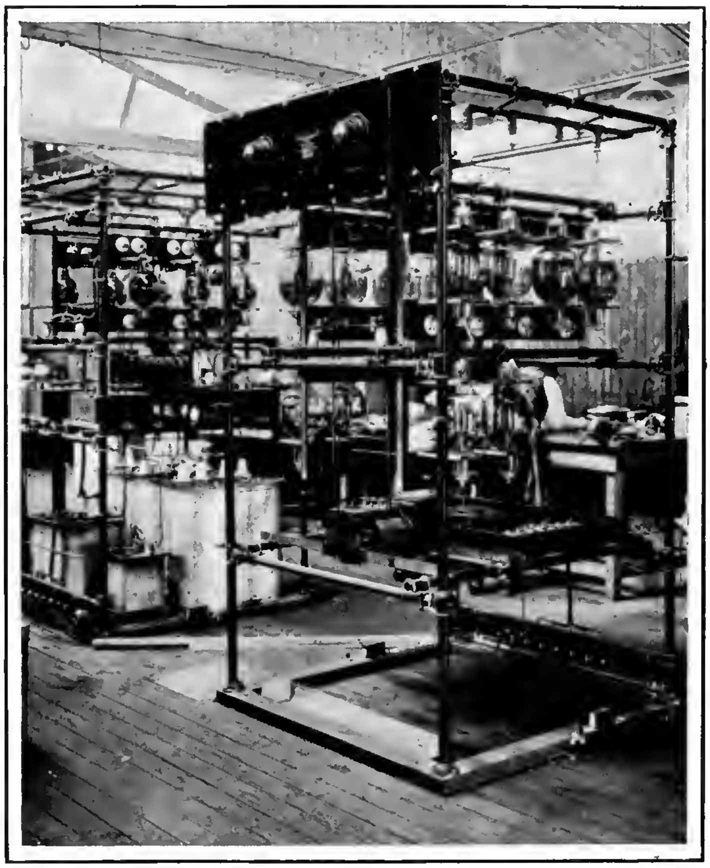
The American Bar Association Air Laws Committee, headed by Chester W. Cuthell, pointed out that the Constitution prohibits the confiscation of private property without compensation. But consideration should be given to the fact that most excess stations were placed in operation in the face of express warnings that there was no room for them on the ether. To compensate such stations is like paying a trespasser in an apple orchard for heeding a "no trespassing" sign. The true value of a broadcasting station is not its physical equipment but the habitual audience which its faithful service has attracted. On that basis, the stations which cause heterodyne whistles marring the programs of long established broadcasters are worth less than nothing, having, as their assets, only antagonized listeners.

The present monopoly of the National Broadcasting Company in extended chain broadcasting will be permanently ended when ether conditions are cleared. The establishment of rival chains is a prospect impossible of consummation as long as the ether remains overcrowded.

The Future of Commercial Broadcasting

THE economic structure of radio broadcasting is unique in that those who are served do not pay directly for its maintenance and the radio industry which it supports assumes little or no responsibility for it. Unrelated businesses, since all manner of advertisers use the medium, are broadcasting's principal source of support. Fortunately, the greater the merit of the commercial program, the more effective its goodwill influence; otherwise commercial broadcasting would be an abuse instead of a boon. It has brought the listener the highest quality of radio talent in the world and, with that, full justification for its existence.

Significant changes, however, are possible in the structure of the broadcasting world. The trend now is to extend a single chain so that subscribing stations tend to lose their identity and individuality. They become mere extensions of a New York studio. In time, there may be two chains. But the number of chains cannot increase indefinitely, as long as outlying stations become closely affiliated with one chain or another. Eventually, the listener, although able to hear twenty or thirty stations with his set, may be restricted in his choice of program material to a local program and to one or two chain programs. Such a system would not long survive because it would rob radio of its variety.



3 LO MELBOURNE, AUSTRALIA

A part of the equipment of the popular 5-kilowatt Melbourne broadcasting station. This station has often been heard in American Pacific Coast cities

In the end, we would not be surprised to see a complete divorcement of program presentation from station operation. Broadcasting artists will appear at one of a score of radio studios, each serving a nationwide wire network. Station program managers will piece out their programs as their policy dictates from any of the thirty or more program sources available. Each station manager will use his own judgment in determining program balance and feature value. For commercial programs, stations will receive compensation varying with the attractiveness of the feature and based not only upon their location but also upon their program standards and their audience. A selfish program manager, or one faced with little competition, will have a predominance of features which pay him good revenue. In the end, his audience will become smaller and the value of his time proportionately reduced. Others, seeking the greatest possible audience, will pay for high grade sustaining features, use only commercial features selected for their program value, and thereby build large audiences. Thus program values will be automatically maintained. Naturally, time of the latter stations will be worth more than that of the less discriminative station and commercial broadcasters will be willing to pay proportionately higher sums to use their facilities.

Vaudeville booking is conducted much in this way. Each theater has its representive. Together they haggle and bargain, balancing cost of feature against program attractiveness. The better the feature, which the commercial broadcaster offers, the less he will pay for his time on the air and, conversely, the higher the standards of the station, the more it will demand from the broadcaster. Any one who wishes, whether he be educator or anarchist or both, may submit himself to broadcasting stations, either paying or being paid according to his program attractiveness, for the privilege of making himself heard. Thus supply and demand, program attractiveness and station value, will rule broadcasting costs and the opportunity to use the microphone will be automatically extended to all who can sell themselves to station managements. Individuality of stations will be encouraged and listening clientèles will take definite forms, according to individual station program policies.

Viewed abruptly, this is a rather nebulous scheme, but, if we consider it step by step, it is a fairly logical prospect. The value of the chain system has been demonstrated by a single large broadcasting chain. Improved radio regulation will encourage two or three chains, each likely to have fairly similar and competing features. Then the inevitable reaction to standardized programs and widespread uniformity will assert itself and the line of demarcation between specific chains will disappear.

Problems for the Radio Commission

A POLITICAL commission, seeking to regulate radio, will be confronted with many difficulties. During the last few weeks, WEAF's program has been marred by a heterodyne whistle. Inquiry at the station reveals the surprising information that they do not know what station is causing the interference. With a little careful tuning, we were able to find out that the station in question was WCFL, operated by the Chicago Federation of Labor. The National Broadcasting Company cannot be blamed for avoiding a quarrel with the great labor organization, regardless of the motives which caused the latter to select that particular wavelength for its operation. The Chicago organization sought a broadcasting license after the ether channels were filled and probably felt indignation that the interests of a great monopoly had an exclusive channel. If petulancy animated their choice of wavelength, it has been visited fully as much upon the ranks of labor which enjoy WEAF's programs as it has to the detriment of WEAF. A political commission, fearing the alleged political influence of labor organizations, might be a little hesitant in applying the principles of priority and service to the listener in such a case.

Remarkable Short-Wave Transmission

CONTINUED use of high-frequency transmission must lead any serious investigator to the conclusion that we know nothing about how high frequency waves travel. The experience of station 2 NZ, operated by a New Jersey amateur, using 300 watts power, indicates some of the strange vagaries of short wave transmission as observed by this operator. A station clearly audible at a certain distance north, may be inaudible at the same distance to the west. Forty-meter stations in New England are rarely heard in New York and stations fifty miles north of New York are seldom heard after 8 P. M. on this wavelength. Yet stations from the south can be heard at varying distances, depending largely upon the weather. Conditions to the west are even more uncertain. When West Coast stations come in well in New York, New York stations deliver a weak signal to them and vice versa. Foggy and drizzly nights, usually poor for broadcast reception, are good for short-wave transmission. When Brazilian stations come in loudly in New York, it is difficult to deliver an audible signal from powerful New York short wave transmitters. On the other hand, communication with Australia and New Zealand gives fairly constant signals. There is less variation in New Zealand reception in New York than there is in reception from middle western stations.

ARTHUR WILLIAMS

New York City

Vice-President, Commercial Relations, The *New York Edison Company*. Especially written for RADIO BROADCAST:

"A discarded radio set is of no use to anybody. It adds nothing to home life, in which it can be made an important adjunct, from the standpoint of education, entertainment, and general home attractiveness. Our own justification for supplying radio programs is primarily, if not entirely, based upon the fact that radios in use consume electric current, either from primary or charged batteries, or directly from the light circuit. I recently testified before the Public Service Commission that our increased revenue due to the use of radio was about a million dollars yearly. One of the significant results concerning the radio has been the seeming satisfaction of the consumers that the increase in their electric bills is justified with the extra use due to radio; possibly they are thinking of their families, more contented to stay at home, or of the lessened drains on their purse for theater tickets, or for evening excursions, which in these days, especially, make very noticeable invasions upon one's bank account."

The Month In Radio

THE U. S. Lighthouse Service is now operating 29 radio beacons, 13 of which are recent installations. The radio beacon emits a distinctive signal so that it is easy to identify. Its direction may be determined by means of a radio compass. A navigator, making for New York, first picks up and locates the Nantucket Shoals Lightship when he is some 300 or 400 miles out. Approaching nearer, he hears the Fire Island signal and finally the Ambrose Channel light vessel directs him to the mouth of the channel. A beacon is being installed in Long Island Sound for ships using the inner course. The active beacons are distributed at most of the dangerous points along the coast, nine on the Pacific, one on the Alaska coast, nine on the Atlantic, two on the Gulf and eight on the Great Lakes. 400 ships, flying the American flag, are now equipped with radio compasses.

THE tremendous growth of the radio industry, one might believe, would reflect itself in increased consumption of copper. In his address before the American Mining Congress, Thomas D'Arcy Brophy stated that the radio industry absorbed from two to three million pounds of copper per year out of the total of 765,000,000 pounds used in the United States. Radio insignificance as a buyer of copper is indicated by the fact that the automotive industry uses 245,000,000 pounds, electric refrigeration about 45,000,000 pounds and lightning rods 15,000,000 pounds.

THE Radio Market News Service has been extended to station KFKX which serves a large area in the great plain states not heretofore reached by the Department of Agriculture's comprehensive radio service to farmers. The number of rural listeners is estimated to have passed the million mark and already half a million enrollment cards have been received by the United States Farm Radio School. Ninety broadcasting stations in every section of the country lend their facilities regularly for half an hour daily to the agricultural radio service.

IN THE season of annual reports by cabinet members, it is interesting to note the references to radio. Secretary Wilbur states that the fleet requires considerable modernization of its radio apparatus in order to avoid interference with radio broadcast entertainment. The Navy has developed high-frequency radio transmitters which give long range communication at low initial cost and maintenance. Both aircraft and submarine radio have benefited from research in radio during the past year. An extensive radio weather service for aircraft in flight in the New York–Washington–Norfolk area, is in operation and it is hoped to extend the system of radio communication and radio direction finding along other important air routes. Photographic records have been obtained, showing the time difference in the travel of radio waves between two points directly and by reflection from the Kennelly-Heaviside Layer, giving another check on its height above the earth. The Naval Research Laboratory has supplied the needs of several government departments for quartz oscillators, used as frequency standards in broadcasting stations. The naval radio intelligence system ashore now comprises 133 stations, including those for communication with the fleet, coastal stations for marine traffic, aircraft stations, harbor stations and radio compass transmitters. During the year, the Navy handled 14,362,987 words, of which half were for other departments of the Government. The increased use of high frequency transmission has contributed largely to the growth of the Navy's traffic.

THE daylight ship to shore transmission record was broken when station KFS at San Francisco communicated with the S. S. *President Wilson* while that ship was 3120 miles west of that port.

ACCORDING to figures issued by the Department of Commerce, the number of stations licensed since July 1 is 108; 34 changed locations; 126 increased power; 93 shifted wavelength; 102 stations are under construction; 63 are about to increase power, and 168 have advised that they are soon to apply for licenses. 22 of the stations licensed since the 1st of July are of more than 500 watts power and 24 of the old stations, licensed prior to July 1, have increased their power to 500 watts or more. Had not that fatal oversight been made in the last few moments of Congress's session last summer, which failed to make effective the joint resolution passed by both Houses prohibiting issuance of additional licenses, the 108 new stations, the 102 under construction and the 168 projected would not be in the problem to-day.

The transatlantic telephone circuit opened successfully on January 7, with full hours of service, from 8:30 to 1 P. M., New York time. Perhaps an ambitious commercial broadcaster will employ it to send his program to European stations. The rate will be about twenty-five dollars a minute or only two and a half times WEAF's toll rate.

A High-Quality Amplifier for the R. B. "Lab" Receiver

Constructional Details of an Amplifier in Which Bypass Condensers and Chokes Have Been Included to Avoid Audio Regeneration

By JOHN B. BRENNAN

Technical Editor

IN THE November, 1926, RADIO BROADCAST, the author described the construction of a complete four-tube receiver embodying the fine points of the R. B. "Lab" circuit which had been developed by several engineers, and on which a very considerable amount of work had been done in the Laboratory of RADIO BROADCAST.

Soon after, a receiver was built which was subsequently described in the January, 1927, RADIO BROADCAST, consisting merely of the two-tube tuner part of the original four-tube receiver. This construction was presented to our readers so that they could tie up this efficient receiver circuit with any unit audio amplifier, such as the Alden Truphonic, the National combined impedance-resistance amplifier and plate supply, the Millen audio channel, and such resistance amplifiers as the Heath, Amsco, Allen Bradley, and others.

Strangely enough, practically every type of audio amplification is represented in this list excepting our old stand-by, transformer-coupled audio amplification, and it is to fill this gap that the paper herewith describes in detail the construction of a transformer-coupled audio amplifier of high merit.

The "Lab" circuit in any form deserves nothing but the best of audio amplifiers. It is a circuit that will satisfy the most critical of builders on points of selectivity and sensitivity; to successfully amplify the output of the detector tube, an amplifier of proved value should be employed.

In the four-tube receiver described in November, 1926, an audio channel was used which gave complete satisfaction where tone quality and volume were concerned, and it is for this reason that the use of the elements employed therein are continued in the construction of the amplifier described here.

When using high-grade transformers, such as the Amertran De Luxe, it is possible that any slight defect elsewhere in the circuit will be noticeably amplified and cause distortion. This is especially true where an a. c. operated B power-supply unit is employed with an amplifier employing these transformers.

Since such power supply units have a shunt tapped resistance across the output to obtain the various plate B voltages, there is a coupling effect produced, due to the resistance which is common to all plate circuits. That is to say, the common resistance couples together the various plate circuits and causes regeneration at audio frequencies which in some cases is detrimental to tone quality. To overcome this disadvantage, it is necessary to employ bypass condensers and r. f. and a. f. choke coils so placed that no coupling takes place. This has been done in the amplifier described here.

RADIO BROADCAST Laboratory would be greatly interested in receiving reports from readers who have constructed the R. B. "Lab" circuit in either the two or four-tube style and who have experienced trouble in the use of B power-supply devices with their receivers.

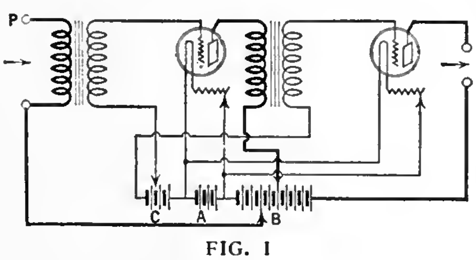


FIG. 1

Other notes of interest, where they concern construction details, operating notes, or results, are of especial concern to the Laboratory staff, and we welcome such reports addressed to the magazine. Photographs of interesting models built by readers are also quite welcome, for by reproducing these, it is possible to give wide circulation to valuable kinks of construction.

The purpose of this article is primarily to describe the construction of a two-stage audio-frequency amplifier which may be combined with the two-tube shielded R. B. "Lab" Receiver described by the author in the January RADIO BROADCAST. In addition, some notes on tubes satisfactory for use with either the two- or four-tube R. B. "Lab" receiver are also included.

Aside from its especial use with this tuner circuit, the two-stage amplifier may well be worked with any other tuner unit the builder may have on hand. Such an amplifier, for instance, could very nicely be used in conjunction with a short-wave tuner. For this latter form of work it is not absolutely essential that two audio stages be employed as most of the reception is done with the aid of headphones, and two stages would produce too loud a signal for comfort. For this reason, together with others, an interstage jack has been included behind the first audio stage so as to enable the operator to plug in after the first audio amplifier. Since the output jack is of the filament-control type, the last audio tube does not remain lighted when the phone plug is inserted in the interstage jack, and, therefore, the half ampere of filament current which the semi-power tube consumes is saved.

On the point of stability, the amplifier shown here incorporates all the worth while features of bypassing and audio frequency filtering that seem to be of definite value. This is especially true when it is considered that, since the amplifier is built as a unit and will quite likely be stowed away in some remote place, necessitating the use of long battery and other connecting leads, there are bound to be some deleterious coupling effects produced, unless such bypassing is resorted to.

In brief observation of the functioning of the bypass condensers and audio chokes, etc., let us analyze the circuit diagram of an amplifier shown in Fig. 1. Here no bypass condensers, audio chokes, or grid filters are shown. It will be seen that audio currents in either the grid or plate circuits of the tubes, to return to the common connecting point (the minus-A lead), must first course through the battery leads which might be several yards long. In the plate circuits, the return is made to a series of B batteries which are common to all the plate circuits. Any resistance in the B batteries will tend to couple the various plate circuits together thereby setting up an audible oscillation, or tendency to produce regeneration.

In cases where a. c. operated B power-supply devices are employed, the situation becomes more complicated because usually the various B voltages are obtained from the a. c. device by taking a drop through a resistance common to all the B plate circuits, as stated previously. Here we have a definite, known resistance to

RADIO BROADCAST Photograph

THE ARRANGEMENT OF THE APPARATUS

In the base layout is shown the placement of the various parts. The wiring, it may be noted, is not entirely visible, for at the terminal of each piece of apparatus, a small hole is drilled in the base-board to allow the wiring to be passed through to the under side. Such an arrangement makes for neatness of appearance

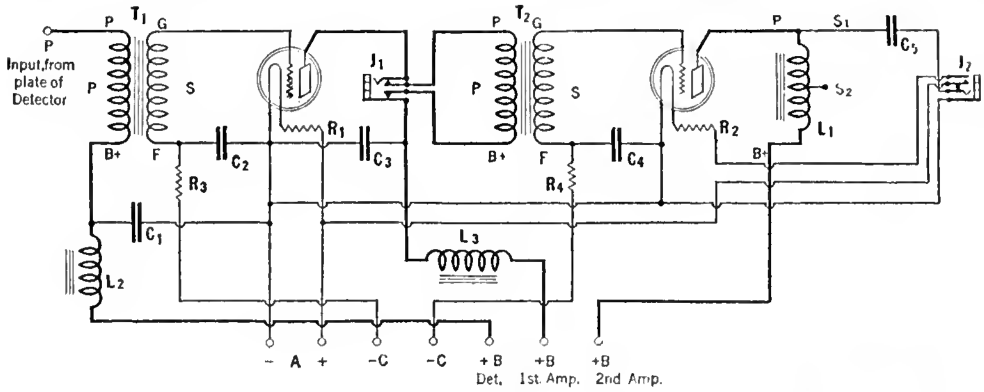


FIG. 2

contend with. In batteries, the resistance coupling effects are produced usually when the batteries become old.

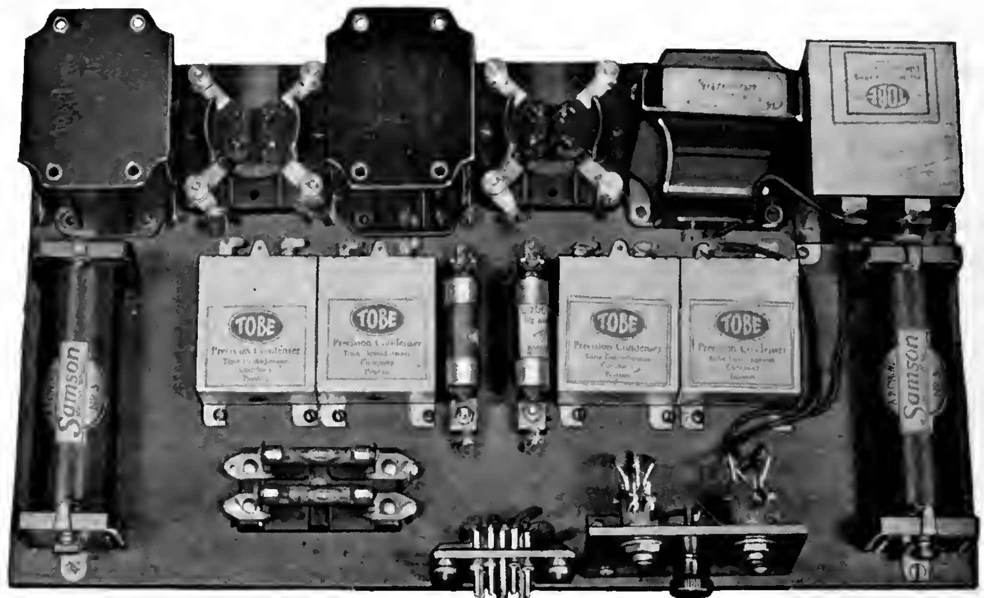
Considering this coupling action, it is obviously desirable to provide a return path for the audio currents, and also to prevent their dividing between the provided path and the battery path. In the first place, condensers will provide the necessary return path direct to the negative-A lead. In the second place, audio chokes and grid filter resistors, when placed in series with the plate and grid circuits respectively, will impede the flow of these currents to the batteries and will necessarily make the currents travel through the bypass condensers provided for that purpose. This is made more clear by referring to the circuit diagram Fig. 2, which is similar to Fig. 1 with the exception that the condensers, chokes, jacks, and filters have been included.

The Samson audio chokes have been employed in the amplifier described. What the audio choke does for the plate circuit, the grid resistor does for the grid circuit. In both cases it will be noted that first an element impedes the flow of the audio currents through the leads which connect either to the batteries or the a. c. supply device, and, secondly, a bypath is provided for these currents so as to make a short return to the minus A of the tube.

Both grid filters and plate impedances, with their associated bypass condensers, are to be highly recommended; in fact, may be an absolute necessity when an a. c. operated power-supply device furnishes the B and C potentials. However, where B batteries are employed, the grid filter resistors may be dispensed with. Note, however, that only the grid resistors are omitted, not the grid bypass condensers.

The several photographs accompanying this article serve to acquaint the builder with the mode of construction employed and very little effort is necessary to construct a similar amplifier.

The materials required to duplicate the construction of the two-tube amplifier unit as shown here is as follows:



RADIO BROADCAST Photograph

THE COMPLETE AMPLIFIER UNIT

In this illustration, the box has been removed. Note that the sockets and transformers, etc., are arranged along the rear edge, while the associated apparatus is disposed on the forward part of the base-board. The double resistor mount, located in the left front part of the base, holds the resistors which make up part of the grid filter circuit, so necessary when an a.c. operated power-supply unit is employed to furnish the B and C voltages.

1 Wood Base-Board 8″ x 14″ x ½″	$ .25
T_1, T_2—2 Amertran De Luxe Audio Transformers	20.00
2 Airgap Sockets	1.20
L_1—1 Samson Output Impedance, Type O	5.00
C_5—1 Tobe 4-Mfd. Output Condenser	3.50
C_1, C_2, C_3, C_4—4 Tobe 1-Mfd. Bypass Condensers	3.60
L_2, L_3—2 Samson Audio Chokes, No. 3	6.00
R_1, R_2—2 Brachstats, ¼-Amp. and ½-Amp.	2.00
1 Lynch Double Resistor Mount	.50
R_3, R_4—2 Lynch Resistors, ¼-Meg.	1.00
1 Yaxley Cable Connector and Plug	3.50
J_1—1 Yaxley Single-Circuit Filament Control Jack, No. 703C	.65
J_2—1 Yaxley Double-Circuit Jack, No. 703	.65
1 Binding Post	.10
Bakelite, Screws, Wire, etc.	.50
Wood for Cabinet	1.00
Aluminum Paint	.50
TOTAL	$49.95

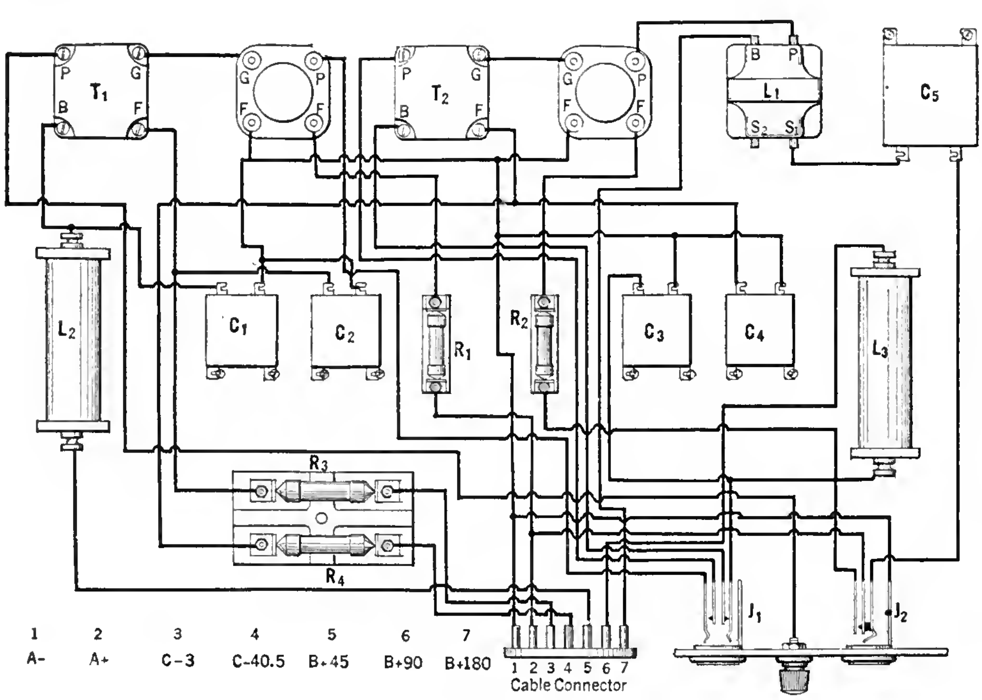


FIG. 3

To assemble the amplifier, refer to Fig. 3, which shows the disposition of the various parts on the base-board, and to the photograph on this page. The bakelite strip is drilled in accordance with the details shown in Fig. 4, and is mounted on the front edge of the base in the position shown.

After the parts have been securely mounted, the wiring is attended to. It will be observed

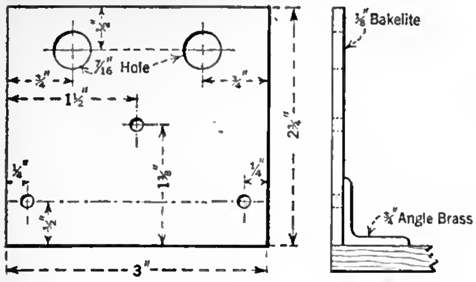


FIG. 4

that, due to the close placement of the transformers and sockets, exceedingly short leads between these parts are possible. It is possible to run much of the wiring, especially the longer leads, under the base-board, through holes drilled near the various terminals. When the wiring has been completed, a box may be assembled around the base. A light coating of shellac will fill up the pores of the wood after which a coat of aluminum paint may be applied to the entire cabinet surface. This latter coat is only necessary when the builder desires to have his amplifier look like the aluminum cabinet of the two-tube shielded R. B. "Lab" Receiver described in the January RADIO BROADCAST.

Fig. 5 shows the assembly details for the box, together with a complete material list of the wood required. The manner in which the various pieces are assembled is clearly shown, and no difficulty will be experienced in this respect, providing the constructor has taken care to cut his wood exactly as specified. The box fits over the base upon which is mounted all the amplifier apparatus, and in the front is cut an opening so as to allow access to the connector plug, and jacks, etc.

After assembling the box, carefully sandpaper the surface. The finer the surface, the better will be the finish of the aluminum paint. If brads are used to hold the pieces together, they should be countersunk, and the small head holes filled with soap. If screws are used, be sure to spot the holes first, then drill out, with a drill several sizes smaller than the diameter of the screw.

CORRECT PLATE POTENTIALS

VALUES of batteries for use with receivers and amplifiers depend chiefly upon the type of tubes employed. The output tube of an audio amplifier, if it be of the semi-power variety, necessitates the use of a definite value of plate potential when a certain fixed value of grid bias is applied. In the case of a C battery detector there are certain values of B battery that must be employed in conjunction with the value of the grid bias used. Both go hand in hand.

A table of B and C voltages for various output tubes is given here.

UX-112		UX-171	
C	B	C	B
6	90	$16\frac{1}{2}$	90
9	135	27	135
$10\frac{1}{2}$	$157\frac{1}{2}$	$40\frac{1}{2}$	180

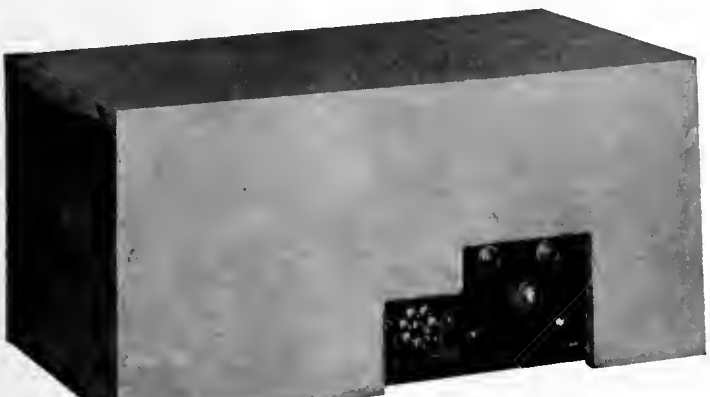
Under all normal conditions the C battery detector will work satisfactorily with 4.5 volts on the grid and 45 on the plate. Some tubes, however, refuse to oscillate over the whole band with these voltages. The remedy is obvious; increase the B voltage to $67\frac{1}{2}$ or increase the regeneration capacity by twisting a pair of insulated wires and attach one end of each wire to the regeneration condenser. The other two ends should be insulated from each other. The main advantage in varying the detector operating voltages is in obtaining a state of regeneration which is considered satisfactory for operation over the entire wavelength range. However, it will usually be found that 4.5 volts of C battery with 45 volts plate battery on the detector tube will be universally satisfactory.

If it is desired to employ the new detector tube, UX-200-A, it is well to replace the grid leak and condenser to the detector circuit and to run the grid return to the negative filament lead.

Stabilization of the receiver, together with more accurate neutralization, is bound to occur when the bypass condensers are applied to the radio-frequency amplifier and detector circuits. This is especially true of the C-battery circuits because in most cases the leads to the C batteries are quite long with every chance for serious coupling or pickup. The bypass condensers eliminate the probability of the coupling and in turn make the receiver more possible of complete neutralization.

It is not amiss to include the bypass condensers, together with the necessary r. f. choke, in the plate circuit of the r. f. tube so as to provide complete bypaths for the r. f. currents. This precludes the possibility of r. f. currents finding their way into the battery circuits. The circuit diagram, Fig. 6, shows the addition of bypass condensers, (Cx) and r. f. choke coil (Lx) to the radio-frequency amplifier and detector circuits.

In the four-tube receiver the variable resistance controlling volume is situated near the left end of the panel while the interstage coil to which it is connected is quite a distance away from it, necessitating long leads which may give rise to intercoupling. By the use of the choke Lx, the r. f. currents are kept out of the resistance and bypassed to the negative line throughthe condenser Cx.



RADIO BROADCAST Photograph

THE EXTERIOR OF THE AMPLIFIER CABINET

For the fastidious constructor who desires the same color scheme for his amplifier as his two-tube R. B. "Lab" receiver, (which is finished in natural aluminum), a box can be assembled to fit over the amplifier, and be finished with aluminum paint. The illustration shows such a box with the amplifier inside

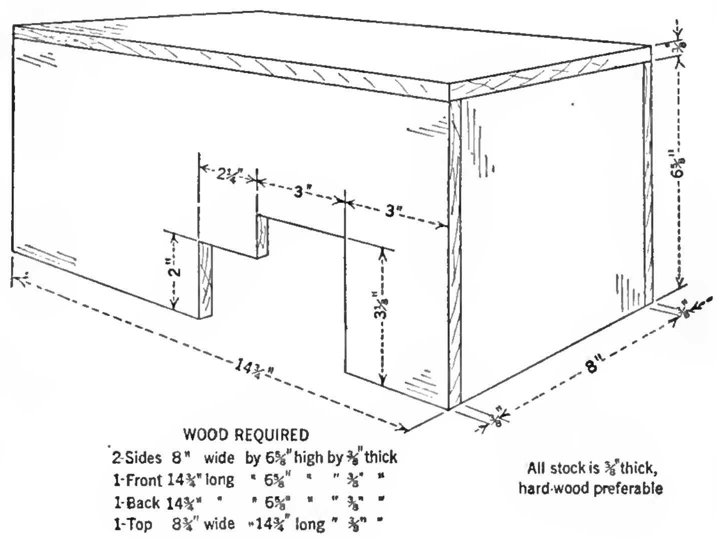


FIG. 5

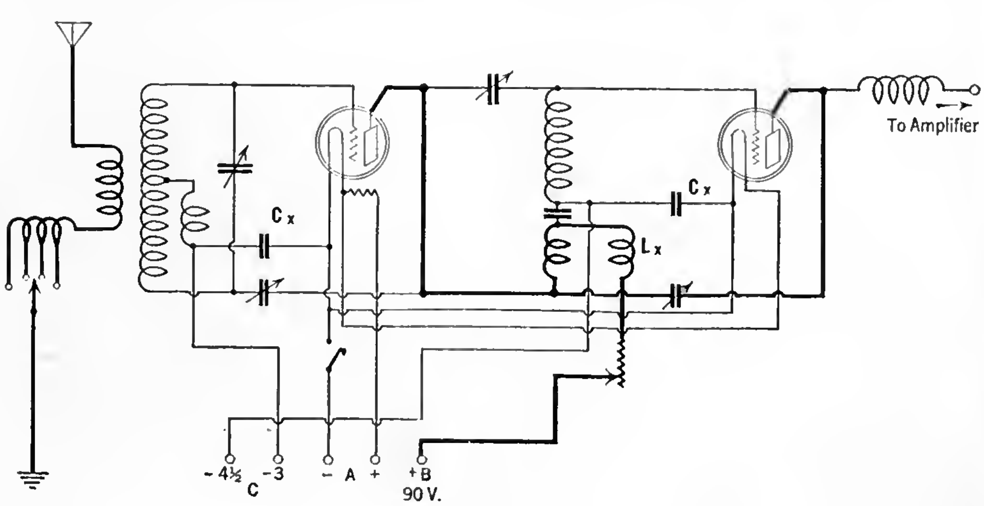


FIG. 6

THE "HI-Q" IN A CONSOLE

Which holds all the power equipment and also a Stevens conoidal loud speaker, the latter being concealed behind the grill

Electrifying the "Hi-Q" Receiver

The Construction of an A. C. Operated Power-Supply Device for the Hammarlund-Roberts "Hi-Q" Receiver which Supplies B Current for All Tubes, A and C for Power Tube

By LESLIE G. BILES

IT IS true that, not so many months ago little or no attention was given in the matter of choosing tubes of different characteristics according to the duties they were required to perform in a radio receiver, but nowadays such selection is carefully made by almost every radio constructor. Reference to the circuit diagram of the new Hammarlund-Roberts "Hi-Q" receiver, Fig. 1 (reproduced from the author's article on this receiver which appeared in the January RADIO BROADCAST), offers the information that the grid return of the detector tube is connected to the negative filament lead. This connection necessitates the use of one of the new special detector tubes of the 200-A type. For the radio-frequency stages, the 201-A type tubes can be used.

When it comes to the output tube, there seems to be a lot of confusion as to the proper tube to use. Shall it be a 201-A, a 112, or a type 171? The use of a power tube greatly increases the amount of energy that can be delivered to the loud speaker without distortion, but plenty of voltage for the power tube is necessary for full amplification.

The relative values of these three tubes as power handling devices when used with the proper grid and plate potentials are as follows:

TUBE	GRID VOLTS	PLATE VOLTS	UNDISTORTED OUTPUT (MILLIWATTS)
201-A	4.5	90	15
112	9	135	120
171	40.5	180	700

Since the 171 type, under the conditions given in this table, will handle six times as much as a 112, and forty-seven times as much as a 201-A tube, its superiority is unquestioned.

With the advent of the power tube, it has become increasingly economical to utilize a device to obtain some or all of the necessary power for a receiver from the a. c. mains. The following data relates to the construction of a power-supply device that has been designed by the author for use with the "Hi-Q" receiver. It supplies a. c. for lighting the filament of the last tube, B voltage for the entire receiver, and C bias for the last tube.

A small-capacity storage battery may be used, in conjunction with a trickle charger and automatic relay, to light the filaments of the other tubes. This combination will result in a set up that will require very little attention except the periodical addition of distilled water to keep the plates of the storage battery covered.

A few minor alterations, necessitating the changing of about half a dozen connections of the audio amplifier in the Hammarlund-Roberts "Hi-Q" set, will have to be made so that the power device can be used to light the filament of the 171 tube and supply the high negative bias.

The following additional material will be necessary:

1 Samson Output Impedance, Type O	$ 5.00
1 Sangamo Series A Condenser, 4-Mfd	3.00
1 Pair Carter "Imp" Telephone Jacks	.60
1 Tobe Veritas Resistor, 2000-Ohm	1.10
1 Durham Metallized Resistor, 50,000-Ohm	.75
1 Lynch Double Resistor Mounting	.50
1 Tobe Condenser, 1-Mfd.	.90
1 Yaxley Pilot Light Bracket, No. 310	.50
1 Brass Angle Bracket, ½ x ½ Inches	.05
1 Piece Panel Material, 3 x 1 inches	.10
TOTAL	$11.90

(Similar standard parts may of course be used).

The new connections of the amplifier which is shown as part of the circuit in Fig. 1, are shown in Fig. 2. To make the changes, it is necessary to follow the subsequent procedure:

Loosen the screws holding the audio amplifier to the baseboard. Remove the wire from the 135-volt binding post and the wire from the "P" terminal of the output tube.

The jack is not to be used again, and may be removed, a pilot light bracket being installed in its place on the panel. Raise the amplifier and remove the wire connecting (at the end of the sub-panel) Amperite No. 3 to the tube socket and the other wire from Amperite No. 3 to the plus A lead of the set. Replace the Amperite mounting with a double resistor mounting.

Disconnect the wire running from the minus A binding post to the minus terminals of the audio tube sockets and the soldering lug on shield section 1D. Connect the minus-A post to the minus terminal of the power tube socket and connect a branch to the lug on the shield.

Remove the wire connecting the minus-F terminal of the second audio transformer to the minus-C binding post.

Connect the minus-B binding post to both

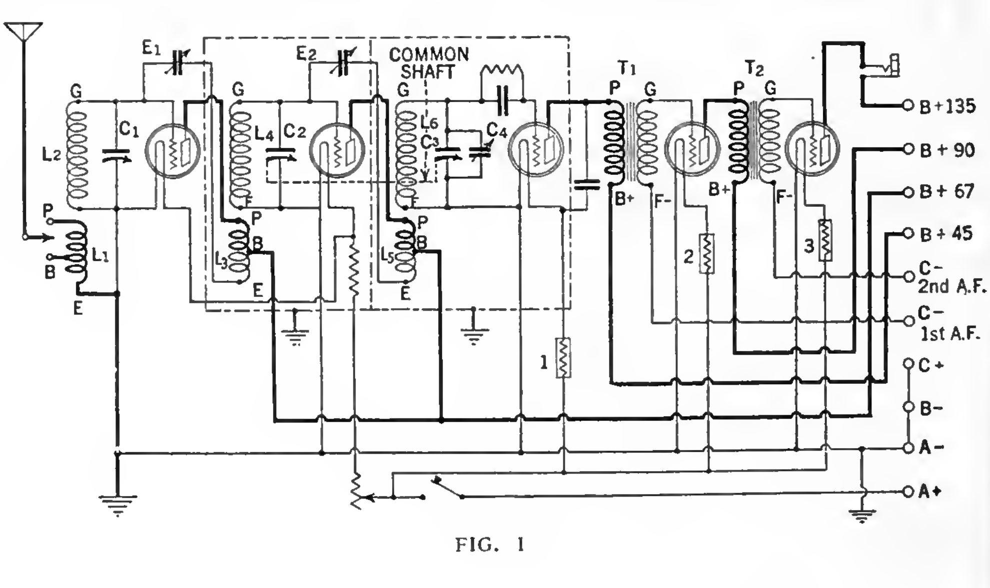


FIG. 1

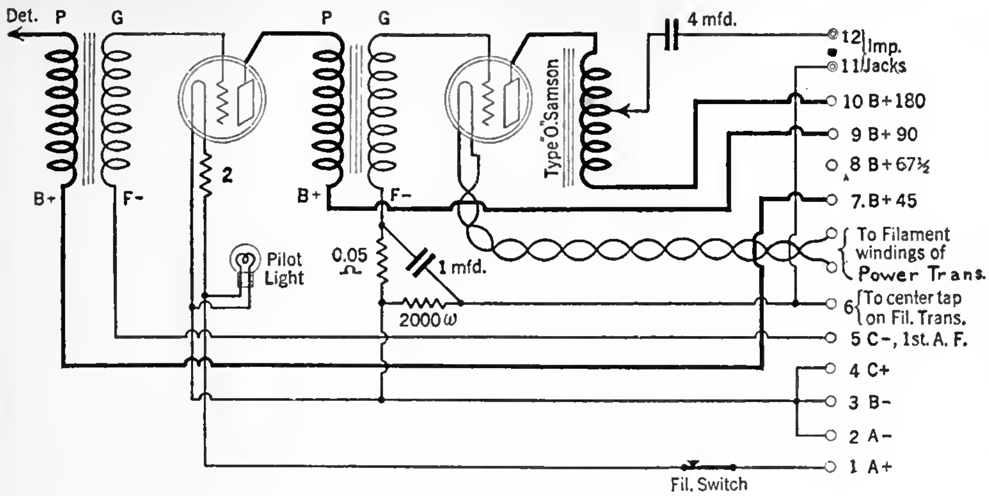


FIG. 2

terminals of the double resistor mounting at the end toward the main control panel.

Connect the minus-F terminal of the second audio transformer to the terminal of the resistor mounting nearest the transformer and in the clips of the mount place the 50,000-ohm resistor. Mount a 1.0-mfd. condenser on the baseboard directly opposite the double resistor mounting and connect one terminal to the soldering lug of the resistor mount which is connected to the F terminal of the transformer.

Connect the remaining terminal of the resistor mount to the minus-C binding post (No. 6 in Fig. 2) and continue a branch wire to the unconnected terminal of the 1.0-mfd. condenser.

A piece of double conductor lamp cord, about two feet long, should be connected to the filament terminals of socket No. 5 to be later attached to the power unit, as the filament of the 171 tube is to be heated by a. c.

The output impedance should be mounted in the unoccupied space at the extreme left of the baseboard. The 4.0-mfd. condenser can be most conveniently mounted by making a small hole in shield section 2B and fastening the condenser against the side of the shield.

Fasten the Imp telephone jacks in the small strip of bakelite and mount this assembly to the baseboard by means of the small brass angle bracket.

In making the following connections for the output device, shown in Fig. 3, use No. 14 Celatsite or other well insulated wire:

Make a connection from the P terminal of the power tube socket (passing the wire between shield sections 1C and 2A) to the P terminal of the output impedance.

Run a wire from the 135-volt binding post to the B terminal of the impedance. Connect terminal S1 of the impedance to one terminal of the 4.0-mfd. condenser, and the other terminal of the condenser to one of the Imp jacks. Connect the other Imp jack to the center tap of the filament transformer.

THE POWER UNIT

NOW let us tackle the job of building the power unit according to the diagram, Fig. 4, or the picture layout, Fig. 5. After the instruments are mounted in place, it only requires sixteen connections to complete the unit. The following is a list of the apparatus required:

1 Thordarson Power Compact, R-171	$15.00
1 Tobe B Block, No. 760	11.00
1 Yaxley Automatic Relay, Type No. 444	5.00
1 Yaxley Cable No. 660	3.50
1 Q. R. S. Red Top Full-Wave Rectifier Tube	6.00
1 Benjamin Socket, No. 9040	.75
2 Clarostats (Variable High-Resistance Units)	4.50
1 Tobe Veritas Resistor, 10,000 Ohms	1.10
1 Tobe Veritas Resistor, 5000 Ohms	1.10
1 Sangamo Bypass Condenser, 1.0-Mfd. Series B	1.95
2 Lynch Single Resistance Mounts	.70
1 Baseboard, 7 x 9 x ½ Inches	.25
TOTAL	$50.85

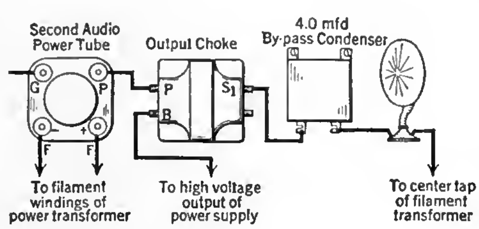


FIG. 3

For the sake of clarity in giving these instructions, we shall assume that the outfit is to be housed in a console cabinet as shown in the illustration, in which case the relay may be mounted on the inside of the cabinet.

There is no set rule for laying out the instruments; the arrangement shown in the photograph on this page will be found to provide short leads and facilitate the wiring. Be absolutely sure that you leave sufficient room between the Thordarson Compact and the Clarostat to enable the cable plug being inserted in place without hindrance from either of these parts or the connecting wires.

In wiring the power-unit, use No. 16 Celatsite, or No. 14 bus wire with Acme cambric insulating tubing. Do not use poor quality insulation.

Three pieces of flexible rubber-covered wire, about eighteen or twenty inches long, are required, one of which is to be connected to the A-plus (red) terminal of the cable connector and another to the A-minus (green) terminal. Connect the remaining lead to the C terminal on the filament side of the power Compact. The A-plus wire is later to be connected to terminal No. 1 of the automatic relay and the A-minus is to be connected direct to the negative terminal of the storage battery. Terminal No. 2 of the relay connects to the positive terminal of the storage battery.

The console makes an ideal installation as it permits the batteries, power-supply unit, charger, and other incidentals to be kept out of sight. It should be selected to harmonize with the other furnishings in the room where it is to be used.

The Superior console, shown in the photograph on page 470, may be secured with a Stevens conoidal speaker built in the compartment at the top, or the loud speaker may be purchased separately to be hung on the wall or placed in a different part of the room.

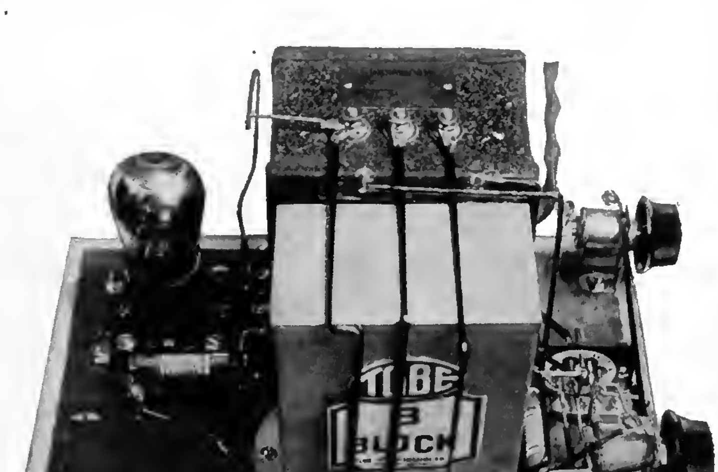
The compartment of the Superior console in which the "Hi-Q" is to be mounted, is in reality a drawer. It is unnecessary to remove the receiver from the baseboard on which the instruments are mounted. The console drawer is furnished with a walnut front slotted in the center to facilitate cutting out a section of the drawer so as to permit the panel of the "Hi-Q" to be mounted behind this walnut drawer front, as shown in the photograph.

After this section has been cut out, a narrow walnut beading, such as is used in picture framing, should be fastened around the edges to give it a finished appearance. The "Hi-Q" should then be placed in the drawer and securely fastened in place.

Fasten the automatic relay on the inside wall of the cabinet as shown in the illustration on page 472, and then place the storage battery and trickle charger in position. A number of convenient holes in the base-board have been provided for passing the cable and other connecting wires from the storage battery and power-unit to the receiver in the lower compartment.

Pass the cable through the larger hole directly over the audio amplifier. Each lead of the cable (except the green and brown) has a little metal tag fastened to it indicating to which binding post of the receiver it should be attached. The brown lead should be connected to the B-plus 67½-volt binding post and the green lead to the B-plus 90-volt binding post.

Now connect the flexible wire from the C



THE POWER-SUPPLY UNIT

This device has been designed for use with the "Hi-Q" circuit, and supplies A and C voltages for the power tube in addition to B voltages for all the tubes in the receiver

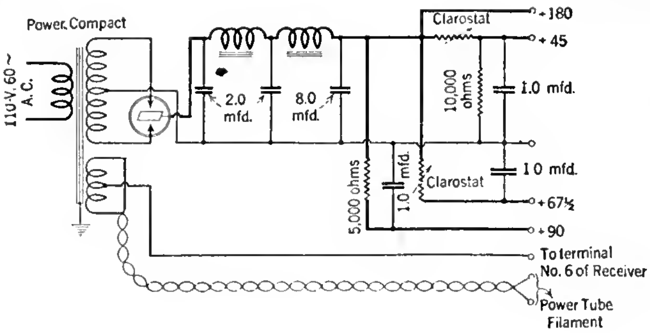


FIG. 4

terminal on the filament side of the Thordarson Power Compact to the minus-C binding post (the fifth binding post from the rear of the baseboard). Then connect the twisted leads from the filament terminals of the power tube to the two terminals marked "F" on the power compact, connecting one wire, of course, to each terminal. Inasmuch as the filament of this tube is heated by alternating current, we do not have to worry about polarity.

The connections are completed by inserting the leads from the cone speaker in the Imp jacks and then placing the clips of the trickle charger on the proper terminals of the storage battery—the red lead going to the positive terminal.

The set is now ready for test. Insert the cables from the power compact and trickle charger in their respective sockets of the automatic relay. Connect the relay cable to the a. c. source.

Before turning the combination rheostat and switch to light the tubes in the set, make sure that the controls of the Clarostats are screwed all the way out, by turning them in a counter-clockwise direction.

Then turn the rheostat to the "on" position and adjust the Clarostats. Caution! Never cut out all the resistance of these units by turning the controls as far as they will go in a clockwise direction, as you are apt to paralyze the tubes. Adjust the Clarostats on a weak signal for maximum volume and clarity.

A milliammeter, with a scale of 0 to 50 mA., will be found valuable in achieving quality of reproduction. This measuring instrument is to the radio man what the stethoscope is to the physician; it enables us to see the functions of certain parts not otherwise visible to the eye.

Temporarily connect the milliammeter in the minus-B lead from the power unit to the receiver, remembering that the plus terminal of the meter connects to the receiver.

Tune-in a powerful local signal and observe the deflections of the indicator needle. The needle will flucutuate with the music; the louder the signal, the greater the deflection. The normal movement of the needle is slightly downward toward the lower end of the scale as loud signals are received. If the needle swings violently upward it is evidence of too high grid bias, and distortion is being introduced which will mar reproduction. Insufficient grid bias will cause excessive downward fluctuation of the needle. To increase the bias, use a lower value of resistor than the 2000-ohm size specified. Increasing the value of the resistor decreases the bias.

If any difficulty is experienced in equalizing the radio-frequency stages, the procedure can be simplified by the addition of two Sangamo Series A 0.25-mfd. bypass condensers in the following manner: Remove the right-hand screw holding the detector circuit tuning condensers to shield section 1 C. Place a spacing washer under one terminal of the bypass condenser, and fasten it to the shield by replacing the condenser mounting screw. This screw provides one connection to the bypass condenser as the shield is grounded to the negative part of the A battery.

Connect the remaining terminal of the bypass condenser to the B plus terminal of the second radio-frequency auto-couple coil.

The other bypass condenser is mounted by making a small hole in shield section 2C directly back of the detector-tube socket. This condenser is wired in the circuit in the same manner as the previous one.

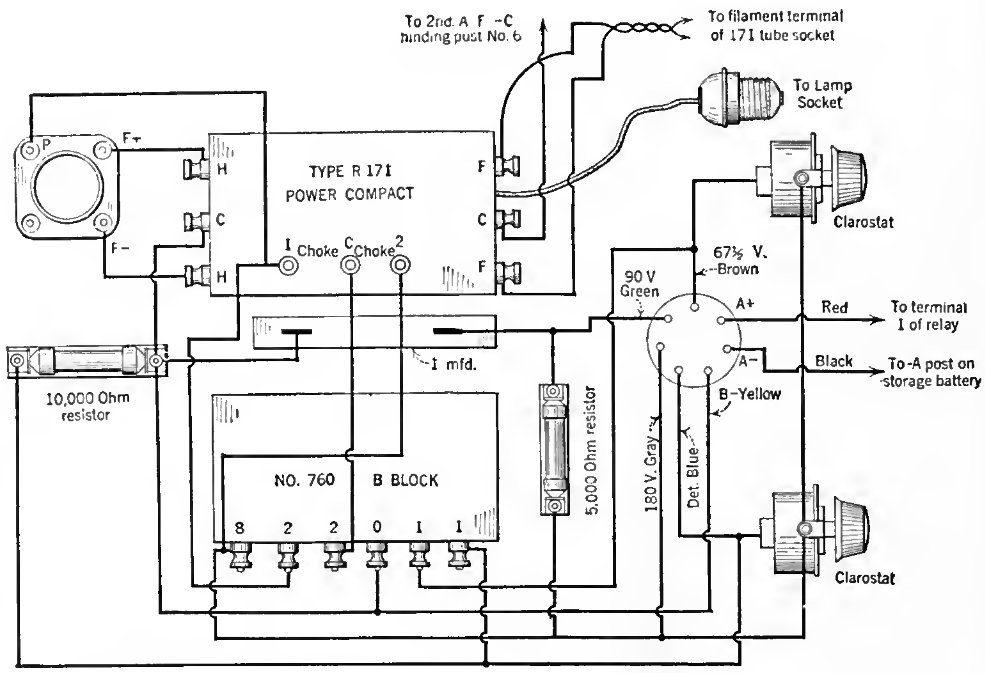
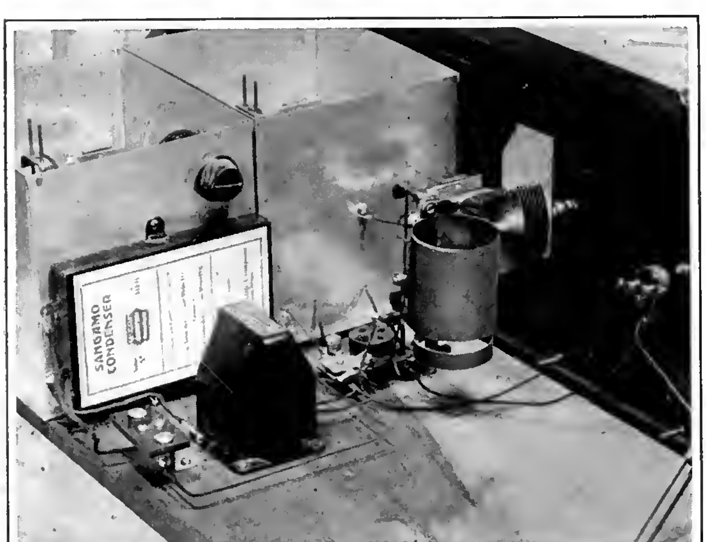
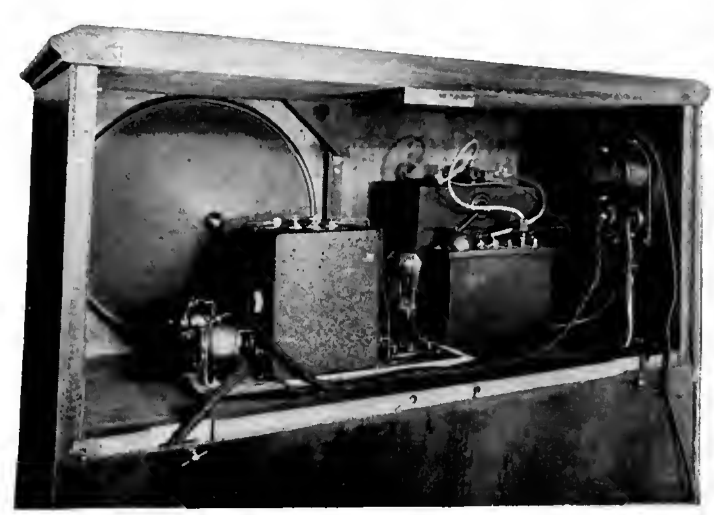


FIG. 5



THE OUTPUT DEVICE
It may be placed in the cabinet behind the condenser tuning the first r.f. stage



A CLOSE-UP OF THE POWER EQUIPMENT
Showing the storage battery, relay, trickle charger, and power-supply device. Note the substantial and well-insulated wiring

THE LISTENERS' POINT OF VIEW

Conducted by John Wallace

Why There Should Be More Vice in Radio

RADIO is too infernally virtuous.

Now, before you apprehensively snatch this copy of RADIO BROADCAST from your little children's hands and consign it to the fiery maw of your furnace, let us make haste to add that we have no particular objection to virtue. It is an entirely praiseworthy institution. But, it always shows itself to best advantage when, for purposes of dramatic contrast, it shines out resplendently from the midst of accompanying vices—even if they be only petty ones. So, our thesis is: resolved, that radio acquire a few vices.

Radio, as we find it at present, is absolutely, utterly and completely devoid of vice. Its goody-goodyness is positively obnoxious. The goody-goody is always obnoxious. For the very virtue of which he boasts is a sterile thing, a negation. In the same manner, radio's flagrant virtue is a negative quality. And since its vice is a completely absent quality it follows that radio has no positive qualities at all, no tendency either towards good or towards evil. In other words it has attained that reprehensible and muchly-to-be-avoided state of complete *innocuousness*.

Than innocuousness there is nothing we know of that is more supervacaneous, nugatory, barren and ineffectual (don't ask where we got those!). The worst feature of innocuousness is that it is the very antithesis of stimulating.

Generally when anybody comes out with a categorical and emphatic statement (such as our contention that radio should acquire some vices), you may look close to home for the reason for the remark. And in the ruthless light of introspection perhaps we should own up to the motive underlying our plaint. The individual whose lot it is to make written comment on any current event rejoices when he encounters a scandal in his particular field of observation. The existence of something vicious gives him something provocative to write about. He may jump in right merrily and flay it, or defend it, according to his lights. The writer on politics has an occasional Teapot Dome scandal over which he may wax wroth and wordy. The drama critic now and again is confronted by an affronting play concerning which he may spill many words, all of which will be gobbled up by his readers. The commentator on society has his occasional Countess Cathcart to provide material for sensational writing. The sports editor discovers that some team has been bought off in advance. All this, deplorable as it is, adds zest to the day's work.

No possibility of the occurrence of the unexpected faces your poor radio reviewer. Year in, year out, radio pursues the even and spotless tenor of its ways.

We say that radio's career has been spotless advisedly. For where indeed is there the slightest smirch of a scandal on its blanched books? To be sure, there was one—the exception that proves the rule. A year or so ago it was discovered that a bootleggers' ship hovering off the Pacific Coast was in some mysterious manner receiving informative assistance from the mainland. It developed that a radio announcer was so wording his announcements as to convey to the bootlegger crew advice concerning the movements of the prohibition forces. The story was printed far and wide and for a time it looked as though radio was going to feel its oats and supply something to talk about besides programs. But alas no, it settled back into its dull, unmischievous routine. And recently a New York announcer got into trouble for his pronouncements on religious tolerance.

We hardly know what to suggest. Friends of ours have come graciously to our assistance with suggestions, but most of them are unprintable. Among them: why not, some day, from our eternally polite loud speaker, a burst of blasphemous language? That would be something to get indignant about. For instance a "remote control" microphone might be installed in some low pool hall. The resulting broadcast would be delightfully vulgar and obscene. As a result ministers would preach sermons from their pulpits; the press would break out in reproachful editorials; the station manager would be tried for disorderly conduct or murder or arson, and finally the station's broadcasting license would be revoked.

Would the net result of this "outrageous procedure" on the part of a "perniciously dangerous" station be entirely harmful? It would not. On the contrary it would be vastly useful. A wave of revulsion at bad language would sweep the nation. Spurred on by sermons and editorials and Womans' Club committees, the country would gloriously and noisily become purged of all inclination towards bad language. Pool halls would be padlocked everywhere and the country would settle down to a new era of belligerent virtue. And radio would have a nice white feather in its cap.

Or suppose some station should undertake to broadcast a series of Saturday night lectures by prominent murderers entitled: "A Few High Lights in My Career." F'rinstance as follows:

This is station KLM and now we present to you our regular Saturday night feature "Half Hours With Prominent Prisoners." To-night folks we are fortunate in being able to present to you Minnie Glabstatter, the Tiger Woman. Miss Glabstatter, you will recall as the lady who poured her first husband into the meat chopper and drowned her second one in the gold fish bowl. She will now tell you her plans for doing away with the present Mr. G. Miss Minnie Glabstatter. . . .

A monstrous suggestion! But why not? The newspapers do it. And think of the stations who refused to lower their standards and stoop to such broadcasts. How they would shine by contrast. The New York *Times* seems much more virtuous for being found side by side, on the stands, with the tabloids.

INGA CRAWFORD AT WRVA, RICHMOND
Miss Crawford is the staff pianist at this Virginia station

DON BERNARD OF WAIU, COLUMBUS

Mr. Bernard is studio director of the station. Beside the duty of devising the radio programs for this station, Mr. Bernard occasionally contributes a tenor solo himself

The opportunities for vice are countless. This station might devote itself to luring young girls off the farm, while that one busied itself at undermining the democracy. This one might preach that the world is flat, while that one defiled the ether with an unexpurgated baritone solo of "Frankie and Johnny." This one might broadcast recipes for homebrew, while that one divulged chorus girls' confessions.

As was evidenced by the instance of the bootleggers' boat, radio's most convenient way of getting itself mixed up in a scandal would be by means of the coded message. But is this golden opportunity for transgression avoided? Is it! This comment from WGY's manager:

> The Schenectady station does not encourage the personal message and its management permits the use of our powerful facilities, only when the request for broadcasting is sponsored by the police authorities of the city from which the message comes and after all other agencies have failed. This rule is rigidly adhered to as the only means of protecting the listener from a great many "lost persons'" announcements and of preventing impostors, criminals, publicity seekers, and practical jokers from imposing on the station management and listeners.

And this from WJZ:

> We receive numerous such requests daily, all of which we decline as politely as possible for several reasons. WJZ's prime motive is to entertain the public. Such messages, while at times they may be humorous to those not vitally interested, are not entertaining. If we accepted any, we would be obliged to accept all, and soon we would be broadcasting nothing else. Another reason for refusing such material is the possibility of unscrupulous persons abusing the latest invention of science and making it an ally of evil rather than of good. If we were not extremely careful, it would be possible, by means of coded messages, for criminals to use the broadcasting stations as a means of communication. Rum-runners, by means of a coded appeal for a lost article, could let accomplices know of the whereabouts of a shipment of contraband, or a master criminal could give last minute instructions to his thugs by means of a prearranged coded appeal for a missing person. With over five years experience in the broadcasting field, we feel that it is much better for the general public that personal messages are not broadcast.

JOY BARTHELSON OF KGO

Miss Barthelson is a member of the Pilgrims, who are frequently heard from KGO at Oakland, California

Now if the stations weren't so darned careful not to be agents of evil, think what a zest would be added to our listening-in. We could all become amateur Sherlock Holmeses. Imagine the pleasure of matching our wits against those of master criminals and the thrill of decoding a message and telephoning it to the proper authorities just in time to prevent the blowing up of the Federal Building!

But, seriously, radio has got to shake itself free of its blind conformity to all that is considered accepted and proper in this day and age, or run grave risk of dying of dullness. Without

THE KDKA LITTLE SYMPHONY ORCHESTRA

Many listeners commented favorably on this ensemble in replying to the questionnaire which recently appeared in this department resorting to any of the drastic means we have suggested earlier in this article it may enliven itself by this simple expedient: a relaxing of its censorship restrictions.

You may retort that radio hasn't any censorship. It is true that there is no official body of reformers sitting glumly in a committee room, attired in head phones, and with fingers placed in readiness on a key that will at a moment's notice charge the ether with a blue-penciling burst of static. But every broadcasting station manager is a self appointed censor, and heaven knows the self appointed censor is the most conscientious of the lot.

Of course he doesn't consider himself a censor; he regards himself as merely a necessarily prudent fellow. He says to an unknown or suspect artist, "Let me see a copy of your speech." If the MS. in question lambastes the Methodists or decries trade unionism or belittles Babbittry, or in any way whatsoever implies that God's not in his heaven or all is not well with the world, he is told "Dear sir, you cannot say that. Some of our listeners would be annoyed." Under the present regimen, the program inspector is right. For broadcasting stations are still trying to be all things to all men and as a result cannot touch on anything even dimly controversial.

In the field of printed publications, a field which very closely parallels broadcasting, we find very few periodicals, whether magazines or newspapers, that are attempting to please everybody. The *Atlantic Monthly* is much despised in one quarter and idolized in another. *True Confessions* is forbidden in some homes and read aloud in others. Personally, we are infuriated by *International Studio* and pleased beyond words by *The Arts*. Only one magazine do we find that attempts to please everyone and that is the *Saturday Evening Post* (also known as the Advertising Mens' Trade Paper). And where, we ask you, is there a duller, less inspiring, more innocuous sheet? We do not mean that there is no room for the *Saturday Evening Post*. Its "More Than Two and a Half Million" belies that. But there is room for no more than one magazine like it.

The trouble with broadcasting is that every station is trying to be the *Saturday Evening Post* of the air. It simply can't work out that way. Some of them have got to take it upon their shoulders to emulate the *Dial*, or *La Vie Parisienne*, or the *Dearborn Independent* or *Snappy Stories* or the *Radical Review*.

Every single station is doing its darndest to maintain its state of innocuousness. Now innocuousness never got anyone anywhere. The remark "The Fundamentalists are very nice people" can certainly be classified as innocuous. As such, its effectiveness is nil. It neither makes the Fundamentalists more fundamental nor the Modernists more modern; nor does it open to either the viewpoint of the other. But say instead: "The Fundamentalists are a bunch of addle-brained hypocrites" and see what happens. Immediately there is action. Minds long covered with cob webs are stimulated to mental exertion. Which is in itself a good thing.

There is nothing more stimulating than opposition. Nothing so tickles one's superiority complex as the listening to statements by an advocate with whom one does not agree, and who is, for that reason, an arrogant idiot. We say to the station managers: Cut loose! Far less enmity will result from the broadcasting of controversial subjects than you think.

What if a few listeners are ruffled at being referred to as imbeciles or menaces, the whole business will be infinitely more lively and hence more fun.

Radio is too infernally virtuous!

AT KOA—THE BROWN PALACE STRING ORCHESTRA

For more than a year this organization, under the direction of Howard Tillotson has been broadcasting dinner concerts from the Denver station of the General Electric Company

Answers the Questionnaire Brought Forth

SINCE we prepare this department many weeks in advance of publication, at the time of writing the first responses to the questionnaire in the January issue have only just come in. And very painstakingly and drolly filled out they are! Of course we won't be able to deduce any general conclusions as to the tastes of our clientèle until all the replies are in, so the statistics will have to wait until the May issue. But in the meantime it seems only fair that we share with you the fun of reading the replies. Here are excerpts from the hundred or so answers we have at hand:

1. Do you listen to your radio as you would to a regular show, or do you simply turn it on and use it as a background to other activities? [This was the first question asked].

I always listen to the radio as I would to a regular show. If conversation or other activities must be indulged in, I shut off the radio.

Generally as a background, except when something of unusual merit is being broadcast.

Every evening *Radio*. (Other activities are the background.)

Your suspicion is right. We smoke, drink our very old rye (at least two weeks old), and talk and talk, and when the radio interferes we turn it down, or shut it off altogether.

Usually as to a regular show. Select programs carefully. Do not listen to all the "bunk" on the air.

If something special, a feature worth while, we listen until the bitter end. Generally however radio is "background."

50–50

Listen about 25 per cent. Use as background 75 per cent. (Your suspicion is correct.)

Yes we give it our undivided attention, when programs are good—otherwise we choke it off.

For a good feature program we listen as though at the theater. Many programs aren't worth listening to, so the set is turned off to avoid competition.

Used as a background mostly, because the general program is of such quality that neither the artist nor the selection is such as to demand continuous attention.

Usually tune-in WJZ; listen and read a good book or magazine. Down to an art now—can even absorb Voltaire and Olsen simultaneously.

2. Do you regularly tune-in on distant stations or do you regularly rely on your local stations? [This was question two.]

Rely on local stations primarily because congestion has almost ruined DX reception.

I am emphatically a DX hound. I get more pleasure from a distant program or a new station than from any amount of locals, who are always with us.

The station from which the program sounds best regardless of location. DX means nothing to a sensitive receiver. All stations are locals.

Probably three fourths of our entertainment comes from the local or near-by broadcasters, *but*, the lure of distance still holds its charms. I have often seen the statement made that the DX hound is vanishing and this is all wrong. It is a natural error. Most radio writers are experimenters and the realization finally comes to all experimenters that we must as yet rely on the locals for *consistent good* reception. The new owner of a radio set demands distance . . . and if his set does not get distance regularly he is dissatisfied. The man who knows nothing of radio expects too much. The man who knows much of radio expects reception over great distances to be decidedly inferior to that of locals—nevertheless most of us still get a kick out of hearing that station two thousand miles away.

The distant ones. If I relied on KFNF and KMA, KSO, KFEQ, etc. I'd be nuttier than I am now. WHO and KFAD only decent stations out here. (Nebraska.)

90 per cent. local, 10 per cent. distance.

Yes sir!! DX gives a thrill that locals, no matter how good they are, cannot produce. The man who says he only wants locals has a good reason for saying it. His set won't get anything else. If he could get DX easily he would be just as much of a fan as the real DX bug.

The writer is a DX hound. This comes after the program part of the family retires.

Rely on local (Cleveland) or near-by stations. DX in my opinion is a thing of the past.

I try regularly in spite of the advertisers, "hi-power," and the congested wave channels. What would the average receiving set be like to-day if there had never been any so called "DX hounds"?

What do you call distant stations? For clearness and volume our (Florida) best programs come from Chicago and New York, KDKA excepted.

Keep two complete sets in commission. One in living room for general entertainment and *quality* reproduction. One in den for fishing, but the fishing has become almost impossible of late due to congestion of ether.

Confirmed DX hound of worst variety.

Not interested in DX. Bores me stiff to hear or read anything concerning DX. Rely entirely on local New York and Newark stations. (not more than 5 in all.)

3. If you had a hundred minutes to listen to all, or any part of the following broadcasts how would you apportion your time? (At the center of the page is a table set up from a random selection of ten ballots arranged in parallel columns. Plays and speeches don't seem to be faring so well!)

INSTRUMENTAL MUSIC *Serious*	15	25	50	10	100	28		40	15	15
Light .	30	25		40		30	40	30	15	15
Popular	30	25		20		1		30	15	30
VOCAL MUSIC*	1	10	20	5		1	10		5	10
RADIO PLAY.	½			10					15	
SPEECH	½	5							5	
EDUCATIONAL LECTURE . .				5		20			20	10
MISCELLANEOUS NOVELTIES .	23	10	30	10		20	50		10	20
TOTAL MINUTES . .	100	100	100	100	100	100	100	100	100	100

*An astounding number of answerers here make marginal and deprecatory remarks about sopranos. Another goodly number demands to know why we didn't leave a space for sporting events. Probably we should have; but we limited ourself to programs originating in the studios.

4. What are the six best broadcasts you have heard? [This was the last question.]

Answers to this question, as you may suspect, cover a lot of ground. Here are a few we come across oftener than others as we glance through the replies: Radio Industries Banquet; Dempsey-Tunney Fight; Victor concerts; National Broadcasting Company Inaugural program; McNamee's World Series 1925; Goldman Band; various Atwater Kent and Eveready Hours; Boston Symphony; New York Symphony; Balkite, Maxwell, Ipana, Goodrich, Royal, A & P, Clicquot, Whittall, and so forth, Hours; Ford and Glenn; Jones and Hare; President's Messages; Army-Navy Game; 1925 and 1926 Democratic National Convention; U. S. Marine Band; Damrosch Recitals; KDKA Little Symphony; WGN's "Down the Mississippi"; Dr. Cadman; KDKA Westinghouse Band; "Roxy"; Penn. Railroad Hour, etc.

Perhaps the most interesting bits of information gleaned from the questionnaires are the unsolicited remarks decorating the margins. Also a number of readers have contributed lists of "pet peeves." Many original and valuable suggestions are made. But lack of space necessitates reserving these quotations for a future issue.

Broadcast Miscellany

WOS is conducting a Missouri Music Appreciation Contest, sponsored by that state's Department of Education. The contest is open to any student in any rural, elementary or high school in Missouri. The final contest will be held Monday evening, March 14. Certificates of award will be given by the Missouri Department of Education to the students. The plan was decided upon to stimulate a greater interest in music among school children and to direct their taste towards good music.

THE erstwhile WOAW is now broadcasting under the letters WOW, which is the official insigne of the Woodmen of the World. At the time the station was granted its license to broadcast in 1923, it asked the Department of Commerce for permission to use WOW as a call but at that time the steamer *Henry J. Bibble*, operating on the Pacific Coast, had been assigned this call. Removal of radio apparatus from the vessel recently caused cancellation of the letters. WOW's station has been completely reconstructed and new equipment installed with a power of 1000 to 2500 watts.

WSM, following a month's silence during alterations, has returned to the air by way of a brand new transmitter, a 5000-watt Western Electric.

THE George Gershwin concert on the Eveready Hour we considered pretty hot. The composer himself was at the piano, and was assisted by the Eveready Orchestra and singers. Of course Gershwin had to be good. But added to the inevitable merits of the artist was the rare skill exhibited by whoever arranged the program. It was ably balanced, the serious compositions deftly relieved by lighter ones, and the announcements were terse and interesting. Outstanding numbers on the program were his incomparable songs "Suanee" and "I Was So Young and You Were So Beautiful." And in more pretentious vein: the "Concerto in F" and "Rhapsody in Blue."

THE Atlantic Broadcasting Corporation has purchased the Grebe group of stations, including WAHG and WBOQ. The new organization has its studio on the seventeenth floor of Steinway Hall, New York City. The transmitters are located at Richmond Hill, Long Island. Its first undertaking was to change the WAHG call letters. The station's call is now WABC; its power is 5 kw.

H. V. KALTENBORN of the Brooklyn *Daily Eagle*, on the subject of radio education:

Another possible development is the creation of an endowed radio university, consisting of a super-power broadcasting station and a special staff of educators selected for their ability to make a wide popular appeal by the lecture method. Such an university would at the same time be a radio research institute free from all the handicaps which circumscribe the influence and activities of the commercial stations. It would not provide entertainment in competition with other stations, but would constantly experiment with new ideas. With an endowment of $1,000,000 and an operating expense of $100,000 a year, such a radio university could rival institutions spending twenty times as much, in the number of its students, character and value of courses, and general contribution to good citizenship. Here is an opportunity for a benefactor who is looking for a new way to do something for mankind. Whoever creates the first radio university will set a force in motion that may revolutionize popular education. The opportunity is a rich one for constructive achievement in the development of our democracy.

FROM KOA is available from time to time a band made up of twenty saxophones. It is directed by James M. Reese

WOR, in coöperation with the Bureau of Information Pro España of the International Telephone and Telegraph Corporation, and the Spanish Chamber of Commerce in New York, is presenting, at present writing, a series of Monday night concerts by the Spanish Symphonic Ensemble under the leadership of Julian Huarte. A commendable effort has been made in arranging these programs to include Spanish music of a type that is more or less unfamiliar.

FRANK REICHMANN, radio manufacturer, opines that "politics, the biggest business in the world, finds itself way behind all other big business in making use of the latest method of advertising. There are Eveready Hours, Ipana Hours, Maxwell Hours, and almost a hundred other hours, but up to now there hasn't been a Republican Hour or a Democratic Hour:

What a marvelous opportunity it would be, let us say, for the Democratic Party to sponsor a series of performances of Paul Whiteman and his orchestra; they have established themselves in the minds of the public as a political organization with advance ideas; they have a jazz mayor in New York and a syncopated governor of the Empire State—why shouldn't they establish a real Syncopated Hour each week over a chain of stations? Now the Republican Party and its old guard, might do well to establish its Hour with an old-time orchestra such as is now touring vaudeville. It would keep in the minds of the public the rustic simplicity of the Coolidge régime without saying a word about it. Of course that would almost leave the Socialist Party without a musical counterpart for broadcasting purposes but upon second thought this wouldn't have to be so, for modernistic music such as is sponsored by the "League of Authors and Composers" fits in ideally with the Socialist program. This provides for the three major parties. It would be up to any new political groups to do some tall thinking for a musical setting. There should always be music enough for all.

ACCORDING to the results of research made by the publicity staff of WBAL, only eight per cent. of the radio fans in this country and Canda are women. Concerning this discovery they comment: "This fact may not be of any actual significance, but it is nevertheless provocative and causes one to consider a bit regarding it. While we have no idea of offering any alibi for the women, the reason for their evident lack of enthusiasm for the radio is no doubt largely due to the fact that women, generally, have but little mechanical sense and, lacking that, they naturally lack the patience to become dial experts. Many letters that come to WBAL are signed 'Mr. and Mrs.' but nine times out of ten such letters are written in a bold, masculine hand."

This does not necessarily mean that women are not as interested in the radio and its development as the men. But just as it has only been within comparatively the last few years that women generally have become automobile drivers, just so will it likely be another decade or more before they will begin to grasp the technical and scientific side of the radio when they will develop from casual "listeners-in" to ardent fans themselves.

What You Should Know About B Power-Supply Devices

Sparks from the Radio Broadcast Laboratory Where Many Units for Supplying Power to the Radio Set Directly from the Lighting Main Have Been Tested—Intelligent Selection Not Easy—Helpful Suggestions for the Prospective Purchaser and User

By EDGAR H. FELIX

RADIO BROADCAST'S laboratory is an ever changing scene. Daily, shipping crates, boxes, and packages arrive, bringing the latest developments of manufacturers. These products are subjected to every conceivable performance test, with a view to determining their value to the broadcast enthusiast.

Among these daily surprises, there is always a large percentage of plate potential power-supply devices. Outwardly, they are all quite similar—a few binding posts, two or three regulating resistances, a tin box finished by some ingenious process, and an instruction sheet. The leaflets, describing these devices for the delectation of potential customers, make like claims of unfailing reliability, silence, unfluctuating output, and capacity to meet the requirements of any set. One would think from such casual observation that all power-supply devices are about alike in their possession of unalloyed virtues. Some brands approach in performance tests these widely claimed good qualities, but others are nothing more nor less than downright failures.

To write of B battery substitutes in general terms, with the object of assisting in their wise selection and their proper maintenance, is difficult because there are no simple rules to guide the prospective purchaser. Faithful readers, radio oracles of their communities, buyers of radio concerns and prospective purchasers, however, write for aid on these matters so frequently, that we know information on the commercial variety of power-supply devices is in great demand. The problem is to give really helpful advice which will aid in appraising the performance of a device, without suggesting a series of impossible laboratory tests.

The history of plate potential supply has been one of continuous progress. Plate potential is the food of the radio set, just as vacuum tubes are its heart. If the plate potential nourishment is not satisfactory, the receiver is bound to be anaemic in its performance. From the beginning of radio, power supply devices have been forced to lag behind tube development for, as new tubes with new requirements come on the market, existing supply devices become inadequate.

POWER-SUPPLY'S BIGGEST PROBLEMS SOLVED

THE power supply devices sold during the first season they appeared on the market were hopeless failures. In the first devices 201-A tubes were used as rectifiers. So inadequate were one or two receiving tubes for feeding plate current to five or six tubes of equal size that power supply devices received a serious setback in public estimation. Then came the new special rectifier tubes, giving adequate current output and fairly steady voltage regulation. Improved filament and non-filament type tubes placed on the market early this season, and certain successful chemical rectifier devices, have finally made the plate potential power supply an acceptable accessory to any radio set of heavy plate current drain.

But the troubles of power supply devices are not entirely solved. The radio industry had quite generally adopted the attitude in its advertising literature that the products of to-day are perfect and that yesterday's weaknesses are entirely overcome. It resents public discussion of imperfections, fearing the effect upon sales. If one whispers that condensers in B power-supply devices are liable to puncture, the wrath of a dozen manufacturers is likely to be heaped on one's head. Yet, the automobile industry thrives, although in its thirtieth year, tires still puncture, valves must still be ground and spark plugs must still be renewed.

We propose to discuss the weaknesses of plate potential devices to aid buyers in their selection and users in overcoming their weaknesses. A little foreknowledge will protect the radio industry from its worst enemy—a disappointed customer.

WHY NEW WEAKNESSES DEVELOP

THE most important limiting weakness of the B power-supply unit has already been practically conquered by the development of tube and chemical rectifiers capable of supplying adequate current of the necessary voltage for almost any type of tube. The weakest link of any chain is always the first to break. A year or two ago it was the tube; now that the tube has come up to requirements, other parts of the B device are beginning to show their failings. This year, condenser breakdown and, to a limited degree, failure of regulating resistances, are the principal sources of service calls. Next year, as condenser weaknesses are overcome, it may be something else. And so it will continue, each problem becoming of lesser magnitude.

The satisfaction which any such device gives bears a fairly close relation to its cost. A B-supply unit can be built to fit almost any price. The cheaper it is, the greater must be its failings. A fifteen-dollar instrument may perform almost as well as a hundred-dollar one on demonstration, but whether it will stand up in use is certainly open to question.

The remarkably fine spirit of service shown by the better manufacturers assures the buyer that he will be protected in his investment if he selects a familiar and freely advertised brand. The first rule in the purchase of a B battery substitute is insistence upon a well known make, purchased through a reputable and responsible dealer. This is of even greater importance than what may be gained by a technical study of such devices.

Essentially, the B power-supply device comprises:

(1) a transformer which steps up the line voltage to an amount determined by the requirements of (2) the rectifier element and the voltage output desired therefrom; (3) a system of inductances and filters to smooth out the rectifier tube's pulsating output; (4) a potentiometer output device to obtain various voltages.

RECTIFIERS, TUBE AND CHEMICAL

THE majority of makers use tube rectifiers of some sort. Not all tubes used in B power-supply devices, however, are perfect. Whether the advantage lies with filament or non-filament types is not as certain as might appear. The fact that there is no filament to burn out in some tubes is a striking argument in their favor. As a matter of fact, however, a filamentless rectifier after long use undergoes vital changes in its gas content so that it loses its rectifying properties. Thousands of filamentless and filament type rectifiers have been subjected to heavy service for as long as two years without breakdown, so that the superiority of one type or the other has not been very forcibly demonstrated. The advantage of large and uniform production which makes receiving tubes superior, applies also to rectifier tubes. Therefore, avoid an unknown tube, with or without filament, and give preference to products of known and established reputation.

Chemical rectifiers, such as those using tantalum and lead as elements, serve for years and some of the best devices made are of the chemical type.

FOLLOWING MAINTENANCE INSTRUCTIONS

ONE warning to the owner of a chemical type of rectifier: Follow the manufacturer's instructions as to maintenance religiously. Adding a few drops of distilled water every few weeks is a very slight labor, much less attention than you give to keep your pet geranium in good health. If you fail to add water periodically, you are bound to have rectifier trouble. If you do obey instructions, you are likely to obtain years of reliable and economical service.

Also watch particularly the instructions given as to placing the chemical type of unit out of service if it is not to be used for a month or two. With some chemical rectifiers, if you do not observe certain precautions, you will find them totally dead when you return from your vacation. Nor can they be resuscitated from their collapse at your callous abandonment without the purchase of new rectifier elements. The precautions which must be observed are quite simple.

Some manufacturers, however, are somewhat bashful in telling you that their power units require a bit of care. If you do not buy from a conscientious dealer who warns you of such things, write a letter to the service department of the manufacturer, asking for instructions as to how the device may be placed out of service temporarily. This simple act may save you ten or twelve dollars.

VOLTAGE REGULATION

THE usefulness of a power device is determined by the range of current drains it supplies at usable voltages. This is termed its voltage regulation. If the unit is of insufficient capacity, it will deliver less to the tubes of the set than the required voltage at heavy current drains. Voltage regulation is modified by the filter element of the device, so that the only way to be thoroughly sure of its capacity is to measure its voltage output over the entire range of current drains encountered with normal receiving sets. The accompanying diagram shows the voltage outputs of several devices tested at the RADIO BROADCAST Laboratory. Before considering the significance of these curves, however, we will examine the filter element, an essential part of the circuit.

The filter is essentially a condenser "tank" fed through high impedances which absorb low frequency current variations. The rectifier pumps out a pulsating current, just as a giant water pump, filling a reservoir. The chokes act like a breakwater, seeking to meet the impact of the pump strokes, so as to make the reservoir beyond as smooth as possible. At the far end of the condenser reservoir, smooth, ripple-free current is drawn. Obviously, the larger the impedance of the chokes and the larger the capacity of the condenser the smoother the output wave form.

No amount of inspection will reveal the ruggedness of the condensers or the impedance of the chokes. The size of the choke is not a guide to its effectiveness because a large choke with a cheap iron core may not be as good as a small one using high quality, selected and aged iron.

AVOIDING CONDENSER BREAKDOWNS

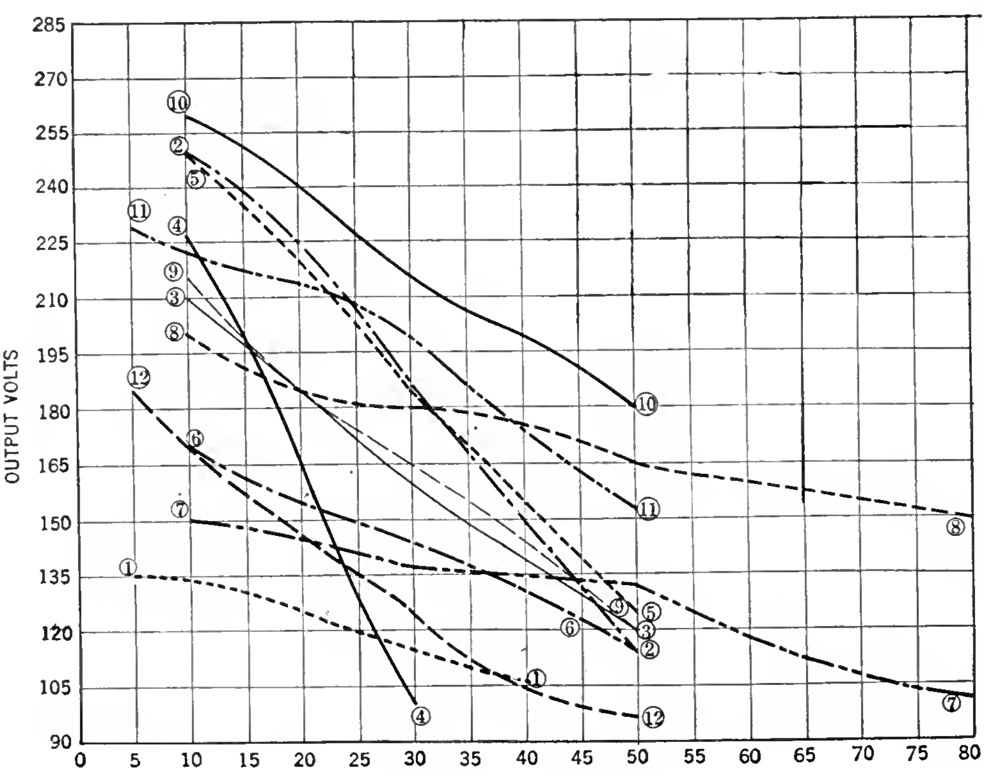
THE purchaser of a B power-supply device can reduce the chances of condenser breakdown to almost nil if he obeys the instructions of his dealer and those in the booklet accompanying the device as to the order in which receiving set tubes and B unit should be turned on and off. Some manufacturers are quite precise in their instructions; others neglect to mention this important point. The mystifying failure of a power device which has given good service throughout the previous evening is probably the penalty of turning on the set incorrectly.

In going over the instruction booklets of a number of manufacturers, we do not find any uniformity in their recommendations. In the absence of advice from the manufacturer, the best practice is to turn on the receiving set first and then the power unit. This places an immediate drain on the device so that excessive voltages will not be encountered. The strain on the smoothing condensers is thereby greatly reduced. When turning off the set, first turn off the B supply unit, thus dissipating the charge which would otherwise remain on the smoothing condenser. Then turn off the receiver tubes. If this practice is invariably followed, the chances are that little or no difficulty will be encountered due to condenser breakdowns. These instructions had best be followed unless the manufacturer definitely states they are not necessary. Many devices are so constructed that difficulties of this nature do not arise.

The series of curves in the accompanying diagram were prepared by RADIO BROADCAST Laboratory, showing the voltage output of numerous makes of B supply units throughout the normal range of current drains. All of these devices show that the voltage falls as the current drain increases. If the tubes of the receiver are not lighted, the current drain is zero and the instantaneous voltage rises in some cases to dangerously high values.

These curves also show the great variety in the output of different devices. Some, when subject to heavy load, strain and weaken because the rectifier tube is not capable of supplying the demand. Others hold up well. Those giving the most uniform output are of two types, (1) chemical rectifier devices and (2) those equipped with ballast or voltage regulator tubes. The chemical devices obtain their good voltage regulation because of their low internal resistance, while the regulator tube types accomplish the result because they automatically vary the rectifier tube's load so that the output is maintained at a specific voltage. The chemical types do not, in a general way, cost more than the usual run of B power-supply devices but those equipped with regulator tubes are more expensive than the average, but they give good service with almost any kind of set.

The family of voltage regulation curves shows a tremendous variation in the performance of different devices. It is a well known fact that a B power-supply unit may give satisfaction with one make of set and fail with another seemingly quite similar. This may be due to faults in receiver design, but more than likely it is due to the power devices' inability to furnish the plate voltage required by the set at its particular current drain.



CURRENT-VOLTAGE CURVES

These curves are of a dozen typical B power-supply units and were made in the RADIO BROADCAST Laboratory. They indicate clearly how the output voltage rapidly drops as the current drain is increased

SELECT A B-SUPPLY UNIT THAT MEETS YOUR SET'S REQUIREMENTS

SINCE the voltage output of most B-supply units depends upon current drain, selection is a matter of knowing a receiver's plate current requirements and finding a device which delivers sufficient voltage for each of the tubes in the set at that particular drain. If the plate voltage supplied to a radio-frequency amplifier is somewhat too high, the average set is almost certain to oscillate. To give leeway in plate voltage output, most B devices are equipped with variable resistances. These and other resistances in the output circuit must be suitably bypassed. A resistance not properly bypassed may cause coupling between two or more stages of the amplifier and thus cause a squeal.

Howling and whistling is usually due to excessive plate voltage supply to radio-frequency amplifier or detector tubes. The lower the current drain the higher the voltage output of most B-supply devices regardless of the terminal markings on the binding posts. Whistling is usually curable by readjustment of voltage supply to the set. A few poorly designed units with inadequate bypassing condensers, cannot be cured of their whistling tendency by adjustment of voltages supplied to the set.

DETERMINING THE CURRENT DRAIN

IF YOU know the exact drain of your set and the voltage required by each tube, it is not difficult to determine, from the voltage regulation curve, whether a certain B-supply device will give it the required plate voltages at the required current drain. As an aid to those who do not possess an accurate milliammeter for measuring current drain, the accompanying table gives the plate current of standard tubes at grid potentials and plate voltages customarily used. Individual tubes vary somewhat from the figures given, and a small percentage deviation in filament current or plate voltage modifies the figures somewhat. But the table is better than no guide at all; with its aid, it is possible to compute the total current drain of almost any receiver. The $1\frac{1}{2}$-volt positive grid bias figures should be used as the basis for determining the plate current of detector tubes in circuits where the grid return is made to the positive filament lead.

INTERPRETING THE VOLTAGE REGULATION CURVE

THE curves in the diagram on this page show the maximum voltage output of various typical B power-supply devices at various current drains. Device No. 1, for example, gives 128 volts at 18 milliamperes and 115 volts, at 30 milliamperes. This device, being equipped with a regulator tube has a good output. It would therefore, be suitable for use with a receiver using an UX-171 tube in the last stage. Device No. 10 would also power such a receiver satisfactorily. The voltage output from each of the other voltage terminals also falls proportionally as these curves indicate.

If accurate data as to the output at various current drains is not available, it is impossible to obtain it with an ordinary voltmeter. The current drain of an ordinary voltmeter is sufficient to modify greatly the output of the B device so that the reading is valueless. A special high-resistance instrument, such as a Jewell No. 116 or a Dongan, Type A, is necessary to measure the voltage output correctly.

RECEIVING TUBES

GRID POTENTIAL	+1½ (Det.)			0				—1½			—3		—4½	—9
PLATE POTENTIAL →	22½	45	90	22½	45	67½	90	45	67½	90	45	90	90	135
TUBE: 201-A	.65	2.3	7.7	.25	1.3	3.4	6.0	.6	2.1	4.7	.25	3.2	2.0	2.5
200-A	.75	3.0	5.5	1.1	2.0	2.9	4.0	1.0	1.5	2.5	.4	1.1	.6	—
199	.61	2.0	5.0	.36	1.4	2.8	4.2	1.0	2.1	3.6	.5	3.0	2.5	—

POWER TUBES

GRID POTENT AL	—9	—16½	—18			—22½	—27		—35	—40½
PLATE POTENTIAL →	135	90	90	135	250	135	135	350	425	180
TUBE: 112	9.0	—	—	—	—	—	—	—	—	—
120	—	—	3.1	—	—	7.4	—	—	—	—
171	—	10.0	—	—	—	—	16.0	—	—	20.0
210	—	—	—	—	12.0	—	—	18.0	22.0	—

Some power-supply devices are equipped with C battery output terminals, eliminating the necessity for a C battery as well as B battery. C batteries are inexpensive and usually give at least a full year's service, hence their elimination, although a convenience, is not of paramount importance.

CAUSES AND ELIMINATION OF THE HUM

THE silence of output is an important factor in the service ability of B power-supply device. This is universally claimed for every power device which we have seen, although attained by comparatively few. The fact that a hum is drowned out by a loud program does not alter the fact that it introduces distortion and imperfection in the musical output. We quote the following sentence from the advertising literature of one manufacturer to show how freely the quality of silence is claimed:

> The —— B-supply device is totally free from hum, even on earphones.

Then, turning to the operating instructions which the customer receives after he has purchased this brand of B device, we read:

> Turn on the current by means of the switch on the supply cord. A very slight hum should be discernible when you listen with each ear about a foot from the unit. This hum shows it is functioning properly.

Under the circumstances, the only criterion in judging the quietness of B-supply device is the listener's own ears.

The hum may be due to inherent faults in design or, with better devices, to the manner in which they are installed. Cheap devices have small smoothing condensers and chokes. This accounts not only for their objectionable hum but also for the manufacturer's ability to produce the device at low cost. More expensive

A TYPICAL B-SUPPLY DEVICE

Similar to many tested in the RADIO BROADCAST Laboratory. It is a product of the Cornell Manufacturing Company, Long Island City

devices sometimes hum, but this is generally due to improper adjustment. The most common cause of hum is magnetic induction from the transformers and chokes into the receiving set. By carefully changing the angle and distance of the B device from the set while it is in use, a position can usually be found which eliminates magnetic induction. Another cause of hum is excessive detector voltage or excessive amplifier voltage, or open or improper C battery connections.

A slight hum is not at all objectionable, but, if it can be heard several feet from the loud speaker, your dealer should be consulted immediately, while the device is still new. He may be able to quiet the device by better placing or improved voltage adjustment; otherwise, he should replace it.

There is no more satisfactory method of testing a B power-supply device than by giving it several days' trial in your own home. A cut price dealer cannot afford to do this for you. The insurance of satisfaction, resulting from buying from a reputable dealer, makes it wise to pay the extra cost involved.

Another brand of blue sky claim, made by some B device manufacturers, are those dealing with the cost of operation. Apparently, B-power units cost next to nothing to operate; a few cents a month at the most.

The chemical types draw a heavy current for the first few minutes of operation, when they are first installed, but the power soon falls to a reasonable figure. The average tube or electrolytic device draws from 15 to 35 watts, according to load; those with one stage of power amplification, between 45 and 50 watts; and regulator tube equipped devices, from 30 to 35 watts.

Using a set an average of 15 hours a week, the total watt hours per month for a 30-watt unit is about 2000 watt-hours, or from 14 to 50 cents a month, according to the power rate. But current is not the only cost. To this must be added tube upkeep and depreciation. Figuring five years' life for a $50 device, depreciation averages 80 cents a month. Tubes at $4.00 a year add another 35 cents a month. So that instead of "ten cents a month," as one maker once advertised, costs may be as high as $1.00 to $2.00 a month. This should not, however, be compared directly with B battery costs because good B devices also give much greater convenience, there being no heavy batteries to carry and install. They also give a steady, instead of progressively falling, voltage output.

From the foregoing dissertation upon the ills and weaknesses of B power-supply devices, one might conclude that they are very unsatisfactory and uncertain devices. As a matter of fact, their most serious imperfections have already been conquered and, if care is used in selection and a few simple precautions observed in care and operation, they give highly satisfactory and lasting service.

NEW UNITS FOR SUPPLYING B POWER

The Valley B Power, using Raytheon tube; the Balkite Combination Radio Power Unit, which, when connected to the A battery furnishes power both to A and B circuits. It is controlled by the filament switch on the set and is automatic. Price $59.50. Next is the General Radio Power Amplifier and B supply. Finally, the All-American "Constant B" using a Raytheon tube, which sells for $37.50

Building the R. G. S. Inverse-Duplex Receiver

A FRONT OF PANEL VIEW OF THE R. G. S. RECEIVER

Constructional Data on a Four-Tube Receiver so Made as to Give Six-Tube Efficiency—Operating Instructions, Emphasis Being Laid on the Correct Usage of the Antenna Tap Switch —Test Results Obtained with This Receiver

By DAVID GRIMES

THIS article is the third in a series describing for readers of RADIO BROADCAST the latest circuit developments in the new Inverse Duplex System. The present article gives the constructional details for the adaptation of these developments to a radio receiver—the new R.G.S. receiver. The parts selected for the R.G.S. were chosen only after many tests on many different makes of apparatus had been made, and overall performance, based on the particular requirements of these circuits, was always the deciding factor. Particular attention was devoted to the design of the audio channel.

Too much emphasis cannot be placed on this phase of the circuit in view of the great demand for receivers delivering good audio quality. It is quite essential to have bass notes, but, at the same time, the high notes cannot be sacrificed in this sudden rush for the deep pitches. Many receivers have this limitation present so that, while they are resonant and mellow on music, they are indistinct for vocal reproduction. By pronouncing the letters in the alphabet, it will be noticed that many of them are merely the vowel "e" prefixed by some high-pitched sound produced by the lips or teeth. Such letters are b, c, d, g, p, t, v, z. Without excellent reproduction of the high audio frequencies, all of these letters would sound alike.

Tone quality is only one of the several features on which the real performance of the new Inverse Duplex is built. By far the most important factors are equal r.f. amplification and uniform r.f. selectivity throughout the broadcast band. From descriptions in the preceding articles, the reader should be well aware that the r.f. filter feedback circuit is responsible for this innovation. Yet, the satisfactory performance of the radio circuit is not based only on the filter coil. The electrical constants of the r. f. filter coil were determined solely with a definite type of r.f. tuned transformer. The design of the filter coil and the design of the tuned transformer are correlated because the object of the feedback circuit is to compensate the inherent deficiencies in the tuned transformers. To make the construction easy, the simplest type of tuned transformer was decided upon before the final values were determined for the filter coil. So please do not adopt some other type of tuned transformer because it is the "ideal" type in some other circuit.

The same coördinate design extends throughout the receiver, so all of the values given have been determined by considerable research. These values, while not critical, should be adhered to if the remarkable performance which this receiver is capable of, is to be expected. In a word, do not attempt substitution as. in this case, will be poor economy in the end.

Having determined the circuits and the proper apparatus to use, the next step is to mount correctly the units so that no detrimental interaction occurs. Reference should here be made to Fig. 1, which shows the top view of the base panel, on which is mounted the equipment. The relative positions of the various parts are indicated in the diagram.

The R.G.S. receiver has been arranged for two-control tuning by combining the second and third tuning condensers on one grounded shaft. This allows the antenna tuning condenser, C_1, to be adjusted separately, which tends toward greater flexibility. Thus, any change in the antenna tap switch which necessitates a change in tuning of the associated tuning condenser, can be made without reference to the double-tuning condenser.

In order to allow for any variations in coils, condensers, wiring, or tubes, and still benefit by the excellent selectivity of the receiver, a small vernier variable condenser, C_4, is placed across the detector tuning unit. This tuned detector circuit is not quite as sharp as the other two tuned coils, so the adjustment of the vernier, when located here, is not critical. Its best adjustment should be found, however, especially if maximum selectivity is desired. The adjustment of this vernier may be slightly different at the various wavelengths.

One section of the physical arrangement will need explaining at once. It appears on the surface that all known engineering rules have been violated in the mounting of the second and third tuning coils. Under ordinary circumstances, coils so mounted would result in instability and oscillation, due to the third coil feeding back into the second. But this all depends on the polarity of the feedback. It is quite true that trouble would occur if these two coils were similarly mounted—so they are not. The third coil is mounted upside down with respect to the second coil. The grid end of the third coil is at the bottom near the baseboard, while the grid end of the second coil is at the top. This causes a slightly opposing feedback to occur, but due to the very loose coupling between the coils, this opposing feedback is only noticeable at the short waves. The stabilizing influence is needed when no shielding is employed as oscillation tends to take place by means of electrostatic feedbacks without the shields. Thus, mounting these two coils in the manner outlined, entirely dispenses with the need for r.f. shielding to obtain stability.

The antenna coil is placed at right angles to the other two tuned coils so that no magnetic feedback is possible, and the remote location of it precludes any possibility of electrostatic feedback from the other coils. The antenna coil is slightly different in its construction. The primary winding is preferably located inside the filament end on a separate section of tubing, while on the other two coils, the primaries are wound on the same tubing as the secondaries, at the filament end. Details of the construction of these coils are repeated here in Fig. 2.

The two radio-frequency tubes and the detector are located near their associated tuning units so that the grid leads may be kept short. The ganging of the two condensers thus up-

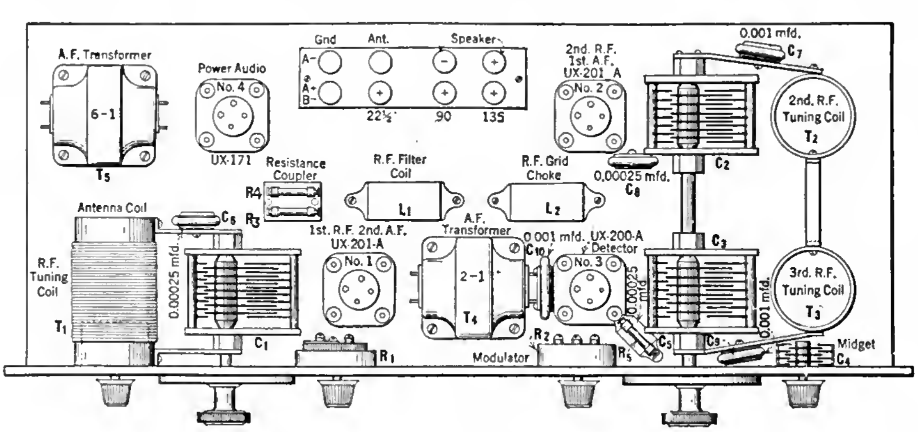


FIG. 1

In this sketch the placement of all the parts entering into the construction of the receiver is clearly shown. The base, which is supplied with the kit, comes drilled so that all the parts may be readily mounted as shown sets the conventional arrangement somewhat, placing the second r.f. tube behind the detector. The two audio transformers are purposely widely separated to prevent annoying audio howls. The power audio tube is placed near this third audio transformer to give a short grid lead. This places the tube somewhat out of line.

The r.f. filter coil and r.f. grid choke may be placed in line, as shown in Fig. 1., with no resulting trouble, because their magnetic fields are very small.

All wires, except those connecting the apparatus with the grid circuits, and the leads to the socket grids themselves, should be run under the base panel in the shortest possible manner, irrespective of criss-crossing. By keeping all of the grid wires above the panel, sufficient separation is obtained to prevent oscillation and extraneous pick-ups. The bypass condensers, with the exception of those on the detector socket, are mounted on the tuning coil frames.

OPERATING INSTRUCTIONS

THE operating instructions are next to be considered. The R.G.S. receiver is very simple in this regard, considering its exceptional performance. Extreme selectivity and distance-getting ability have always been associated with delicate adjustments. Not so with the R.G.S. receiver. This is due to the exceptionally efficient long-wave amplification that the circuit produces. But the operator must follow certain suggestions if the ultimate is desired. No two circuits require the same tuning adjustments, and the new Inverse Duplex is no exception to this. It has its own simple operating peculiarities which are fully discussed here.

In the first place, it is necessary to understand the correct operation of the antenna switch. The selectivity, distance, and tone quality will depend a great deal on the proper setting of this switch. No other adjustment is nearly so important. This switch connects with a series of taps on the antenna primary coil. The first tap connects with two turns only, the second with four turns, the third with eight turns, the fourth with sixteen turns, and the fifth tap with thirty-two turns. As the taps are increased, it is as if the antenna were being lengthened and, as the lower taps are used, it is as if the antenna had been shortened. The antenna tap switch acts like an electrical reel by means of which the antenna can be electrically lengthened or shortened.

It is this lengthening and shortening of the antenna that is so important in order to secure best reception under all conditions. If you understand just what effect a long or a short antenna has on receiving conditions, you will understand fully the effect of the antenna tap switch. A short antenna always makes a receiver more selective and at the same time brings in the short-wave stations with more volume. A long antenna broadens the tuning of a set somewhat, especially at the short waves, but brings in the long-wave stations with greater efficiency.

Still another function of the antenna switch must be considered. When receiving some powerful local station, the radio energy can easily overload the detector tube. By cutting down the antenna somewhat (dropping to a lower tap), the radio energy can be reduced and the detector will then deliver an undistorted output.

An important thing to remember in adjusting this antenna switch is that the correct tuning position of the variable condenser associated with this coil will change slightly whenever a change is made in the tap switch setting. As the length of the antenna is increased, the setting of the tuning condenser drops below the setting of the double condenser, while shortening the antenna will bring the proper setting of the single condenser back to approximately the setting of the double condenser for any special station.

To make this antenna switch operation clear, a few examples will be given. Assume that a 570-kc. (526-meter) DX station is to be tuned-in.

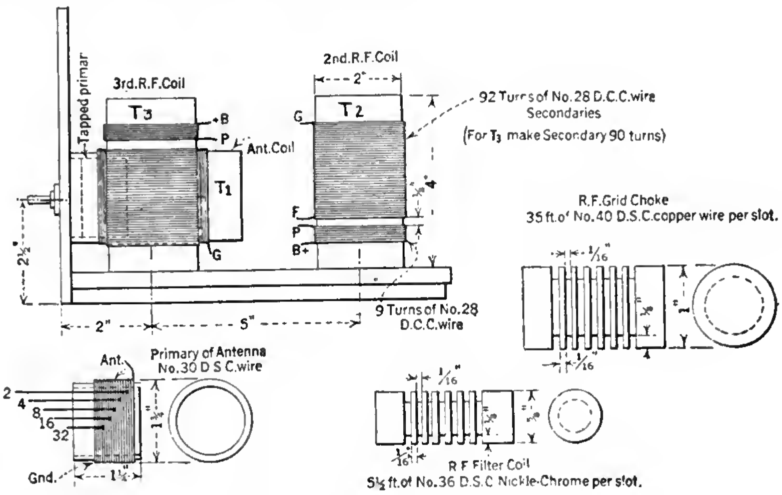


FIG. 2

The coils and chokes for the R.G.S. receiver are wound in accordance with the specifications given here. Note that the secondary for T3 is wound with only 90 turns of wire while the other two tuning coils have a 92-turn secondary

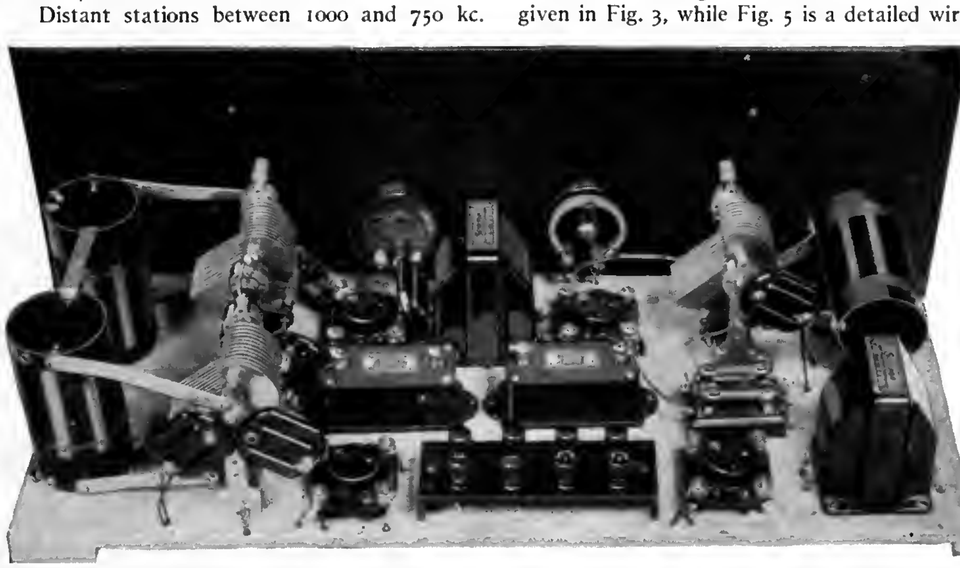
Under ordinary conditions tap 5 (32 turns) would give best results, and the single condenser dial might read 85 while the double condenser would read 92. But near-by local stations being heard in the background might make more selectivity a necessity. Hence tap 4 (16 turns) is used. Probably nothing would be heard upon dropping to tap 4, until a readjustment of the single tuning condenser is made. On tap 4, the single condenser would probably read 88. Upon shortening the antenna, the tuning position will be found to have risen slightly. Some locations demanding super selectivity might force the antenna setting down to 3, which is pretty low for a long-wave DX station around 600 kc. (500 meters).

Distant stations between 1000 and 750 kc. (300 and 400 meters) usually come in best with the antenna switch on position 3, although, here again, selectivity may not be best until the setting is dropped to tap 2 and the single tuning condenser reset. On distant stations between 1500 and 1000 kc. (200 and 300 meters), either tap 2 or 1 will be best. In operating the set for the first time, tap 3 is suggested, as it is a very good compromise for all wavelengths. Even then, you may be required to drop this to a lower tap if a local station is choking the detector tube.

The next important control is the volume regulator. This controls the audio energy at its source. By means of this volume control, the audio is kept within the limits of the tube so that quality may be had with good volume. If this adjustment is set too high, distortion will first take place in the UX-171 power amplifying tube. If it is boosted still higher, overloading of the resistance stage will occur, producing a choking noise in the loud speaker. Merely reducing the volume will restore the set to normal. In practice it is best to leave this control about a quarter or one-half the way on at most, unless more volume is desired on the weaker stations. When shifting from one station to another, always keep the volume control down. It has no effect on tuning so no tuning readjustment is necessary when operating this knob.

The 2-ohm rheostat regulates the current in the filaments of all four tubes, and when turned to the "off" position, acts as the cut-off switch. By using a low resistance, formed of many turns of large wire, a smoothly operating control of the tubes is obtained. The total variation in the rheostat only changes the voltages on the tubes from four to six, while this two-volt change offers just the right amount of variation for the new UX-200-A detector tube. The rheostat has, therefore, practically no effect on the amplifying tubes, but mainly controls the detector tube for best sensitivity and freedom from noise. For normal performance, the rheostat should be turned slightly more than half way on, placing about 5 volts on the filaments.

A schematic diagram of the R.G.S. receiver is given in Fig. 3, while Fig. 5 is a detailed wiring



STUDY THIS PHOTOGRAPH IN CONJUNCTION WITH FIG. 1

In this back-of-panel view the manner of running the under-base wiring through holes in the base is shown diagram. All of the dotted lines in this latter drawing represent wires run below the base panel. The solid wires are run above the base panel. This scheme forms a very neat layout as well as automatically affording some separation between the grid and plate wires.

Specific types of tubes are recommended with this circuit design for very definite reasons. The high efficiency of the receiver is obtained through coördinate operation of the various parts—including the tubes. This applies particularly to the detector. To insure the same exceptional performance as obtained here in our laboratories, use the tubes recommended. These are given in Fig. 1.

It is fully realized that it is no easy matter to fairly present the real performance of a radio receiver because so much depends upon local conditions. This has led to the generally accepted practice of comparative demonstrations between some well-known receiver and the one under test, so that, other conditions being equal, the actual performance of the new receiver could be judged in terms of some standard. Many such tests, conducted in many difficult localities have revealed the high selectivity of the R.G.S. Inverse Duplex receiver. Fig. 4 shows at a glance the performance of an R.G.S. receiver tested at Grasmere, Staten Island, while all the locals were on the air. Grasmere is about 10 miles from WEAF and 25 from WJZ. The excellent selectivity, even at the long waves, is at once apparent. While WJZ and WEAF blanket any distant reception between them, the dials do not have to be turned very far either side to bring in the remote stations without interference. The location where the tests were conducted in Staten Island is even worse than the mileages indicate. The New York stations come in with practically undiminished volume, traveling the intervening distances mainly over water, while the distant Western stations must pass through a high ridge that runs north and south through the center of Staten Island. This locality is thus favorable to the reception of New York locals and unfavorable to Western reception. Several well-known standard radio receivers have failed to bring in even one distant station in this locality under modern congested conditions of the air.

The following is a list of parts necessary for the construction of the R. G. S. receiver described in this article:

C_1—1 National Single Condenser, 0.00035-Mfd.	
C_2, C_3—1 National Double Condenser, 0.00035-Mfd. Each Section	$26.50
2 National Dials	
T_1, T_2, T_3—3 National-Grimes Tuning Coils, with Antenna Switch	
T_4—1 Samson 2–1 Audio Transformer	5.00
T_5—1 Samson 6–1 Audio Transformer	5.00
4 Spring Sockets	3.00
C_4—1 Hammarlund Vernier Condenser, 15-Mmfd.	1.25
1 DeJur Resistance-Coupler (with Condenser)	1.50
R_2—1 Centralab Modulator 200,000 Ohms	2.00
R_5—1 Lynch 2-Meg. Resistor	
R_4—1 Lynch 1-Meg. Resistor	1.75
R_3—1 Lynch 25,000-Ohm Resistor	
C_6, C_7, C_8, C_9, C_{10}—5 Sangamo Condensers (3—0.001-Mfd. and 2—0.00025-Mfd.)	2.30
1 Front Panel (Drilled and Engraved)	6.00
1 Base Panel (Drilled)	4.00
L_1—1 Grimes R. F. Filter Coil	2.50
L_2—1 Grimes R. F. Grid Choke	2.50
8 Eby Binding Posts and Drilled Terminal Strip	2.00
C_5—1 Dubilier Grid Condenser, 0.00025-Mfd.	.25
R_1—1 DeJur Rheostat, 2 Ohms	1.10
Acme Connecting Wire	.75
R. G. S.—Grimes Blue Prints and Instructions	4.50
TOTAL	$71.90

The above selection of parts may be obtained in kit form complete with front panel and base panel drilled and engraved.

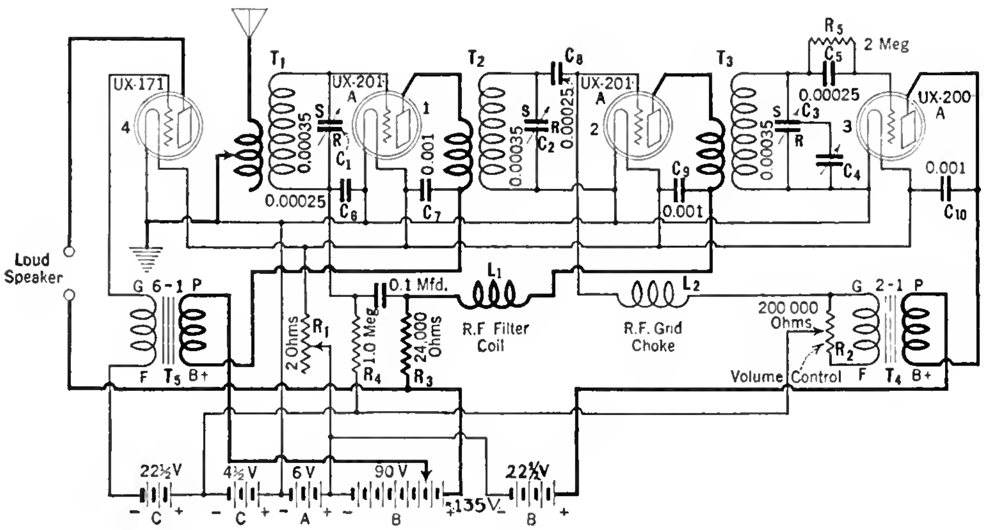


FIG. 3

To identify the various units as indicated here it is well to refer to Fig. 1. The same identification letters have been used for this diagram and Fig. 1. This schematic circuit gives one the general idea of the circuit employed while the wiring diagram shown in Fig. 5 is a direct aid in the actual wiring of the receiver

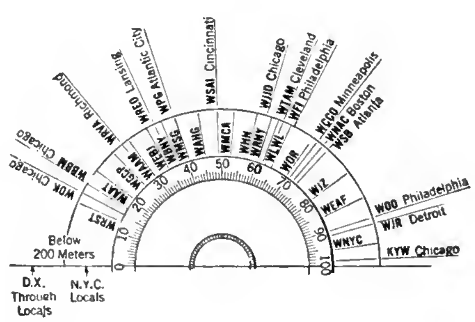


FIG. 4

In this representation of a tuning dial are shown the Greater New York locals in one group while the distant stations which were received through the locals are shown in the outside band

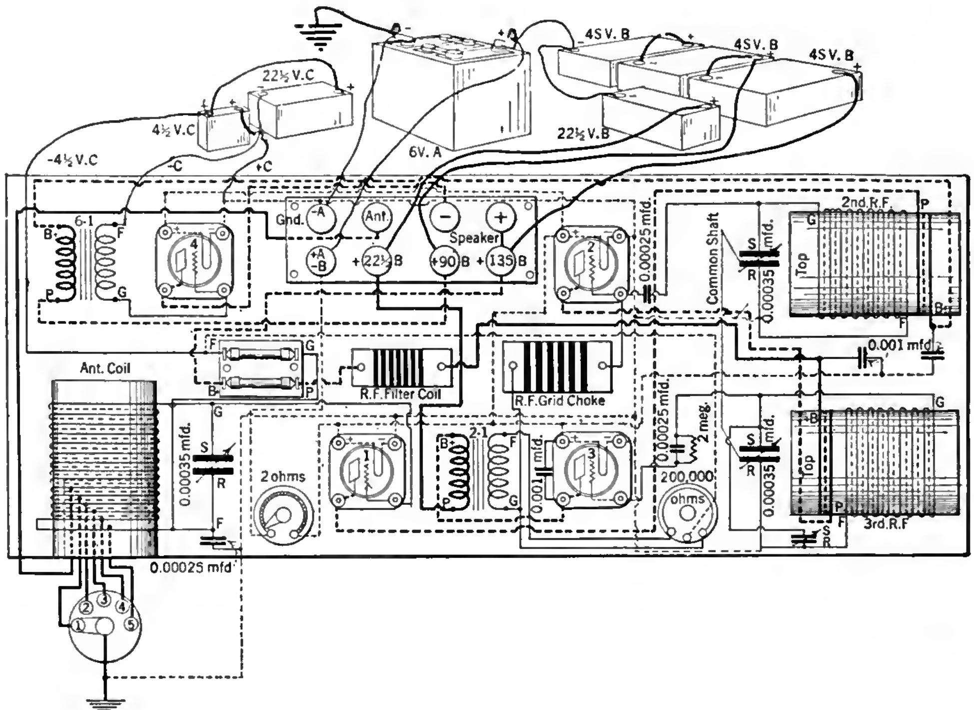
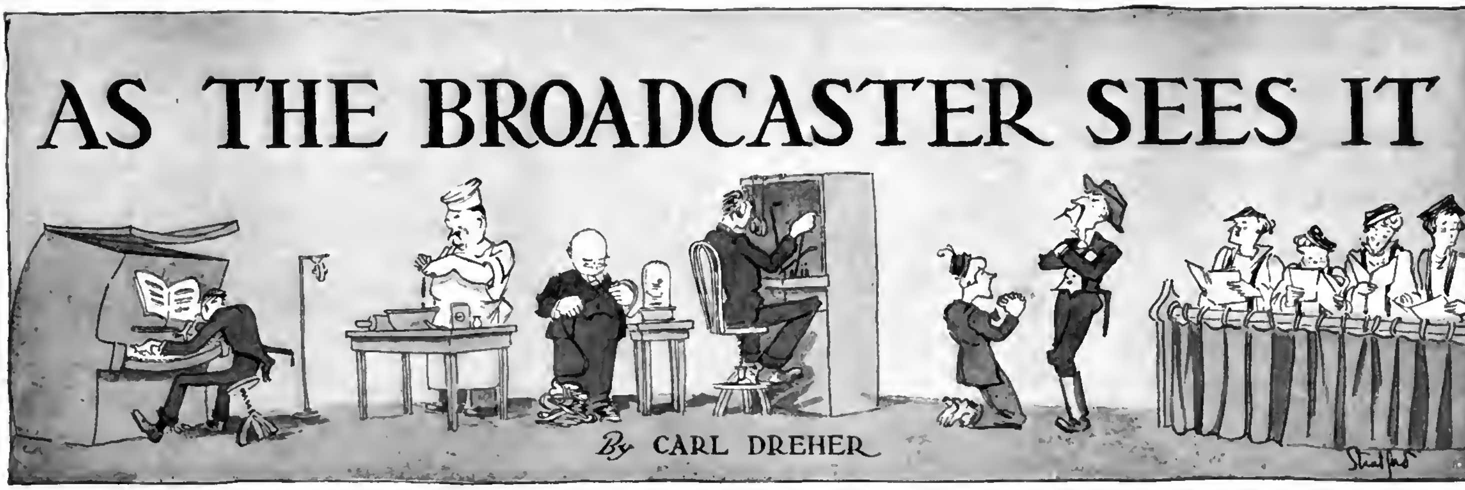


FIG. 5

This wiring diagram, aside from showing the point to point wiring, coincides with the parts layout shown in Fig. 1. As an aid in wiring, the two should be referred to constantly. The dotted lines show those wires which are run below the base while the solid lines indicate those connections which are made above the base



Drawings by Franklyn F. Stratford

An English Experiment in Highbrow Broadcasting

RECENTLY, looking over an issue of the British *Radio Times*, I noticed with interest that the B. B. C. had put on, through 2 LO, two scenes from Thomas Hardy's great epic poem, *The Dynasts*. Furthermore, they featured it, giving it a place on the program at 8.55 one evening.

The Dynasts is the story, told in blank verse with occasional rhymed couplets, of the Napoleonic wars. It is one of the few epic poems of modern times, and far more original, moving, and artistically successful, to my mind, than such an effort as Tennyson's *Idylls of the King*. But it is highbrow stuff. Although it sheds lustre on the English tongue, not one in a hundred of English-speaking people has ever heard of it. Even many readers who are not totally ignorant of Hardy's novels—every high school student has heard of *Tess of the d'Urbervilles*—are unaware that as he approached old age, the novelist turned again to his first medium, poetry, and, in the years between 1903 and 1908, published this epic-drama in three parts, nineteen acts, and one hundred and thirty scenes. It is a beautiful and magnificent creation, but hardly the sort of thing to appeal to readers of the tabloid newspapers. To savor it properly, one must have some literary background. Hence I was surprised to see the thing on a radio program. Radio, in general, goes in for the lighter amusements.

The two scenes broadcast were, to be sure, those of a most nearly "popular" cast, the first on the quarter deck of the *Victory*, Nelson's flagship at the battle of Trafalgar, and the second in the cockpit of the vessel, where the Admiral ended his romantic and stirring career some three hours after a French sharpshooter picked him off from the mizzen-top of the *Redoubtable*, as the ships were lashed together, both on fire, their cannon mowing down the crews with chain-shot and ball, and the decks running with blood. This scene must have been pictured in the reading through the London transmitter, although I doubt whether some of the realistic details of the description, such as "splinters looped with entrails of the crew," were retained, to harrow the sensibilities of the modern Britons. But surely the beautiful lines spoken by the captain of the *Victory*, awakened from his reverie when the dying Nelson asks him:

What are you thinking, that you speak no word—

those lines, surely, were not omitted. It is pleasant to think of them winging their way over those very farms of Wessex which inspired the poet when he wrote:

Thoughts all confused, my lord:—their needs on deck,
Your own sad state, and your unrivalled past;
Mixed up with flashes of old things afar—
Old childish things at home, down Wessex way,
In the snug village under Blackdon Hill
Where I was born. The tumbling stream, the garden,
The placid look of the grey dial there,
Marking unconsciously this bloody hour,
And the red apples on my father's trees,
Just now full ripe.

And then, after the Admiral dies with the battle still raging overhead, the Chorus of the Pities, to the accompaniment of aërial music:

His thread was cut too slowly! When he fell,
And bade his fame farewell,
He might have passed, and shunned his long-drawn pain,
Endured in vain, in vain!

Stuff more estimable, I should say, than the noises of the competition to "decide the chicken calling supremacy of the Adams County Poultry and Pet Stock Association," actually being pumped through the long-suffering ether of the sovereign state of Nebraska at this writing. Send in your votes, dear listeners. Which would you rather have, Hardy or a hog-calling contest?

"A MORE ESTIMABLE BROADCAST THAN A HOG-CALLING CONTEST"

The Listener Behind the Scenes

IN THE December, 1926, RADIO BROADCAST with a loud blare of trumpets, I unloosed a new idea on the radio world, in the form of a scheme to entertain the jaded listeners by taking them behind the scenes of the broadcast studio and showing them, on the air, how the miracle is worked. New idea, did I say? The contents of the following polite note, dated Nov. 17, 1926, from Mr. Hugo Gernsback of WRNY, have a bearing on that question:

I noted with interest on page 181 of RADIO BROADCAST that you suggest taking the listener behind the scenes. From the enclosed program which we ran some time last month you will see we actually did this, with excellent results. It is a feature which I originated, and I am sorry you didn't listen in to it. We had everything that you could think of, behind the scenes. We even actually tried out artists and showed the public how the microphone was placed, how the artist was walked back and forth.

Then the whole next week's program was discussed and the listeners shown how a program is put together. Further, all the technical details, such as gain on the control board, distortion, modulation, and all other techncial points, were graphically shown. The program lasted about one hour.

The program in question was distributed to the customers of WRNY's "Novelty Night," on October 15th, and it was entitled "Behind the Scenes in a Broadcast Studio." The evidence is conclusive. All I can add is that, as these inventions burst on me about two months before they can be printed, Mr. Gernsback and I must have had the idea at about the same time. If there were any money in it, no doubt we should be suing each other, in accordance with time-honored radio traditions. But, alas, there is only glory, and Mr. Gernsback indubitably walks off with that.

A slightly dissimilar intimate broadcast was put on extemporaneously at WSAI on November 15th, according to a report from that station. It appears that Mr. Paul A. Greene, Director at WSAI, was making an advance announcement to the Cincinnati populace, some minutes before the start of the National Broadcasting Company's gala opening program from New York, scheduled to start through WSAI at 8 P. M. Suddenly there issued from a monitoring loud speaker in the booth the voice of the control operator, designated in the report as "Larry": "Watch 'em, they're (meaning New York) going to be early." Nobody knew that this little studio admonition had been radiated until the listeners began to call in to ask who was early, what had happened, can't you do it again for little Robert, etc.

I have always maintained that the listeners like accidents on this order. They provide a kick in several ways. First, there is the glimpse behind the scenes. Second, it is something unusual and therefore exciting. Third, it is pleasing to see another fellow slip on a banana peel and go on his ear, especially if he is wearing a top-hat. To be in on one of those few occasions when a dignified broadcasting station lets loose on an unexpectant world one of the yelps or barks constantly circulating behind the curtain—that is a rare treat. The listeners, I know, love it. But when it happens in a station with which I have anything to do I admit I fall into the state of Mark Twain's cat throwing a fit in a platter of tomatoes.

So much, therefore, for behind-the-scenes broadcasts, intentional and unintentional. A little of them goes a long way.

Fashions in Broadcasting

IN THE radio world the changing flux of styles rules, just as in the choice of clothing, smart night clubs, and summer resorts. And just as irrationally, it may be added, for, while the advent of a new style is frequently based on something sensible enough, the imitations of the original innovation generally result in a foolish pursuit of novelty in all its forms, good and bad.

An example: cone loud speakers. The cone speaker was originally introduced to the broadcast listeners in the form of a well-designed tympanum with a high-grade, balanced armature type of unit. It was superior to the commercial horn speakers that preceded it, and quickly attained deserved popularity. Other good cone speakers were put on the market to satisfy the demand. So far, so good. Now, to the eye, the main difference between the old loud speaker and the new was in the substitution of a flaring cone of parchment or paper for a horn. Inevitably many people jumped to the conclusion that any cone speaker was superior to any horn. This superstition was speedily utilized by some small manufacturers who turned out, in the aggregate, quantities of almost worthless speakers equipped with the magic cones. The units were not of the balanced armature type; they were simple telephone receivers no better than those used with cheap horn loud speakers. They had small, thin diaphragms, with the inherent double frequency component and generation of overtones due to unsymmetrical displacement of the diaphragm. They lacked true lows and they lost the highs; in between they were prolific in harmonics, resonance peaks, and rattles. Any novice in electro-acoustics could predict the performance after one look at the construction, but the things sell because they are cheap and because they are in the fashion. Many people with fair horn speakers spend money for cones the characteristics of which are no better than, if they are as good as, those of the horns they supplant. If they kept the horns and equipped the set with a power output tube, they would be spending their money far more wisely. If, after that, they bought a *good* cone speaker, they would be making real progress with the art. But instead, they follow the fashion blindly and nobody profits but the fly-by-night manufacturer.

The broadcasters in a given locality frequently display a similar weakness at the transmitting end of the circuit. The broadcasting stations, like newspapers, watch each other pretty carefully. One of them develops a popular feature—a singer of sea-chanteys, let us say. It is rumored around town, among the broadcast directors and their attendant concert managers, hungry artists, and spies, that W—— got five thousand letters in two days as a result of the sea-chantey program. Immediately all the assistant program directors rush down to the docks, seeking warblers of sea-chanteys. Finding none, they resort to vaudeville agencies, organizations of retired minstrel singers, drummers who are said to be talented in imitating the late Lew Dockstander, and other such luminaries of the entertainment world. The air is then filled with renditions of "Give Me Some Time To Blow the Man Down," and the public is supposed to be satisfied. But, nine chances out of ten, none of the imitations proves popular. The style has been followed, not in the essential elements which made the first program successful, but only in the external, immaterial factors.

The fault is the same in both cases—that of the actual situation regarding the cone speakers, and that of the hypothetical sea-chantey program. Each contains true elements of progress. The reward is public approval. Then come the imitations, some good, but mostly bad, since the object is a quick, easy profit, and external features are more readily imitated than inherent characteristics. When there is room for them in the market, the good imitations succeed, which is salutary. Sometimes the bad imitations are also swept along to temporary commercial success on the tide of public interest. That is not salutary. It is a case of clever men exploiting the tendency of human beings to run in droves. The only remedy lies in honesty and scientific progressiveness on the part of the organizations at the selling end of the radio business, and a discriminating intelligence on the part of the purchasers and listeners. That takes time to cultivate. But, as one shrewd observer said, all that glistens is not gold, and, as a later immortal pointed out, you cannot fool all of the people all the time.

"THEY RUSH TO THE DOCKS, SEEKING WARBLERS OF SEA CHANTEYS"

One Who Cannot Be Surpassed

THE prize this month, or any other month, goes to the remote control operator who was caught one Sunday morning eating his breakfast while broadcasting a church service. He had set up, cut in all the microphones, been put on the air; then he had calmly strolled around the corner for his unpostponable meal. I admire that man. He went the limit. All the broadcasters who have ever unbalanced an orchestra, neglected a gain control, or reduced the plate current of an amplifier to zero by overloading—they are all pikers compared to him. If I had the money, and that fellow could be purchased, I'd exhibit him in a cage at every broadcast station in the country, with a sign around his neck reading, "Greater Gall Hath No Man Than This."

Abstract of Technical Article

IV.

The Nature of Language—A Résumé of Recent Work on the Physics of Speech and Hearing, by R. L. Jones, Engineering Dept., Western Electric Co., Inc., *Journal of the American Institute of Electrical Engineers*, Vol. XLIII, No. 4, April, 1924.

SINCE the organs of speech are substantially the same in different races, and are capable of emitting only a limited variety of sounds and pitches, the elements of speech show many similarities in different languages. The organs of speech include the lungs, which supply the motor element in the form of streams of air expelled through the vocal passages. This bellows- action of the lungs, as far as speech is concerned, is a secondary function, the primary object being the interchange of oxygen and carbon dioxide, without which life cannot be supported. The breath supplied by the lungs passes between two muscular ledges whose tension and separation may be varied, permitting vibration over a range of frequencies—the vocal cords. The tongue and lips shut off or permit the breath to issue, and also have some influence in determining the resonance effects of the mouth, nose, and throat cavities. What we have, essentially, is a system of bellows, vibrators, valves, and resonance chambers, all adjustable with remarkable speed and precision, and controlled by reflex actions which become largely unconscious after speech has been learned.

The sounds of speech, as represented by letters, fall into five classes: (a) Pure vowels, (b) Transitional vowels, (c) Semi-vowels, (d) Stop consonants, (e) Fricative consonants. In English, there are thirty-six letter sounds. The production of pure vowels involves vibration of the vocal cords in a manner characteristic with each speaker. There is a fundamental tone, somewhat lower for men than for women, with overtones. The mouth and throat cavities reinforce some of these harmonics, according to the position of the tongue and mouth. For example, the long *u* sound, as in "tool" is formed with the lips rounded, and the tongue drawn back so as to make the mouth a single cavity resonant at about 300 cycles. This single cavity is used for other sounds of *u*, *o*, and *a*, the resonance peak for broad *a*, as in "far" being around 1000 cycles, with the tongue no longer much raised, so that the effect of the throat cavity begins to be felt in a double resonance. This double peak becomes pronounced in the short *a* of "at," where the mouth and throat form connected cavities, with two re-inforced tones between 800 and 1200 cycles. For the long *e* sound the resonance peaks are more widely separated, the frequencies being in the neighborhood of 300 and 2500 cycles. The tongue in this case is well forward, affording a large resonance chamber in the throat and back of the mouth, with a small cavity between the tongue and the lips for the higher frequency.

Transition vowels or diphthongs are formed in passing from one vowel to another. For example, *w* is simply *u* plus a pure vowel. If one pro-

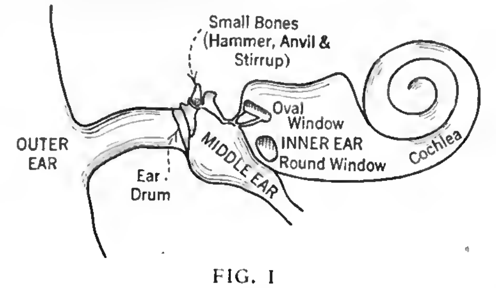


FIG. I

nounces the long sound of *u*, followed by a pure vowel, such a word as "way" is the result, the *w* being a characteristic transition vowel.

H is simply a forcible expulsion of breath through the glottis (the opening between the vocal cords) preceding a vowel. This letter is classified as a transitional vowel. *L* and *r* partake of the nature of both vowels and consonants, and receive a separate classification as semi-vowels.

Stop consonants are characterized by the formation of a stop in some part of the mouth. The sound of the consonant "p" is made by exerting breath pressure against the closed lips, and suddenly parting them, releasing the air. The same motions, plus vocalization, produce "b." The unvoiced stop consonants are *p*, *t*, *ch*, and *k*. Those involving the vocal cords are *b*, *d*, *j*, and *g*. The nasal group, in which breath is released through the nose, comprises *m*, *n*, and *ng*.

Fricative consonants, as distinguished from the stop group, utilize the rushing or hissing sound of breath passing through an outlet, involving the lips, tongue, teeth, or palate. These are the same organs of the mouth and throat used in producing stop consonants, so that the essential difference is the complete closing and subsequent release for the stops, and an incomplete closing for the fricatives. Similarly, vocal cord vibrations are present in some cases and absent in others. For example, the sound of "f" is obtained by expelling the breath through the outlet between the upper teeth and the lower lip, without vocalization. If the voice accompanies the same procedure, "v" is the result.

Jones next describes briefly the equipment for physical analyses of speech. This portion of the paper, and the curve of the energy distribution of speech, or, as Jones entitles it, the "Acoustic Spectrum" of English, are taken from the Crandall-MacKenzie paper on "Analysis of the Energy Distribution in Speech," abstracted in the January Radio Broadcast. As was stated there, the vowel sounds carry most of the energy of speech. The reason for the 200-cycle maximum in the energy distribution curve is shown by some analyses of sung vowel sounds presented by Jones. These show maximum components, in every case, close to 200 cycles, for one particular speaker. The higher frequencies, up to 6000 cycles or more, are carried by the consonants, and, because their importance in determining intelligibility is by no means proportional to their

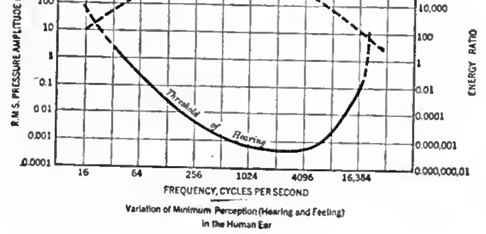


FIG. 2

weak energy, cause the most difficuly in high quality electrical reproduction.

The paper continues with a description of the mechanism of the ear. The outer ear is essentially a collector of sound in the form of air waves, which impinge on the drum separating the outer from the middle ear. The middle ear contains a mechanical transmission chain of small bones which carry the sound vibrations to a membrane or oval window giving access to the inner ear. Some small muscles in the middle ear have the function of accommodating the mechanism for effective hearing of sounds of various intensities. The inner ear is a delicate and complicated system for converting acoustic vibrations into nerve currents. It is essentially a spiral shell of bone, the cochlea, filled with liquid, and containing the rod-like terminals of the auditory nerves, some 3000 in number, constituting the basilar membrane. These rods appear to respond selectively to vibrations of different frequencies, thus permitting the apperception of pitch. Besides the oval membrane through which the vibrations are received, the inner ear is provided with a round window or membrane which may be bulged out by the liquid in order to relieve excess pressure. Fig. 1 shows the general features of the auditory system as described above. This picture represents my own idea of the anatomy of the ear, and is not given by Jones.

We do not know precisely how changes of intensity of sound are detected by the ear: it may be through proportionate agitation of the nerve terminals, or by the width of the band affected on each side of the point of selective vibration.

The ear mechanism between the drum and the nerve terminals has a definite vibratory impedance, varying like any other such system with frequency and amplitude. At very high frequencies, say 20,000 cycles per second, the impedance may be so high that no perceptible energy reaches the inner ear. We may expect a varying sensitivity, accordingly, to sounds of varying pitches. This characteristic is shown in Fig. 2, which is part of Fig. 4 of Jones' paper. From this curve, showing just audible sounds at various pitches, we note that the maximum sensitivity of the human ear is at about 3000 cycles, and is fairly constant between about 500 to about 7000 cycles per second. The variation of sensitivity is great; a note of 30 cycles or 17,000 cycles requires a million times as much energy to become just audible than one of, say, 1000 cycles. The region most essential in speech is roughly that in which the ear is most sensitive, pointing to a progressive evolution of both organs to a common basis of operation, now sapiently utilized by the telephone companies in furnishing a 200–2000 cycle band for the conversation of their customers.

Sounds may be felt by the ear as well as heard, if the intensity is sufficiently great (about 1000 dynes R. M. S.). The curve of sensitivity of feeling for sounds is roughly the reflection of the hearing curve shown in Fig. 2, it being concave downwards, with a maximum at about 1000 cycles, and dropping off to the limits of audition, which are about 20 cycles on the low end, and 20,000 on the high, for the average person of normal hearing. In other words, very low and extremely high pitched sounds are felt as easily as they are heard.

While even the energy required for feeling is not great, that required for audibility is marvellously small. In the favorable region shown in Fig. 2, the minimum audible tone corresponds to a pressure change per square centimeter of about 0.001 dyne. This, Jones states, is about equivalent to the weight of a section of human hair one thousandth of an inch long, which is something like a third of its diameter!

(To be continued)

Curious Problem for a Broadcaster

NEATLY typewritten note received by a New York broadcasting station during October, 1926:

WE, THE POWERS OF THE ETHERIC PLANE, authorize you to broadcast the following:

MAN SHALL EAT NO MORE FLESH WHILE THE WORLD STANDS; AND IN THE DAY THAT HE EATETH THEREOF HE SHALL DIE.

Later communication written on the same typewriter:

WE, THE POWERS OF THE ETHERIC PLANE, authorize you to broadcast the fact that on the fifteenth day of November, Nineteen Hundred and Twenty-six, a book entitled *The Love-Story of the Ages or the Second Coming of Christ* will be placed upon the book-stands of New York, N. Y. and Washington, D. C. No comments are permitted. Any neglect in the fulfilment of our instructions is punishable by instant death.

The officials of the broadcasting station, pleased at the prospect of a speedy termination of their miserable lives, did nothing. They were rewarded, after an interval, by the following gracious proclamation:

WE, THE POWERS OF THE ETHERIC PLANE, commend your acceptance of our directions, and wish to state that the difficulties you have experienced thereto have been owing to our intervention. You will not begin the broadcasting of material already submitted, until Monday the eighteenth of October: and because of the spirit in which you have undertaken to carry out our instructions, we are calling your attention to the fact that on the first day of December, 1926, New York, N. Y. and Washington, District of Columbia, are to be totally destroyed by fire. You are permitted to dispose of personal and business property to the best advantage, placing the proceeds in a private vault in Philadelphia, headquarters of E. P. Dutton & Company, Publishers, after the fifteenth of November.

Possibly the POWERS OF THE ETHERIC PLANE got that way from trying to devise a plan for regulating radio in such a manner that Congress, the public, the Administration, and all the broadcasters will be pleased.

Note for Radio Historians

DO YOU remember, you radio men whose memory goes back to 1915 or thereabouts, the silicon detectors then used by the United States Navy, one of which it was every amateur's hopeless dream to possess? They were worth, in the glory of their swivel joints, bright nickel plate, and hard rubber bases, some $15, and in those days $15 was a lot of money. Well, passing down Cortlandt Street, the foremost abbatoir of radio equipment in New York and the world, the other day, I noticed a heap of those detectors on sale before one of the shops. They were the genuine article, engraved with the traditional formula: "Silicon-Antimony Detector, CR-535, Manufactured for Navy Department, Bureau of Steam Engineering," and they were to be had at 75 cents apiece. And nobody was buying them! *Sic transit gloria mundi.*

Broadcast Station Service Data

USEFUL tables from Dr. Alfred N. Goldsmith's paper on "Reduction of Interference in Broadcast Reception" in the *Proceedings of the Institute of Radio Engineers*, Vol. 14, No. 5. October, 1926:

Estimated service range of stations of various powers, in the eastern portion of the United States.

Antenna Power	Service Range
5 watts	1 mile
50 watts	3 miles
500 watts	10 miles
5000 watts (5 kw.)	30 miles
50,000 watts (50 kw.)	100 miles

Type of service corresponding to various field strengths.

Signal Field Strength	Nature of Service
0.1 millivolt per meter	Poor Service
1.0 millivolt per meter	Fair Service
10.0 millivolts per meter	Very Good Service
100.0 millivolts per meter	Excellent Service
1000.0 millivolts (1.0 volt) per meter	Extremely Strong Signal

Memoirs of a Radio Engineer

XVII

DURING the second term of my radio course at the College of the City of New York, the United States entered the war. Radio, which had been considerably upset by the preceding years of anxious neutrality, now had the lid clamped down with a sharp official snap. Even the great triangular antenna which covered the campus of the College, with its six wires running from the tower of the Main Building to Townsend Harris and Mechanic Arts, had to be taken down, although shortly afterwards two of the wires went up again for the United States Navy's listening-in station, which was installed during the summer of 1917. But before going on with the story, I had better try to give a picture of how things stood at this time in the radio world.

The war started in 1914, as we are not yet likely to forget. In the early months of 1915 I was writing a weekly newspaper column of radio comment for the Rockville Centre *Owl*, under the heading, "Wireless for Amateurs." Probably these were not the earliest descriptive articles on radio to find a place in a newspaper, but certainly they were among the grandfathers of the present radio supplements and critiques. There were about twenty-six of these *Owl* radio essays which astonished the uncomprehending burghers of Rockville Centre, a suburb not very far from Garden City, where these recapitulations now go into print; but our only interest in them lies in the fact that the red flames of the conflagration to the east cast their glow even on that innocent radio column, loaded with all the wisdom of my nineteen years. Two quotations may be justified on this account:

"Within a little more than three years," I wrote on May 14, 1915, "there have been three great maritime disasters. Together they account for the loss of almost four thousand lives. Ice sent the *Titanic* down into the sea weeds; an ill manœuvred collier was the end of the *Empress* of *Ireland*, and now the *Lusitania*, has gone to take her place in that company. Men build ships and sail them on the sea, but the sea insists on its percentage, and takes it on occasion. It is remarkable, too, that when Nature spares a ship, man, with his no less effective weapons, goes ahead and sinks her. Yes, the *Lusitania* is gone. We are never going to hear her spark again. It feels rather queer when you reflect that only last Saturday you heard her working Sea Gate as she steamed down the Bay. Only a week ago, and now her funnels are in the mud, and the fish are eating the insulation off her multiple tuner. A sad end for such a fine ship, and one that is doubly sad because it can accomplish no possible good to anybody, least of all to the people who caused it."

"Never before in the memory of the oldest wireless operator has the air above New York City been as busy as this week. The number of radiograms transmitted every hour is astonishing. They are sent out by several classes of stations. First of all there are the battleships, big and little, lying in the Hudson. They use shrill, high frequency sparks in communication with the Brooklyn Navy Yard on various short wavelengths; 750 meters is perhaps the one most used. The Navy Yard, in addition, transacts its usual business with Newport, Fire Island, Philadelphia, and Arlington. Sea Gate takes care of the coastwise liners. Then we have WCG at Bush Terminal attending to the needs of a large brood of Sound steamers. The *Herald* sends war bulletins on reduced power. As if all this was not bad enough, the inevitable British cruiser off the Hook chimes in occasionally. Considering the great amount of business transacted, there is remarkably little confusion. Everybody sends the signal number "4" before transmitting. This is a double question: "Are you clear? May I transmit?" The answer *K* or *I* indicates that the inquiring station is at liberty to send off its radiogram. The answer "Min" or the standard abbreviation of • ▬ • • • indicates that transmission will cause interference. The word "rush" after a call entitles one to special consideration. It means that the operator is burdened with an important message which he wants to get off as soon as possible."

It was the war that first brought the interference problem into radio, what with the enormous increase in shipping and general message traffic. The congestion of the ether, as we know it in broadcasting, is nothing new. As, according to the law of Mathus, population always presses on the means of subsistence, so, since about 1915, the number of radio stations has always pressed on the available ether channels. Aside from this factor, however, the average radio operator in United States waters heard little about the war, whatever was going on behind the scenes. There were the *Herald* bulletins I wrote about, sent on reduced power so that the German receiving stations could not possibly utilize them. And the British cruiser droned out long messages in numeral code to Halifax, or to another unit of His Majesty's Navy, as she lay guarding the entrance to New York Harbor, so that no Teutonic vessel could venture out or in. Many thousand tons of German shipping lay bottled up at the Hoboken docks during 1914, '15, and '16. Then the United States went in. The German ships were seized by the United States Navy. And, while it was about it, the Navy also seized American radio, from the power board to the antenna insulators, and held it in duress for two years.

A Five-Tube Non-Oscillating Receiver

Wherein an Effective System of Receiver Stabilization is Described—The Causes of Oscillation in Radio-Frequency Circuits—The Triple Duties of the Milliammeter

By T. H. NAKKEN

THIS article is concerned with a method of stabilizing radio-frequency amplifiers and the application of this system to a five-tube receiver employing two tuned r.f. stages, a non-regenerative detector, and a transformer-coupled audio amplifier. The receiver has only two tuning controls because a gang condenser, C_2 is used to tune the second and third coils. It is capable of giving excellent tonal quality when worked with a good quality loud speaker, and is absolutely stable in performance. The receiver is easily and permanently stabilized, and will not squeal once it has been adjusted. It tunes sharply and will satisfactorily separate local stations.

In designing any tuned radio-frequency receiver, one of the most important problems is to properly stabilize it, since any ordinary high-frequency amplifier has an inherent tendency to oscillate, and when this occurs, reception is ruined by the howls that are created. Stabilization can be obtained in various ways, and it will be worth while to orient very briefly our thoughts regarding these different methods.

Perhaps the ideal way of preventing oscillations in a high-frequency amplifier is through the use of a bridge system, since such a method does not introduce any loss, and is, theoretically at least, capable of being arranged so that its effect is practically constant over the entire band of broadcast frequencies. However, a bridge system is difficult to adjust, necessitates that the apparatus be laid out very accurately, and that the wiring be carefully done. There are indeed few receivers on the market efficiently designed and completely neutralized.

Diametrically opposite to this method, we have the simple "losser" systems. Resistance in series with or across the tuned circuit very effectively prevents oscillations, but it also precludes considerable amplification. Such systems are generally easy to adjust but are not constant in effect over the entire broadcast spectrum. Consequently, if adjusted so as to prevent oscillations at the high frequencies (short wavelengths) where they are most likely to occur, the loss in amplification at low frequencies is considerable.

Between these two methods (the bridge systems, constant over the broadcast band but difficult to adjust; and the "losser" system, very simply adjusted but also very inefficient and unequally effective over the broadcast band), there lies a third system, also quite easy to adjust and fairly constant in effect at different frequencies. This leads us to the Phasatrol, a stabilizing device used in the receiver illustrated in this article. The Phasatrol is easily adjusted and will completely prevent oscillations. Also its effect is fairly constant with frequency so that only a slight loss of amplification at low frequencies (long wavelengths) occurs. To properly understand the action of the Phasatrol, one should fully realize why a radio-frequency amplifier always tends to oscillate, and it will be attempted to give here a simple, understandable explanation of the reasons causing oscillation.

We all realize that a vacuum tube is an extremely sensitive device, which amplifies almost completely without any distortion any kind of electrical disturbance which is experienced by its grid—the one element which controls its actions. Now, in a radio receiver there are many electrical currents flowing in various circuits, and each one of these circuits creates its own electrical disturbances, which easily may act upon one or more of the grids of the different vacuum tubes. This reaction of the various circuits is called coupling, and only too easily gives rise to the familiar squealing, always an indication of oscillations in the receiver. This oscillation is the nightmare of every radio manufacturer and experimenter, and ceaseless labor is being expended everywhere to prevent the occurrence of these oscillations.

Oscillation will almost invariably occur when there exists coupling between the various stages of radio-frequency amplification, and, in general, we may say that there are two ways in which circuits can be coupled, *i.e.*, inductively and capacitively. By judicious design we may construct receivers in which extraneous coupling has been reduced to an absolute minimum, by using parts that show the least tendency to act as coupling devices, and placing them in such a way that the danger of coupling is largely prevented.

But even when in the receiver itself, not the slightest chance exists for coupling of any kind whatsoever, there would remain one coupling device, which always tends to cause oscillations and instability. This is the amplifying tube itself, in which there exists an inherent capacitive coupling factor due to the proximity of its elements, notably its plate and grid. Any change in the potential of the plate reacts capacitively upon its grid, and these changes in plate potential almost invariably occur in such a way that their disturbing effect on the grid coincides with the original disturbance on the grid. This means, then that this inter-element capacity has the effect of building up the original disturbance, and when this happens, oscillation is sure to occur, unless proper action is taken in the design of the receiver to prevent this inter-element capacity from having such an effect. When we analyze why this influence of the plate upon the grid has the effect of causing oscillations, we will understand the method employed in the Phasatrol to overcome this.

Generally, in a radio-frequency amplifier, the coupling device between two successive stages is a tuned r.f. transformer. Such a transformer almost invariably consists of an untuned primary and a secondary, the latter being tuned by means of a variable condenser. The plate circuit contains a coil and therefore the circuit obeys the laws that govern the behavior of alternating currents in inductive circuits. Now it is a well known fact that, in such a circuit, the current lags behind the voltage, as it is expressed. This means that, as there is a difference in the time of maximum voltage and the maximum current in such circuits, the current reaches its maximum value after the maximum voltage has been developed. This then can also be expressed by saying that the voltages are ahead of the current, which in this instance is very important. When we now consider that the current fluctuations in the plate circuit are due to disturbances on the grid, it follows that, when the currents lag behind the voltages, the potential changes in the circuit, and of the plate, therefore, are advanced with respect to the plate-current changes.

When the plate changes in potential, which change of potential is always larger than the original impulse on the grid, the plate reacts upon the grid, due to the fact that the two form a small condenser. The back action of the plate on the grid is therefore a capacitive one, and there is an electrical law which states that in capacitive circuits the voltages lag behind the currents, meaning that the voltages developed reach a maximum only after the current has reached its maximum, or rather, when the current has already passed its maximum. This is exactly the reverse action of an inductive circuit.

When we look at these facts, we will see that the voltage variations of the plate are in advance of the current, but that the voltage variations of the grid, due to those on the plate, experience a lag. These voltage variations of the grid due to the plate circuit variations, will almost coincide with the disturbances on the grid which caused the changes in plate current in the first place. In other words, the back coupling, due to the capacity between the tube elements, reënforces the original impulse and this condition causes the further building up of the original impulse, and either regeneration, or, if the back action is strong enough, oscillation, occurs.

It follows that, if we only

RADIO BROADCAST Photograph

A FRONT ASPECT OF THE RECEIVER

The milliameter serves as an excellent check on the quality, as explained elsewhere in this article

Radio Broadcast Photograph

HOW THE APPARATUS IS ARRANGED

This rear view clearly shows the neat layout of the parts on the sub-panel

could cause this back action of the plate upon the grid not to coincide with the original impulse, there would be less danger of oscillations being caused by this inter-element capacity. A method of doing this is illustrated in the accompanying circuit diagram. In this circuit we see that we have placed a shunt resistance, R, in the plate circuits of the r.f. tubes. Here we see that condensers C, and primary inductances L, are shunted by a plain resistance R, which kind of circuit is an ideal absorption circuit, its effectiveness as such depending upon the size of the resistance.

It will be seen that the plate circuit now contains a capacity as well as an inductance, and that, due to the presence of these two, the relationship between voltage and current is changed, so that the plate voltage variations will more or less coincide with the current variations, as the inductive effect is largely offset by the capacity, which has an effect opposite to that of the inductance. The effect of the condenser will not completely prevent oscillations but will make it much more difficult for them to occur. The remaining tendency toward oscillations is overcome by the variable resistance. The resistance is more effective at high frequencies where the back coupling tending to create oscillations is greatest. The Phasatrol then fulfils its function in two distinctly different ways: First, it changes the phase relationship of potentials and currents in the plate circuit, so that the potential variations of the plate are much less liable to be the cause of oscillations, while in the second place, the device acts as an absorption circuit which can be accurately adjusted to the exact requirement of every individual receiver.

THE NECESSARY PARTS

REFERRING again to the diagram, we see that, for the exception of the Phasatrols, which are placed in dotted lines, the receiver is a conventional one in most respects. A list of parts used in the receiver is given below:

L_1, L_2, L_3—Three Bodine Matched Coils	$6.00
Five Eby Sockets	2.50
R_1—Four Amperites, Type 1-A	4.40
R_2—Amperite, Type 112	1.10
T_1, T_2—Two Thordarson R-200 Audio Transformers	16.00
C_1—Hammarlund Midline Condenser 0.00035 Mfd.	4.75
C_2—Hammarlund Midline Gang Condenser (2—0.00035 Mfd. Sections)	8.00
Lynch Single Resistor Mounting	.35
R_3—Lynch 2 Megohm Grid Leak	.50
Seven Eby Binding Posts	1.05
Four Carter Pin Jacks	.60
S—Cutler-Hammer Filament Switch	.60
R_4—Electrad Royalty 700,000 Ohm Variable Resistance	2.00
R_5—Electrad Royalty 500,000 Ohm Variable Resistance	2.00
MA—Jewell Panel Mounted Milliammeter 0—50 Scale	7.50
Two Eby Dials	5.00
Wire	.50
P_1, P_2—Two Electrad Phasatrols	5.50
C_3—Electrad 0.5 Mfd. Bypass Condenser	.60
C_4—Sangamo 0.00025 Mfd. Grid Condenser	.40
C_5—Sangmo 0.001 Mfd. Fixed Condenser	.50
C_6—Electrad 1 Mfd. Bypass Condenser	1.80
TOTAL	$71.65

Panel 7 x 23 inches
Sub-Panel 7 x 23 inches

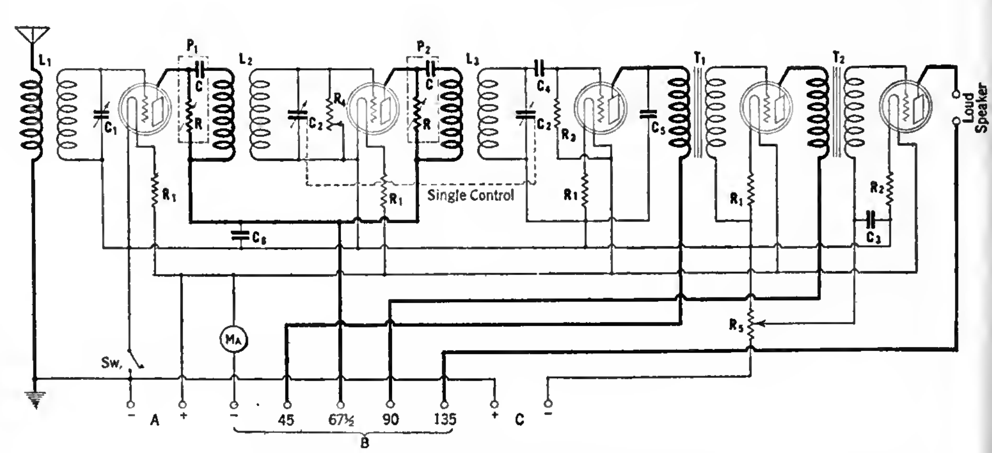
The placement of the parts is evident from the photographs, and these, in conjunction with the circuit diagram, should give sufficient information to enable a home constructor to build the receiver. The "figure-eight" Bodine coils are placed on the market in sets of three matched coils, and this makes it possible to use the Hammarlund gang condenser and thus eliminate one control. The 700,000-ohm Royalty variable resistance located near the left center of the panel, is the volume control. Since this control is in the r.f. stage, it is possible to prevent overloading of the detector on strong local signals.

The milliammeter to the left on the panel is placed in the common negative B-battery lead. The meter used in the model had a 100-mA. range, but a 50-mA. range is large enough. The receiver ordinarily draws about 25 mils, with a 112 type tube in the output. With a 171 type output tube, the total plate current will be about 35 mils.

The meter is an excellent accessory because it will serve to check up on the quality of the reception. To understand this use of the meter, one only has to remember that, in order to be undistorted, the signal currents should be pure alternating currents, increasing and decreasing from the mean value of the steady current to the same extent. If this condition is fulfilled, the meter needle should remain still even with the loudest signal. Violent fluctuations of the meter will always be indicative of distortion, which can usually be remedied by adjustment of the C bias.

In order to make the best use of the meter for this purpose, there is installed on the front panel a Royalty 500,000-ohm potentiometer, which is shunted across the C-battery connections. The moving arm is connected to the F lead on the second audio transformer, and has also a connection to one of the terminals of a 1-mfd. condenser, whose other terminal leads to the general minus line. This control enables us to adjust the C-battery voltage to the best value possible, the meter giving visible evidence when the correct value is reached. There is still another service, for which the meter will prove of invaluable service, *i.e.*, in the stabilization of the receiver.

To do this successfully, the condenser dials should be turned to about 10. When, now, one of the two dials is moved, and the receiver is in oscillating condition, the needle of the meter will suddenly jump, as the dial passes a certain point. As soon as the correct position of the Phasatrols is found, the meter will remain perfectly still when tuning; the Phasatrol is then adjusted to greatest sensitivity on a short wavelength station, and the receiver is ready for operation and logging. In adjusting the Phasatrols, reduce each unit a small amount at a time —otherwise it is quite possible to make the receiver broad in tuning and a loss of sensitiveness will be noticed particularly on the long wave stations. In this way each resistance will remain about equal, in value, and give best results.



THE CIRCUIT DIAGRAM OF THE RECEIVER

Using Phasatrols in which these units are shown in dotted lines. Separate B-plus binding posts are indicated for the r. f. and first a. f. plate voltages but these two may be combined as was done in the model made up. Also no C-plus post is used on the model since this lead was connected to the negative-A post. Only seven binding posts are then necessary. The antenna and ground are connected through pin jacks, as are also the loud speaker leads

Constructing an Amplifier-Power Supply Device

How to Build a Three-Stage Resistance-Coupled Power Amplifier Operated from the A. C. Mains —Data for the Winding of the Power Transformer, Choke Coils, and Output Impedance, Are Given

By JAMES MILLEN

THE cost of the various parts required for the construction of combination high quality amplifiers and a. c. operated power-supply devices of the type described in this and the past two issues of RADIO BROADCAST, is rather high. As the power transformer and choke coils contribute a good share toward this figure—say $30—many constructors who have the necessary facilities and patience may deem it worth the trouble to construct their own units.

The main difficulty to be overcome in the construction of small power transformers and filter chokes lies in securing suitable laminated iron cores. If the core can be secured from a toy transformer or some other such piece of apparatus, then the job is very much simplified. If not, then a sheet of transformer steel, such as No. 29 gauge Apollo special electrical sheet, must be cut into strips one inch in width, and the strips used to build up the cores, as shown in Fig. 1, A and B.

Though, perhaps, this can be done by hand, it will be best to take the sheet to a tinsmith and have it cut into the desired size pieces with a pair of squaring shears. The individual pieces must be cut to as near a uniform size as possible, in order to facilitate the final core assembly. If the edges are burred, then the burrs should be removed. Commercially, burred laminations are passed through a set of steel rollers, but the home constructor will doubtlessly have to resort to the tedious process of filing.

When a sufficient quantity of the proper size laminations have been gathered together to provide a core one inch in thickness, each should be given a thin coat of shellac and allowed to dry before assembling. The assembly of the cores for the chokes and transformer is not the same. It will be noted, in B, that each successive layer of laminations for the transformer core overlap, while no overlapping of the strips takes place in the cores for the choke coils.

First let us take up the construction of the coils for the chokes. Two chokes, consisting of two cores and two coils, are required. The coils are preferably wound on forms made from wood to the dimensions given in Fig. 1, C. As a great many turns of wire are to be wound before the two choke coils and transformers are completed, it is well worth the time to construct some simple form of winding machine if a lathe is not available for the purpose. A simple, yet quite practical coil winding machine can be rigged up by mounting the coil form or bobbin on the hand wheel of a sewing machine. Another way is to make use of a hand drill clamped in a vise.

The two choke coil windings consist of approximately 5000 turns each of No. 31 enamel wire, random wound on the two forms. Care must be used in winding to exert an even tension on the wire at all times. It is also extremely important to guard against short-circuited turns. A single short-circuited turn is quite sufficient to make an otherwise excellent coil entirely worthless. The finished coils should be protected with several layers of wrapping paper.

When assembling the cores around the choke coils, the method shown in Fig. 1, A, should be employed, so as to form air gaps at the end of each core. A piece of paper of about half the thickness of one of the pages of RADIO BROADCAST should be placed in each of the air gaps so as to prevent the two adjacent core legs from touching each other. Clamps should then be made from strips of brass or steel and the entire core firmly fastened together with the gaps pressed as tightly closed as the paper will permit. Should it, for any reason, be desirable to use these same chokes with heavier currents than will be encountered within the amplifiers described, the size of the air gaps should be increased by inserting several thicknesses of paper.

THE TRANSFORMER

ALTHOUGH the transformer actually consists of fewer turns than even one of the choke coils, more time will probably be required for its construction because it consists of several individual coils, or windings, placed one on top of the other. First, next to the core (which is shown in Fig. 1, B.), comes the 110-volt winding, or primary. This winding consists of 840 turns of No. 26 enameled copper wire, layer wound, with a strip of glassine or Empire paper between each layer. If a little care is taken, no great difficulty will be experienced in making a neat layer-wound coil. When the primary has been completed, several layers of heavy wrapping paper, or better yet, Empire cloth, should be wound in place before starting the filament winding.

The filament winding, for use with a 171 power tube, consists of 40 turns of No. 20 cotton-covered enamel wire. A mid tap is brought out at the 20th turn by bringing out a long uncut loop and twisting it into the form of a double wire.

There is a very definite reason for placing the filament winding between the 110-volt primary winding and the high-voltage secondary winding. All parts of this filament winding are at all times within a few volts of ground potential, which enables this winding to serve as a most satisfactory electrostatic shield between the 110-volt winding and the high-voltage winding. This has the effect of greatly reducing the line disturbances, principally the ninth harmonic of the fundamental power line frequency which is at times so evident in the loud speaker of a. c. operated sets in which no provision for electrostatic shielding is made.

On top of the filament winding, several more layers of insulating material are placed before winding the high-voltage secondary. This high-voltage secondary consists of 3520 turns of No. 31 enameled copper wire with a tap taken out at the 1760th turn. Glassine or Empire cloth should be placed between the layers of this coil.

In assembling the power transformer, so stack the core pieces that there are no air gaps, as shown in Fig. 1, B. As in the core of the choke coils, the transformer core must be tightly fastened with core clamps made from strips of brass or steel. The clamps are shown in Fig. 1, D.

THE OUTPUT IMPEDANCE

ALTHOUGH a choke similar to one of the filter chokes just described will serve quite excellently as an output impedance, it is needlessly large and cumbersome for the purpose. A

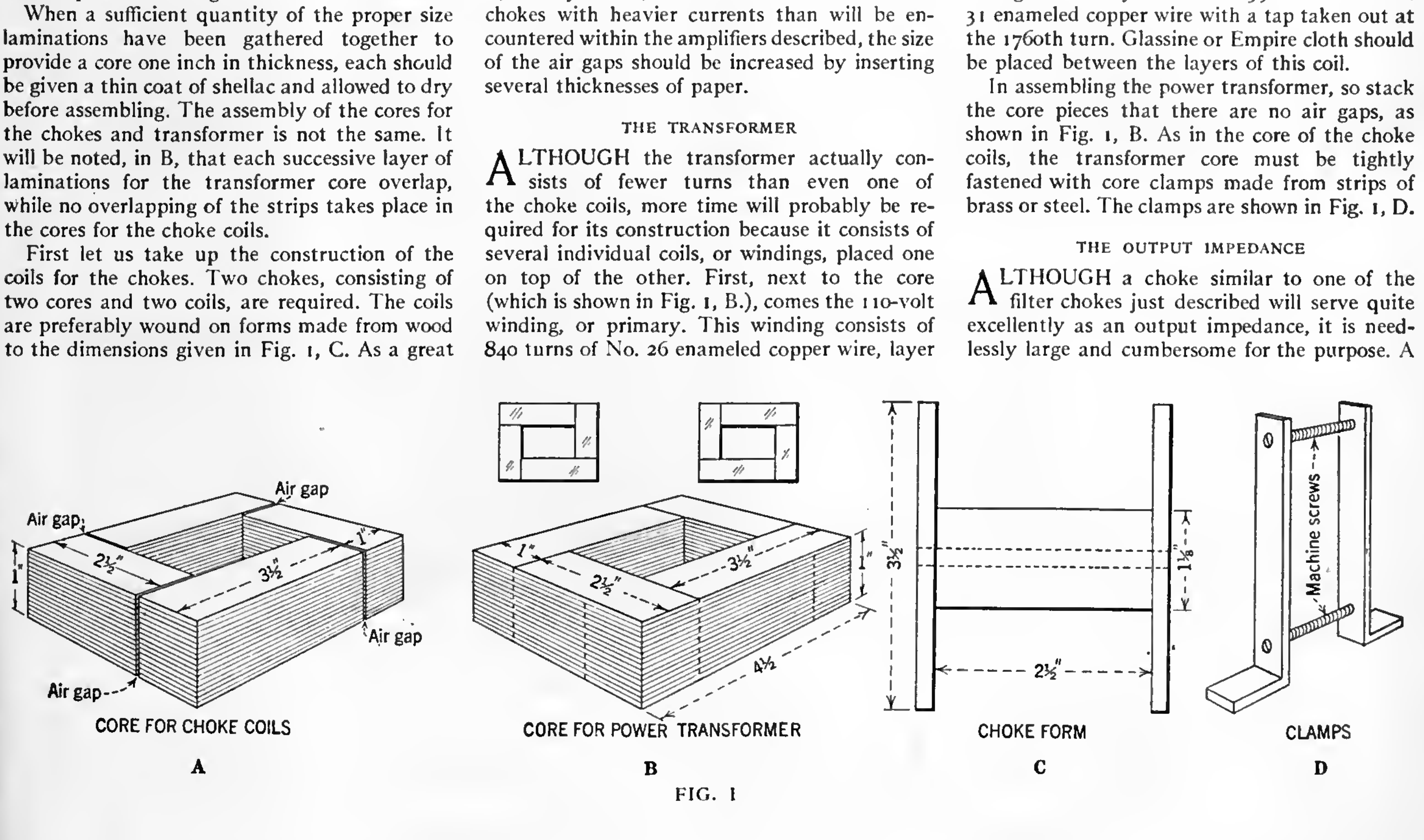
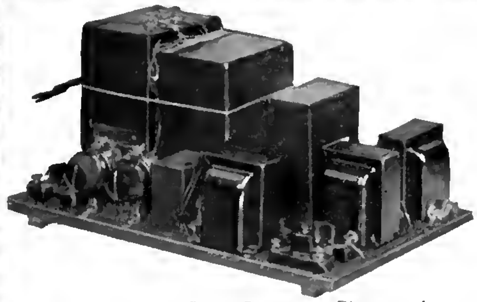


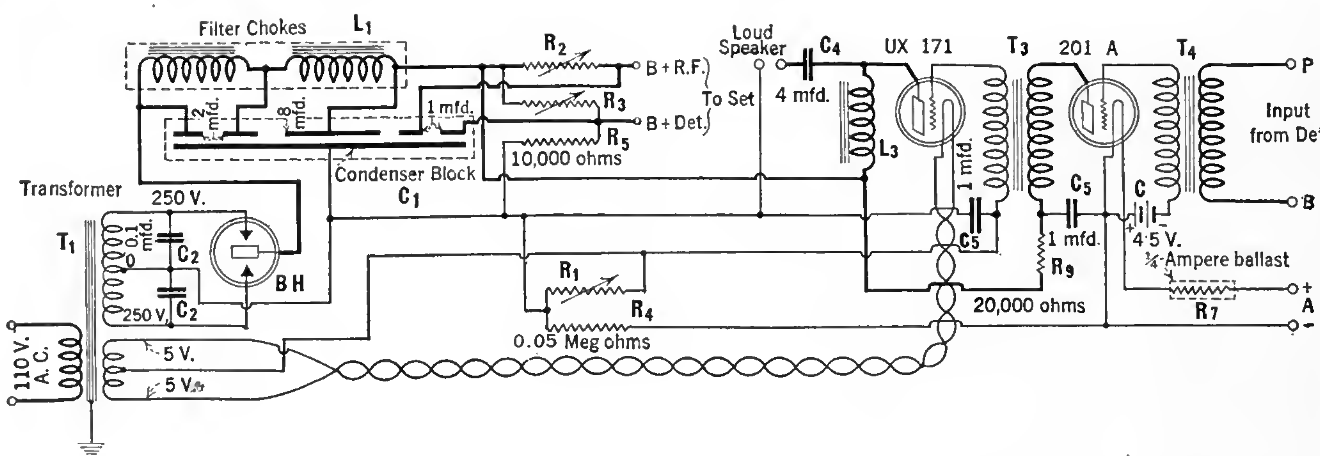
FIG. 1



Radio Broadcast Photograph

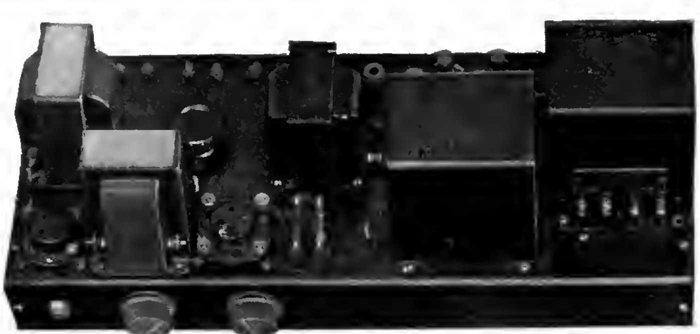
THE LIST OF PARTS

T_1, L_1, C_2—Thordarson Power Compact, No. 71	$15.00
C_1—Potter Condenser Block	12.50
C_4—Polymet 4-Mfd Condenser	3.50
C_5—Two Polymet 1-Mfd. Condensers	2.00
Three Airgap Sockets	1.80
Lynch Double Mount	.50
Two Lynch Single Mounts	.70
R_7—Lynch Equalizor No. 4	1.00
R_4—Lynch Metalized Filament Resistor, 0.05 Megohms	.75
R_9—Tobe Veritas, 20,000 Ohms	1.10
R_5—Tobe Veritas, 10,000 Ohms	1.10
R_1—Tobe Veritas, 2000 Ohms	1.10
L_3—Thordarson Impedance, Type R-196	5.00
T_3, T_4—Two Thordarson Type R-200 Transformers	16.00
R_2, R_3—Two Clarostat Variable Resistors	4.50
Base-Board, Wire, Posts, C Battery	1.00
UX-201-A Type Tube	1.75
UX-171 Type Tube	4.50
Raytheon B H Rectifier Tube	6.00
TOTAL	$79.80



A TRANSFORMER-COUPLED AMPLIFIER-POWER SUPPLY DEVICE

Designed to supply B voltage for the whole receiver. The filament of the output tube is supplied with a.c., and C voltage is also obtained from the mains for this tube. The circuit diagram gives the connections and constants used in the circuit. Above is a photograph of the complete unit which is unusually compact



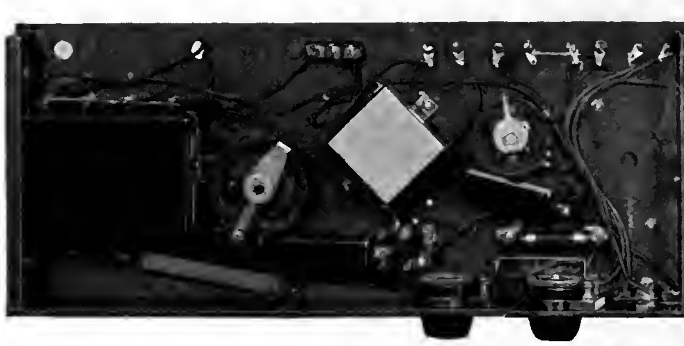
Radio Broadcast Photograph

ANOTHER AMPLIFIER-POWER DEVICE

The circuit diagram which applies to the amplifier device illustrated here is substantially the same as that shown in the box above. The 5-ohm resistance strip specified in the list of parts should be connected in series with one of the filament leads of the power transformer to drop the voltage to 5 volts. The potentiometer, R_{13}, is connected across the filament terminals of the power tube socket in order to obtain the equivalent of a center tap. The total capacity in the filter section is 8-mfd. as opposed to the usual 12-mfd.

THE LIST OF PARTS

T_1—General Radio Power Transformer	$10.00
L_1—General Radio Filter Chokes	10.00
C_1—Four American Electric Filter Condensers, 2 Mfd.	7.00
C_2—Two Tobe 0.1-Mfd. Buffer Condensers	1.40
C_6—Two American Electric Bypass Condensers, 1 Mfd.	2.40
L_3—Thordarson Choke, No. R-196	5.00
C_4—Tobe Fixed Condenser, 4-Mfd.	3.50
T_1, T_2—Two Rauland Lyric Transformers	18.00
Three Sockets (General Radio, Benjamin)	1.75
R_7—Rheostat, 10 Ohms	.75
Resistance Strip, 5 Ohms (Taken from Old Rheostat)	
R_2, R_3—Two Electrad Royalty Resistors, No. 2 and No. 3	3.00
Lynch Double Resistor Mounting	.50
R_1—Tobe Veritas Resistor, 2000 Ohms	1.10
R_4—Durham Metalized Filament Resistor 0.05 Megohms	.75
Two Electrad Short Jacks	.50
Binding Posts	.45
Bakelite	3.00
Garfield Brackets	1.25
R_{13}—Potentiometer, General Radio, Type 214	3.00
UX-201-A Type Tube	1.75
UX-171 Type Tube	4.50
Raytheon BH Rectifier Tube	6.00
TOTAL	$85.60



Radio Broadcast Photograph

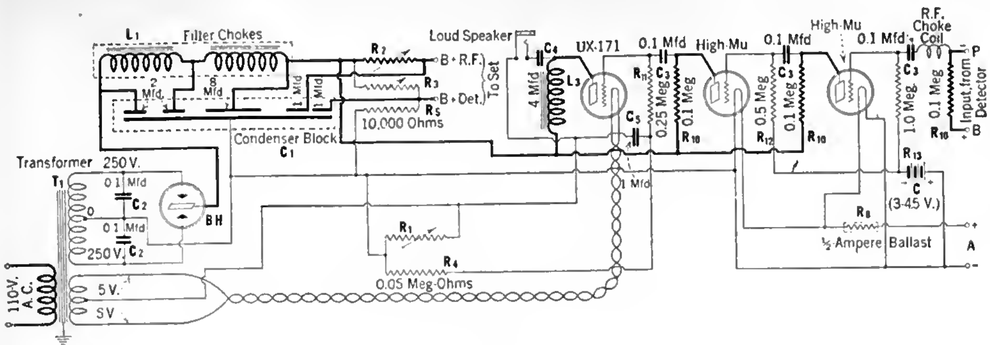


FIG. 2

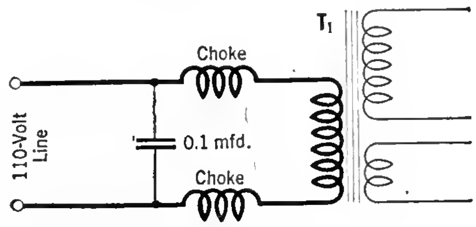
more compact, and more easily constructed coil, can be made from an old audio transformer core. The one used in the amplifier shown photographically on this page and schematically in Fig. 2, is wound on the core of an old type 231 General Radio audio transformer. Any transformer core of equal or greater cross section (½″ x ½″) will prove satisfactory. The coil consists of from 6000 to 8000 turns of No. 34 enamel covered wire, random wound. In assembling the core, the core pieces should be so stacked as to provide a slight air gap.

It will be noticed that the home-constructed transformers and chokes used in the amplifier shown on this page are not shielded. It will also be noted that the transformer is not placed very close to the choke coils and that it is placed in such a manner relative to the choke coils so as to provide a minimum of coupling for stray electromagnetic flux. There is generally quite a field of stray or leakage flux in the immediate neighborhood of a home-constructed transformer, unless the core is exceedingly well made. Should this flux link with the turns of the choke coils, an alternating voltage will be set up across the terminals of the chokes, and so produce a hum in the output of the radio set.

Undesirable magnetic coupling between the transformer and choke coils can be eliminated in either of two ways. One is that utilized in the construction of the model shown here, *i. e.*, the wide separation between the different units, and the other is the complete shielding of the transformers and chokes as shown in some of the models using commercial parts, such as the one shown on page 492, using General Radio power transformer and double choke units. In order to be effective, this shielding should consist of completely closed boxes of sheet steel of not less than 25 mils in thickness. These boxes, or containers, must be sufficiently large so as not to come closer than within ½ inch of any part of the transformer or choke cores, and of course, they must be grounded.

The following is a list of parts employed in the construction of the home-made amplifier-power supply device described here (other parts similar in electrical characteristics can be used):

T_1—Transformer, L_1—Two Choke Coils, L_3—Output Choke } Home-made	$ 5.00
C_1, C_2—Filter Condenser Block (Polymet)	11.50
C_3—Three Coupling Condensers, 0.1 Mfd. (Polymet)	1.80
C_4—Output Condenser, 4-Mfd. (Polymet),	3.50
C_5—Bypass Condenser, 1 Mfd. (Polymet)	1.00
4 Eby Binding Posts	.60
R_1—Centralab Radiohm, Variable, 0–2000 Ohms	2.00
R_2—Centralab Radiohm, Variable, 0–25,000 Ohms	2.00
R_3—Centralab Radiohm, Variable, 0–500,000 Ohms	2.00
Yaxley Open-Circuit Jack	.50
3 Lynch Double Mounts	1.50
Lynch Single Mount	.35
R_5—Elkay Equalizer with Mount, No. 2	.75
R_{10}—Three Durham Metalized Filament Resistors, 0.1 Meg.	2.25
R_{11}—Durham Metalized Filament Resistor, 0.25 Meg.	.50
R_{12}—Durham Metalized Filament Resistor, 0.5 Meg.	.50
R_{13}—Durham Metalized Filament Resistor, 1 Meg.	.50
R_4—Durham Metalized Filament Resistor 0.05 Meg.	.75
R_6—Tobe Veritas Fixed Resistance, 10,000 Ohms	1.10
Base-Board, Wire, Fahnestock Clips, Etc.	1.00
Two High-Mu Tubes	5.00
UX-171 Tube	4.50
TOTAL	$48.60



R. F. Chokes are approximately 200 millihenries (1500-turn Honeycomb coils)

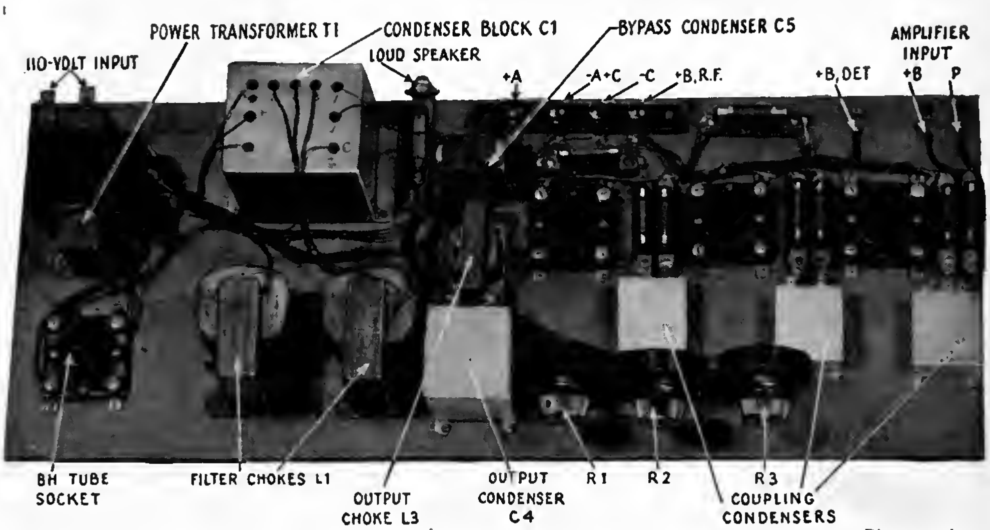
FIG. 3

Frequently, in outlying districts, difficulty is encountered due to the introduction of radio frequency disturbances into the radio receiver, via the power unit, from the local power line. Although this condition generally presents a problem for local solution, a general cure may be accomplished in a good many instances by the introduction of the arrangement of choke coils and condensers in the power line, close to the transformer, shown in Fig. 3.

LINE BALLAST LAMPS

THE UV-876 and 886 Radiotron ballast tubes, as used in the Radiola 30, the RCA 104 loud speaker, and several of the Victor and Brunswick electrically operated phonographs, are for the purpose of automatically adapting these devices for operation on power supplies of different line frequencies and voltages, rather than, as their name might indicate, serving to counteract fluctuating line voltages. While they will compensate, to a marked degree, such line fluctuations, this compensation is not at all necessary where B and C power is obtained from the same power-supply device, as variations of the one automatically tend to neutralize or counteract any harmful results which might be caused by variations of the other. The tubes were designed for use with one particular amplifier and power supply and not for experimental or home construction purposes. For this reason it is not advisable to attempt to use one of the Radiotron ballasts in a home-constructed power unit for not only will the construction become somewhat involved, due to the necessity of rebuilding the power transformer for a 60-volt instead of a 110-volt supply and of "loading" the secondary circuit until the primary current is of the proper value, but nothing is gained where the device is to be used in any one locality. Whether the line voltage is 105 or 120 makes no real difference in the performance of a home-constructed amplifier, for the various B and C voltages are obtained by means of variable resistors which may be adjusted to supply the desired voltages.

There is one position in which the line ballast tube is of real service, other than that of making a power unit readily adaptable to power lines of different frequency and voltage, and that is in connection with an A, B, C, unit, such as was described by B. F. Roland in the October, 1926, issue of RADIO BROADCAST. In this instance, it is extremely important that the filament current for the 199 tubes does not fluctuate to any appreciable extent with variations in line voltage. The line ballast tube will reduce these fluctuations to a negligible amount.



RADIO BROADCAST Photograph

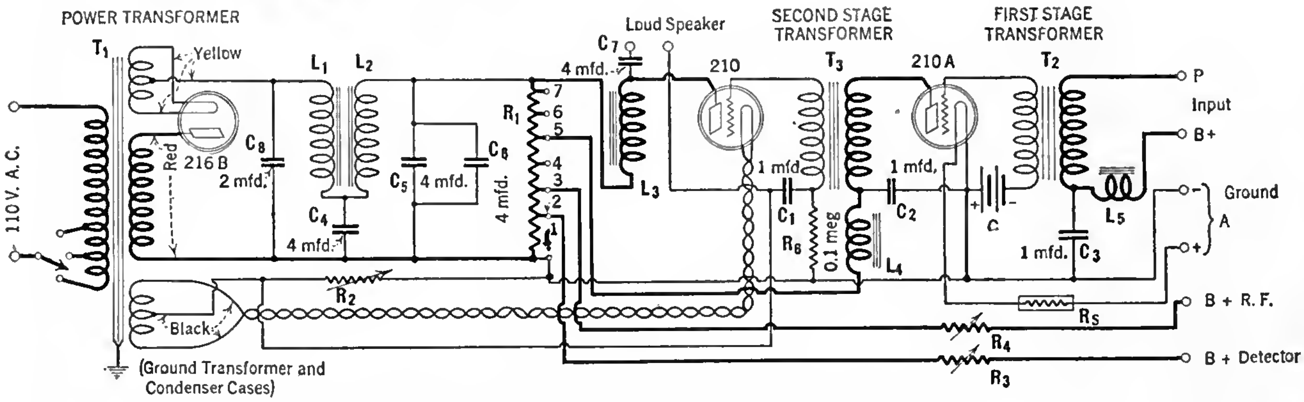
THE HOME-MADE AMPLIFIER-POWER SUPPLY DEVICE

The schematic diagram of which is given at the top of this page, in Fig. 2. The Polymet condenser block contains the two buffer condensers, C_2, in addition to the others required in the power side of the device

Radio Broadcast Photograph

THE LIST OF PARTS

T_1—Amertran Transformer, Type PF-52	$18.00
R_1—Amertran No. 400 Resistor	7.50
L_1, L_2, L_3—Three Amerchokes, Type No. 854	12.00
T_2, T_3—Two Amertran Deluxe Transformers	20.00
R_2, R_3, R_4—Three Clarostats	6.75
R_5—Elkay No. 4 Equalizor and Mounting	.75
L_4, L_5—Two Samson Audio Chokes, No. 3	6.00
R_6—Lynch Fixed Resistor, 0.1 Megohms	.75
C_1, C_2, C_3—Three Tobe 1-Mfd. Bypass Condensers, No. 301	3.75
C_4, C_5, C_6, C_7—Four Tobe 4-Mfd. Power Pack Condensers, No. 604	28.00
C_8—Tobe 2-Mfd. Power Pack Condenser, No. 602	4.00
Carter Short Jack	.25
Eveready C Battery, No. 771	.60
Six Binding Posts, with Strip	1.00
Three Airgap Sockets	2.25
Base-Board	.75
UX-210 Tube	9.00
UX-201-A Tube	1.75
UX-216-B Rectifier Tube	7.50
Lynch Single Resistor Mounting	.35
TOTAL	$130.95



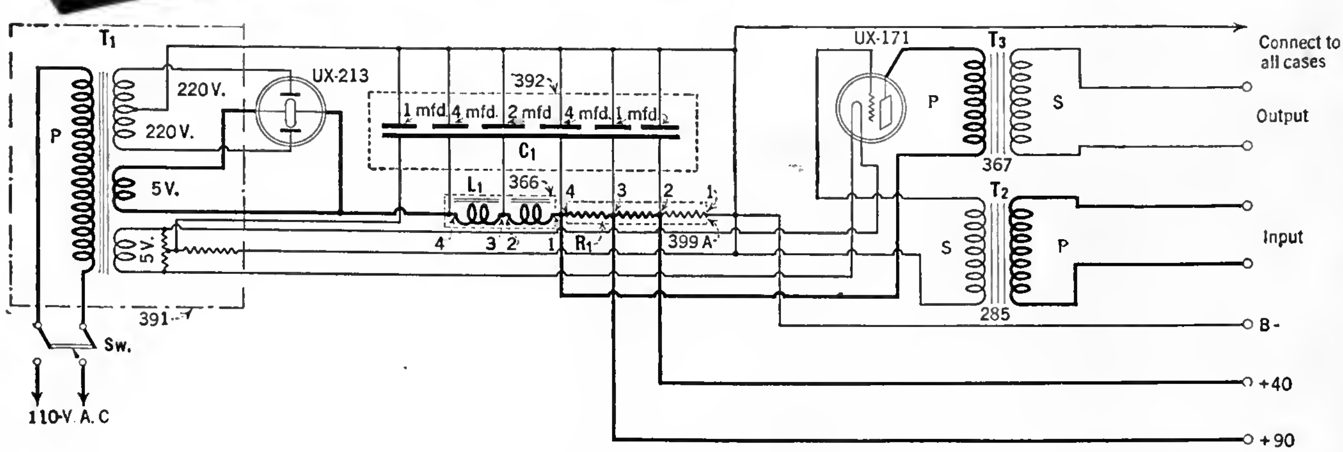
A HIGH-VOLTAGE A.C. OPERATED POWER AMPLIFIER

Which employs the 216-B as a rectifier and a 210 power tube in the last stage. Filament current is supplied from the a. c. mains for the last tube, as is also the grid voltage. The circuit gives the connection and values of the different apparatus. A preferred arrangement of this amplifier, using an UX-171 output tube, was shown in the upper box on page 385 of the February Radio Broadcast

Radio Broadcast Photograph

THE LIST OF PARTS

T_1—General Radio Power Transformer Unit, Type 391
C_1—General Radio Condenser Block, Type 392
L_1—General Radio Choke Block, Type 366
R_1—General Radio Voltage Tap Resistance, Type 393A
T_2—General Radio Input Audio Transformer, Type 285
T_2—General Radio Output Transformer, Type 367
2 Sockets
Sw—1 D. P. D. T. Snap Switch
7 Binding Posts, with Terminal Strip
1 Base-board
1 Attachment Plug and Cord
1 UX-171 Tube
1 UX-213 Tube
These parts may be obtained in kit form, price $47.50 without tubes



A ONE-STAGE AMPLIFIER-POWER SUPPLY DEVICE

Employing an UX-213 tube as a rectifier and an UX-171 as an amplifier tube. Plate current is supplied for the tubes in the main part of the receiver. The various elements enclosed in dotted lines in the circuit diagram indicate that such may be obtained in one unit. The photograph shows the general layout of the amplifier unit. This amplifier is particularly adaptable to the "Universal" Receiver

Equipment for the Home-Constructor

How to Use Some of the New Equipment Tested and Approved by the "Radio Broadcast" Laboratory

By THE LABORATORY STAFF

THE first articles of new equipment to be described this month are the chokes, impedances, and transformers made by the Samson Electric Manufacturing Company, and which are illustrated on this page. These various pieces of apparatus were tested in the Laboratory and some data are given below with regard to their characteristics and uses:

TYPE 85—This is a small radio-frequency choke coil satisfactory for use in filtering out of a circuit any radio-frequency currents. Three of these chokes were tested in the Laboratory and gave an average inductance of 90 millihenrys and an average resistance of 220 ohms. The impedance of these chokes to the lowest radio frequency used by any broadcasting station is approximately 283,000 ohms. Their impedance at the highest audio frequencies, say 8000 cycles, is only 4500 ohms, approximately, which is negligibly small in comparison with the impedance of an audio transformer. Two of these choke coils were used in the two-tube shielded "Lab" receiver which was designed and constructed by Mr. John B. Brennan, one of them being located in the radio-frequency stage and the other in the plate circuit of the detector tube. These r.f. chokes measure about $1\frac{1}{2}''$ long and are about the same height. They are supplied with both soldering lugs and binding posts. Price $2.00.

TYPE 125—This choke coil is similar to the type 85 and can be used for the same purposes. Three of these chokes gave an average inductance of 200 millihenrys and an average d.c. resistance of 400 ohms when measured in the Laboratory. Home-constructors unfamiliar with chokes and their uses might consider a resistance of 400 ohms to be too high, but this is not so. Suppose we had a 201-A tube in an r.f. amplifier, operating with 90 volts on the plate and a $4\frac{1}{2}$-volt C battery. The plate current would be about 0.002 amperes. Now, if we wanted to keep the r.f. currents out of the B battery we would put a choke coil, K_1 in Fig. 1, in the plate circuit of the tube, and then bypass the r.f. currents to the filament with the condenser C_1. If the choke coil was a type 125 its impedance at 500 kilocycles would be 627,000 ohms. Its impedance, being proportional to the frequency, would be even higher at higher frequencies.

The drop in plate voltage across this choke coil will be equal to the plate current (0.002 amperes) times the d.c. resistance (400 ohms). The loss in plate voltage then figures to be 0.8 volts, which is an insignificant amount. This is the only effect of the choke coils resistance (not impedance), that is, to cause a loss in plate voltage, and an ordinary resistance could be used with equally effective results were it not for the comparatively high loss in plate voltage which it would cause. If a resistance were to be used, it would be necessary to employ one with a value of 627,000 ohms, and then the loss in plate voltage would be 627,000 x .002 = 1254 volts. To impress 90 volts on the plate would require a battery with a voltage of 1254 + 90, or 1344 volts! Hence a resistance is entirely unsuited. If you ever want to arrange a receiver so that the radio frequency currents in the plate circuit are kept out of the battery, use a choke coil and never a resistance. Price $2.25.

TYPE 3—This choke coil is for use in filtering audio frequency currents out of any circuit. The average inductance of three samples proved to be 3.1 henrys, and the average resistance, 586 ohms. These choke coils are suitable for use in audio frequency circuits whereas the other choke coils are designed for radio-frequency circuits. Two points at which these chokes might be used are indicated in Fig. 1, K_2, where they function to prevent, to a considerable extent, coupling in the plate supply which might cause howling. These chokes are usually unnecessary when the amplifier is supplied from B batteries but are frequently of value if a line power-supply device is used for the plate supply. They measure about 4" long. Price $3.25.

TYPE D—This is a dual impedance made in accordance with the Donle design. Three of them can be used in constructing a three-stage high-quality audio amplifier. Price $5.00.

TYPE G—This is a grid impedance satisfactory for use in the grid circuits of an impedance-coupled amplifier. Price $4.50.

TYPE P—A plate impedance of this type may be used in the plate circuit of an impedance amplifier, and an excellent double impedance amplifier may be made up using type P impedances in the plate circuits and type G impedances in the grid circuits. Price $4.50.

TYPE O—This is an output impedance to be used in eliminating the direct current from the windings of a loud speaker. A fixed condenser with a capacity of two microfarads or more must be used in conjunction with this output device. See Fig. 1. Note how the audio currents indicated by the dotted lines flow directly back to the filament and do not pass through the battery. Price $5.00.

SYMPHONIC TRANSFORMERS—The Symphonic audio frequency transformer is a comparatively new product of the Samson Company put on the market to supply the home-constructors' demand for a very high-quality unit. The transformer is enclosed in a brushed copper case which gives it a very nice appearance.

Two of these units were used in an amplifier constructed in the Laboratory, and proved very satisfactory. The amplifier which was constructed is illustrated on page 494 and it was used with good results in conjunction with several different receivers, including the R.B. "Lab" two-tube shielded receiver. The price of the Symphonic Transformers is $9.00 each.

In connection with the use of the above-mentioned Samson apparatus we would suggest that interested home-constructors write to the Samson Electric Manufacturing Company and obtain from them their booklet entitled *Audio Amplification.* This booklet, costing twenty-five cents, contains a great deal of information regarding circuits using the apparatus described here.

RADIO BROADCAST Photograph

A GROUP OF SAMSON APPARATUS

The No. 3 choke is in the foreground and the small choke in the rear is a type 125. The grid impedance, type G, is on the left. The other impedances made by Samson are similar in appearance

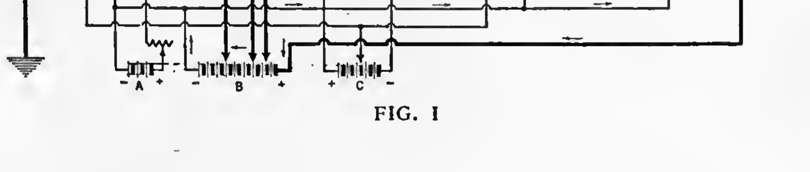


FIG. 1

B POWER-SUPPLY DEVICE

THE Greene-Brown Company's B power-supply device is an excellent unit capable of supplying sufficient voltage for the operation of an ordinary radio receiver using a 171 type tube in the output.

A photograph of this plate supply unit is shown on page 494. It is equipped with a high-voltage tap for supplying a power tube such as the 171, and an intermediate voltage tap for the other audio and radio frequency stages and a third tap for supplying the detector plate voltage. The voltage at both the detector and intermediate taps is variable so that any desired voltage can be obtained. There is a terminal on the front of the device to which a ground may be connected. This unit uses a QRS double-wave rectifier tube of the filamentless type. A rectifier of this type has a very long life so that no replacements should be necessary for many months of service.

In testing these devices, the Laboratory frequently resorts to the use of the oscillograph. The oscillograph is an electrical instrument which will show visibly whether there is any residual ripple in the output voltage of the device. This plate supply unit showed a perfectly flat output on the oscillograph. The curve is shown in Fig. 2, and for purposes of comparison, we show alongside of it a curve taken on a power-supply device which is about two years old. The ripple, shown up by the oscillograph, would make this old device very unsuited for use in conjunction with present-day amplifiers. The Greene-Brown unit, with its flat output characteristic, can be used without any danger of an audible hum in the output of the receiver. Both of these curves were made when the devices were delivering a 20-milliampere load.

A POWER SUPPLY DEVICE

Made by the Greene-Brown Manufacturing Company. Price, $39.50

Radio Broadcast Photograph

Radio Broadcast Photograph

AUTOMATIC POWER RELAYS

The device on the left is made by the Jewell Electric Instrument Company. That on the right by the Yaxley Mannfacturing Company

AUTOMATIC SWITCHES

TWO automatic switches, the Yaxley ($5.00) and Jewell, are shown in a photograph on this page. They are for use in conjunction with a receiver when the plate voltage is obtained from a power-supply device and a trickle charger is used in conjunction with the storage battery. These switches are similar in construction and design to the Brach Controlit described in the February issue on page 379.

These switches make the operation of a radio installation automatic, and decrease the amount of attention which must be given to the various pieces of apparatus, as the switching on and off of the various power units is automatically accomplished. The 110-volt a.c. supply is connected to the cable on the switch. The cable from the trickle charger connects to one plug on the switch and the power cable on the power-supply device connects to another plug. When the set is turned on, the switch automatically connects the 110-volt supply to the power-supply unit and disconnects the trickle charger. Turning the set off actuates the switch so that the trickle charger is turned on and the power supply turned off. The filament switch on the receiver controls the entire installation. These switches are easily wired into the circuit. They consume no power and are fool proof.

TRICKLE CHARGER

THE France Manufacturing Company makes a non-acid chemical trickle charger which will supply current to a storage battery at a rate of ½ ampere. Price, $10.00. This trickle charger, shown in an accompanying photograph, is constructed in a very simple manner so as to make all the parts easily accessible.

For the benefit of those readers not familiar with trickle chargers, such a device consists of a small transformer connected, in this case, to an electrolytic rectifier, the combination being capable of supplying about ½ ampere to a storage battery. The trickle charger is turned on whenever the radio set is not being used, and the storage battery thereby kept in a fully charged condition. As we do not always remember to turn the charger on and off, it is worth while to install a device that will automatically do this. Therefore, this trickle charger might be used very satisfactorily in conjunction with either the Yaxley or Jewell switch mentioned above, to make a radio installation requiring practically no attention, except to add a small amount of water to the trickle charger and battery every few months.

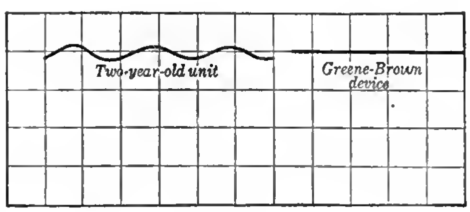


FIG. 2

CABLE CONNECTORS AND CONVENIENCE OUTLETS

IT IS becoming increasingly common to find the radio receiver installed in the living room, and the power amplifier and batteries down in the basement. To connect these two installations together the products of the Yaxley Company will be found valuable.

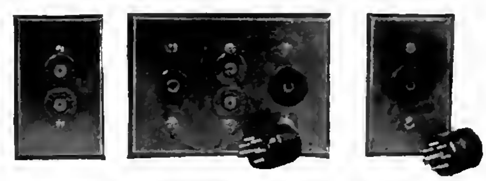
Radio Broadcast Photograph

A TWO-STAGE AMPLIFIER

An amplifier made up using two Samson Symphonic transformers

One of their cable connectors, No. 670, might be attached to a receiver with the leads from the radio receiver connected to the cable terminal plug on the convenience outlet No. 350, shown in the center of the picture, the convenience outlet being mounted in the baseboard in the living room at a point convenient to the receiver. Leads then pass down the walls of the house or through a hole in the floor into the basement, where they might terminate in another convenience outlet.

Leads from this outlet are then connected to the batteries and to the input of the power amplifier, while the output of the power amplifier can then be again brought up to the convenience outlet located in the living room and connected to the loud speaker jack on the outlet. The batteries in the basement may be controlled by an automatic switch so that the entire installation is automatic in operation.



Radio Broadcast Photograph

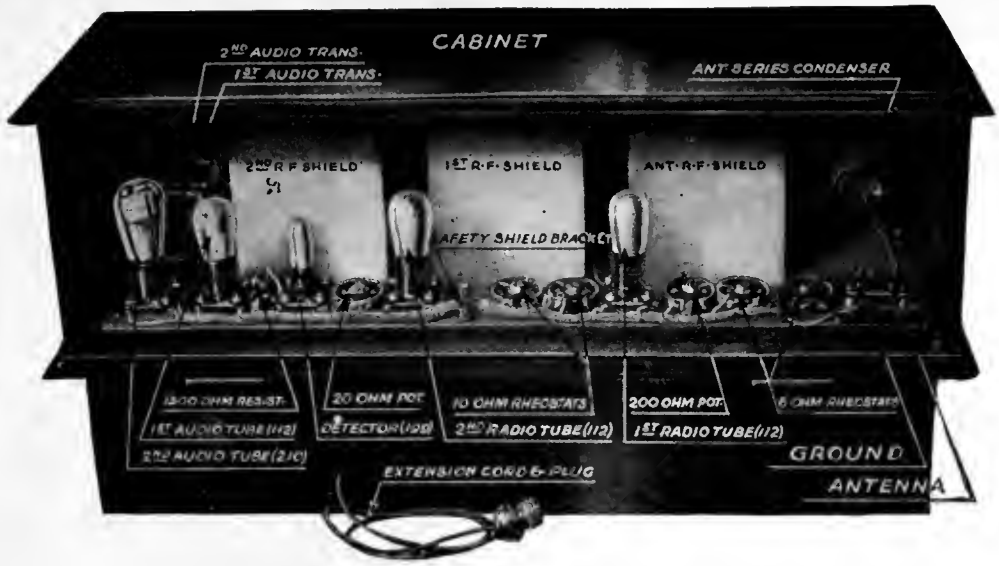
YAXLEY CONVENIENCE OUTLETS

The No. 136 outlet illustrated at the left has two terminals—for the antenna and ground. The type 350 in the center has, besides these two terminals, a telephone jack and a cable connector plug. The type 137 at the right contains only a cable connector plug. Prices, $1.00 to $4.50

The No. 670 cable connector contains seven leads, all of them differently colored and marked with cable markers. The leads are marked as follows: A+, A—, B+ Det., B—, B+ Amp., and two blank leads that may be used for C battery connections.

Radio Broadcast Photograph

THE FRANCE TRICKLE CHARGER



AN INTERIOR VIEW OF THE GAROD EA RECEIVER
Note the neat cabled wiring at the rear of the sub-panel

A. C. as a Filament-Supply Source

A Description of a Popular Commercial Receiver—the Garod Model EA—Which Is Operated Entirely from the A. C. Mains

By B. F. MIESSNER

Chief Engineer Garod Corporation

THE operation of radio receivers directly from the a. c. house mains has always been a problem which has greatly interested radio engineers. After extensive research, and the accumulation of a great amount of data, the problem of design has been solved in a few instances. Whether a. c. operation will entirely supplant other means of powering the receiver is a question which will have to be left for the future.

Of the tubes in commercial use, the 112 type has been found to lend itself most readily to a. c. operation. This is due, in the most part, to the heavy oxide coated filament which does not fluctuate so much in temperature with the alternations of the current. By using the correct grid, plate and filament voltages as previously shown, the operation of such tubes is entirely satisfactory. As yet, no completely satisfactory means have been devised to use a detector supplied directly by a. c. To take care of this, it is customary that one of the 199 type tubes be used, its filament being energized by the total plate current of the other tubes in the receiver.

In the February issue of RADIO BROADCAST was discussed, with the help of curves, the different types of tubes and their characteristics under actual a. c. operation. The preceding article also dealt thoroughly with the different causes of hum and the methods of eliminating it. The present article will take up the practicable application of a. c. operation to a commercial receiver.

The Model EA Garod receiver has been designed and produced to meet a growing need for a receiver in which all batteries are eliminated, and with a much finer and fuller tone quality than has hitherto been available. The receiver is of the neutrodyne type, employing five tubes in the receiver and one rectifying tube in the a. c. power supply unit. It is made under licenses from Hazeltine and from the writer.

The power conversion system does two things; first, it develops an alternating current suitable for excitation of the filaments of the amplifier tubes, and second, it develops a direct current for supplying the plate current of all the tubes and the filament current of the detector tube.

The power-supply unit is mounted in the table portion of the receiver, and is entirely enclosed in an enameled sheet-iron box. The top and sides are removable as a whole without disturbing the enclosed apparatus which is mounted on the base-board. The opening or lifting of the lid opens an automatic safety switch which cuts the line circuit so that the user can not make accidental contact with high voltage terminals. The unit is designed to operate on a. c. lines of 60 cycles, 110 to 125 volts. It will not operate on 25 or 40 cycles, or on direct current, but seems to operate satisfactorily on a 50-cycle line.

To provide for voltages which differ slightly from the usual 110-volt standard, the transformer primary is tapped at different points which are designed to take care of any voltage variation in the mains and still provide the same value of voltage for the vacuum tubes.

There are three secondary windings on the power transformer, one of 7.5 volts and 3 amperes for exciting the filaments of the amplifier tubes in the receiver; another of 7.5 volts and 1.5 amperes for exciting the rectifier tube filament; and a third of 525 volts and 60 milliamperes for providing the a. c. for rectification of the B supply power.

To prevent the passage of electrostatic disturbances from the lighting circuit to the receiver circuits, a shield winding is provided, consisting of a layer of wire insulated from, and between, the primary and secondary windings of the transformer. One end of this winding is connected to the transformer clamping frame and grounded through the power box and receiving set ground.

The line current from the house lighting socket enters the power box through the attachment cord provided, one wire of which has connected in it the operating switch mounted on the front of the table. This side of the line is connected through one of the fuses on the output terminal board to one side of the transformer primary. The other side of the line enters the power box and connects directly to the other fuse, and from this through the automatic switch, to the other side of the transformer primary. These fuses are provided to protect the power converting equipment from overloading, which might result from excessively high line voltage, or from connection to direct-current or 25-cycle lines, which would produce excessive current in the transformer, and which might burn it out.

House lighting fuses ordinarily are of 15-ampere capacity, and would provide no protection whatsoever for the power equipment. The power consumed by this receiver is approximately 100 watts, the primary current being about $\frac{9}{10}$ of an ampere at 110 volts. The fuses are rated at one ampere and will open the circuit should the primary current of the transformer exceed one ampere. No apparatus other than the A winding on the transformer is necessary for providing the filament current. The system, therefore, is exceptionally simple in this regard, as no conversion system from alternating current to direct current, such as is used in most power driven receivers, is necessary. The power equipment provided is used chiefly for B power of high voltage and high current capacity, which is so desirable in providing distortionless reproduction at the required volume.

The B supply portion of the power equipment consists of the rectifier tube, the high-voltage secondary winding of the transformer, the choke coil, several condensers, and resistors.

The rectifier tube and transformer winding together provide a half-wave rectifier for the a. c. supply, and the filter system converts this rectified a. c. into practically pure direct current. Directly across the rectifier output is a 4-mfd. condenser which is flash tested at 3000 volts before assembly at the factory. Its purpose is to provide a reservoir for d. c. energy and a bypass for a. c. energy.

In series with the positive side of the filter line is the choke coil marked A in the accompanying diagram. It is a 50-henry choke having two air gaps of 0.01 inches formed by ten-mil paper between the laminations forming the two halves of the choke coil's magnetic circuit. This choke coil has a resistance of approximately 600 ohms and consists of about 7000 turns of copper wire.

Across the filter line, on the output side of the choke, is another 4-mfd. filter condenser which functions as a d. c. reservoir and as an a. c. bypass to further smooth out the ripple of the rectified current. The voltage across the first 4-mfd. condenser should measure approximately 400 volts (r. m. s.). The actual peak value of the voltage across this condenser is approximately 525 volts. The second 4-mfd. condenser has approximately 364 volts (r. m. s.) across it, and its rated operating voltage is 600 (the same as the first one).

The plate supply of the second audio or power tube is taken from the filter output on the output side of this filter choke coil. A reduced B voltage is obtained for the radio- and first audio-amplifier tubes of the receiver by connecting in series with their plate supply a 5000-ohm resistor. This resistor is at the front of the power box at the right-hand side. To ventilate it properly, holes have been provided beneath it and above it in the power box lid so that air may circulate and prevent overheating. These same holes also provide for ventilation of the rectifier tube.

Directly across the filter line, between the B and the output side of the 5000-ohm resistor, is a 100,000-ohm fixed resistor which is located in the rear right-hand corner of the output terminal board. It is soldered in the connecting clip provided for it. This resistor prevents excessive voltages in the filter circuit when the set load is taken off by the removal of all the tubes.

To the left of the 100,000-ohm resistor is a 500,000-ohm one of similar type mounted in the same manner, which provides a plate current of reduced voltage for the detector tube. The voltage of the input side of the 500,000-ohm resistor, or directly across the 100,000-ohm resistor, is the voltage which feeds the two radio- and the first audio-amplifier tube plate circuits. It should measure about 150 to 175 volts, depending upon the adjustment of grid voltage for these tubes, as will be explained later.

Across the output side of the 500,000-ohm resistor supplying the detector plate circuit is a 1-mfd. condenser whose function it is to still further eliminate the slight alternating current ripple superimposed upon the direct current output of the filter system. Inasmuch as the audio frequencies of the plate circuit of the detector tube are twice amplified, that is, by the first and second audio tubes, the plate circuit supply for the detector tube must be perfectly smooth and without any variation.

THE OUTPUT DEVICE

INCLUDED in the power box assembly, besides the power conversion equipment proper, is the output choke (B in the accompanying diagram) together with a 1-mfd. condenser, the two combining to form an efficient output device for the protection of the loud speaker and to better quality. The plate circuit of the second audio tube is fed from a point on the output side of the filter choke, A, through the output choke B. This latter choke is, of course, connected in series with the lead to the plate circuit of the second audio tube.

The output choke for the loud speaker coupling is mounted on the rear side of the transformer. Air gaps in the two choke coils are provided for the purpose of giving maximum inductance to the chokes at the particular value of direct current flowing through the coils. If the air gaps provided by the paper spacers were omitted entirely, magnetic saturation of the iron core would result, and this would produce a considerably lower inductance in the coil than if saturation did not occur. It has been found that, for a given amount of direct current in the coil, a definite size of air gap will provide the maximum amount of inductance. Choke A, which must carry about 60 milliamperes of direct current, requires a considerably larger air gap than the choke B, which carries only the plate current of the second audio tube (approximately 25 milliamperes).

A COMMERCIAL A.C. OPERATED RECEIVER
It is the Garod EA receiver, the circuit diagram of which is shown on the following page

The two 4-mfd. filter condensers, the detector bypass condenser, and the 1-mfd. loud speaker output condenser are all mounted in a condenser unit installed beneath the output terminal board.

The terminals on the power box are arranged for connection to the cable leads coming downward from the receiver.

The pilot light receives its illumination from the rectifier tube and thus an extra lamp for this duty is dispensed with. The rectifier tube socket is mounted in such a position that the majority of rectifier tubes fit in it with the long axis of the elliptical plate in a vertical position, so that no danger of a sagging filament touching the plate will be encountered.

USING A LOOP

THE radio circuit of the EA receiver, as has been stated is of the neutralized tuned radio-frequency type, consisting of two such stages, a detector, and two stages of transformer-coupled audio-frequency amplification. The receiver is designed for use with antenna and ground, and these, in as good a form as possible, should always be used. In locations, however, where it is impossible to put up an outdoor antenna, an indoor antenna or a portable loop may be used. A loop may be connected directly across the antenna and ground binding posts and should be tuned by means of the radio-frequency volume-control knob (left-hand small knob) which operates a series tuning condenser.

In some localities, where many powerful broadcasting stations are located and interference is troublesome, a loop may be preferable to an outside antenna. By tuning the loop, and by virtue of the directional effects obtained by turning the loop, selectivity of a considerably higher order is obtained over that of an outside antenna. The range, however, is reduced.

When an antenna is used, the series antenna condenser is of great service in controlling the radio-frequency input to the receiver. It is also possible, by means of this condenser, to change the electrical length of the antenna within wide limits so as to change the overall selectivity of the receiver. When the condenser is all in, it is short-circuited so that the full antenna pick-up is available. As its capacity is decreased, the energy transfer is decreased, and the selectivity of the receiver is increased, in the same manner as if the actual physical length of the antenna itself were reduced.

Coupled to the antenna through the first radio-frequency transformer primary is the tuned input, or grid circuit, to the first radio-frequency tube. A bypass condenser of 0.006 mfd. is connected between the low-potential side of this grid circuit and the filament for the purpose of bypassing radio-frequency currents which otherwise would be compelled to flow through various portions of the receiver, including particularly the grid biasing resistance common to the plate circuits of the receiver.

The plate circuit of the two radio-frequency tubes is bypassed by a 0.01-mfd. condenser to the filament circuit for the same purpose as the grid bypassing condenser. The radio-frequency transformers consist of low loss bakelite tubes upon which are wound the primary and secondary coils of the transformer.

In the operation of the vacuum-tube filaments on a. c., it is necessary to use negative biasing on the grids to eliminate a certain type of disturbing hum which would otherwise be produced. The biasing necessary for this purpose, and for the normal biasing required for the audio tubes to prevent distortion, is obtained from the voltage drop across the resistors in the negative leg of the B supply to the filament circuit. The normal biasing voltage for the first and second radio stages and first audio stage is obtained from the voltage drop across the 200-ohm variable resistor in the receiving set on the right-hand side of the first radio tube socket.

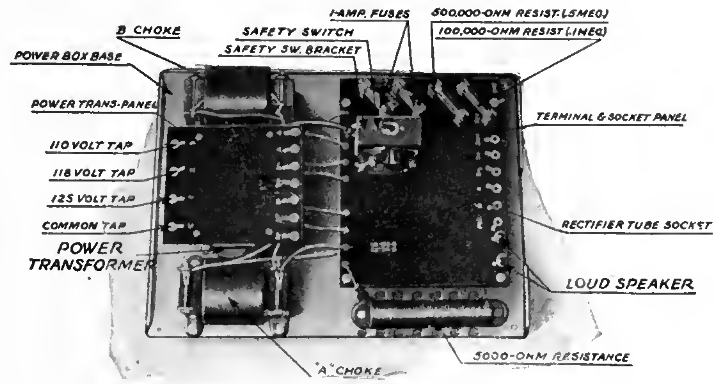
Since the total plate current of all the tubes of the receiver passes through this resistance, and since this resistance is variable, the biasing on these tubes may be controlled by a variation of this resistance. Its chief value is in the control over the total plate current which energizes the detector filament and which control makes it possible to change the natural vibration period of the detector filament. It is found that a small percentage of the 199 detector tubes, even with the use of the best obtainable cushion sockets, will pick up energy from the loud speaker and develop an audio frequency or acoustic howl between the detector and loud speaker. If the loud speaker is resting in its normal position on the top of the receiver cabinet it is possible to eliminate this howl by a small change in the 200-ohm biasing resistance. This will change the filament current in the detector tube, and so alter its natural vibration period that the sound energy fed back will be out of phase with the vibration in it, and thus stop the howl. The detector filament, as before explained, is inserted in the negative B lead and is energized by the total plate current (approximately 60 milliamperes), of all the amplifier tubes in the receiver. Across this detector tube filament is connected a fixed resistor of 1000 ohms which will maintain the B circuit should the detector tube be pulled out while the set is in operation. A sudden interruption of the circuit by the removal of the detector tube will produce a high inductive voltage across the choke coil which would be impressed upon the filter condensers, and might possibly cause their breakdown were the resistance not to be included.

The first and second radio-frequency tube filaments are connected in parallel and have resistances connected in them. The first audio tube also has, in each leg of its filament supply, a variable resistor. These resistors are provided for the purpose of regulating the voltage of the tubes at the desired value below the $7\frac{1}{2}$ volts supplied by the A winding of the transformer for use directly upon the filament of the 210 power tube.

A one-half megohm potentiometer regulates the signal voltage to the first audio tube for volume control, and a one-quarter megohm fixed resistor across the second audio grid circuit adds a slight load, which improves quality.

SELECTIVITY AND DISTORTION

TESTS have proved that there is a definite point in selectivity in the radio-frequency circuit of a receiver beyond which a designer cannot go without materially increasing the distortion introduced. If the selectivity is too high, the side bands which carry the higher audio frequencies of the broadcast signals will be cut down materially, and the reproduction will suffer because of this. The EA receiver has been designed to provide as satisfactory a degree of selectivity as is possible without materially, or seriously, cutting off the higher frequencies by side-band elimination. You will find receivers which are more selective than the EA receiver, but a careful examination of reproduction quality will show that side bands are probably being cut by the more selective receiver, and that the reproduced quality is sacrificed because of it. Overall resonance curves for the whole receiver show a band width at one-half the resonant response of about 7 kilocycles at 500 meters and 15 kilocycles at 300 meters.



THE POWER CONVERSION UNIT

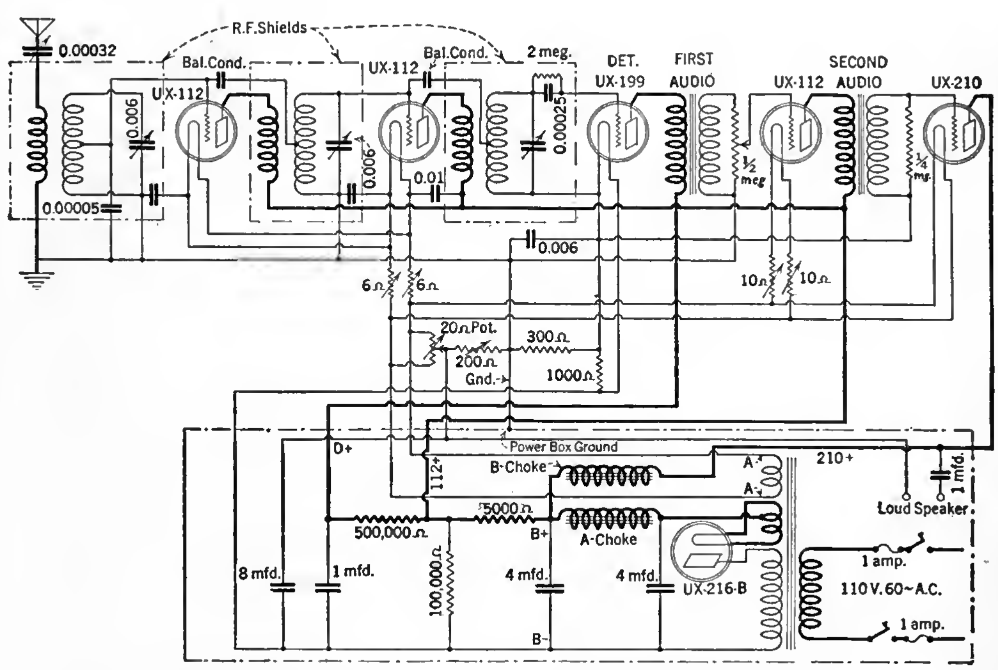
In addition to the inherent design of the radio-frequency circuits which reduces side-band cutting in this receiver, there is provided an audio-frequency amplifying and reproducing system which has been designed with utmost care for the preservation of all the frequencies present in the broadcast music. The transformers are of special construction, with a large amount of iron to prevent saturation, and coils of large dimensions to prevent the loss of high frequencies by capacitive bypass, and with windings of extremely high inductance for the preservation of extremely low tones, which form the foundation of the musical structure.

In addition to these high-quality transformers, another extremely important feature is the use of power tubes for the prevention of overloading and the reproduction of low tones at high volumes.

Even with the best of transformers it is not possible to reproduce the whole audio spectrum as transmitted by our better broadcasting stations with tubes of ordinary size and operating at ordinary plate voltages. The 210 power tube provides an undistorted output energy of approximately 100 times that obtainable with the 201-A tube and for this reason provides an amplifier of correspondingly lower distortion.

The 201-A tube will not reproduce the lower tones, necessary for satisfactory musical reproduction, at the volume levels ordinarily used in the home. A 210 tube will accomplish this result very easily and will, in addition, extend the volume many times without distortion so that practically full tone reproduction is available without distortion.

Another factor of importance in connection with the high tone quality in this receiver is the use of an output coupling device for the loud speaker. The use of a large size choke coil and a condenser as an output coupling is the simplest and best way to eliminate distortion resulting from high plate current in the loud speaker windings. In addition, the use of this coupling removes the high B voltage of the power-tube plate circuit from the loud speaker terminals and entirely prevents any danger of accidental shock from such a cause.



THE CIRCUIT DIAGRAM OF THE RECEIVER DESCRIBED

Adequate protection of the power unit from the mains is provided by the fuses

RADIO BROADCAST is the official publication of the Radio Club of America, through whose courtesy, the foregoing paper has been printed here. RADIO BROADCAST does not, of course, assume responsibility for controversial statements made by authors of these papers. Other Radio Club papers will appear in subsequent numbers of the magazine

Book Reviews

A Biography of Emile Berliner, Inventor of the Microphone—What the Radioman Should Know about Isobars, "Highs," "Lows," etc.

The Microphone in the Making

EMILE BERLINER—MAKER OF THE MICROPHONE. *By Frederick William Wile. Preface by Herbert Hoover. Published by the Bobbs-Merrill Company, Indianapolis, Indiana. 353 pages, 30 illustrations. Price, $4.00.*

WHEN Herbert Hoover writes the preface and Frederick W. Wile the text, a book is produced worthy of your notice. That the subject is Emile Berliner, one of the picturesque personalities of the past fifty years, assures interest to the reader—and profit, also, if one would learn from history in its most attractive form of biography. Emile Berliner aided two arts with important inventions at strategic moments in their early days, the art of the telephone in 1877, and that of the phonograph ten years later.

Inventions, whether of means or methods are, broadly speaking, products of evolution; they arise like brachiopods, Java men, or four-toed horses from antecedent conditions. Given a suitable and general state of scientific knowledge, the induction motor and the telephone, insulin and permalloy, the quantum theory and relativity, are inevitable, although the name of the inventor will depend on accidents of native ability, personal interest, and background of experience. Individual credit is not thereby lessened; genius is enhanced, not diminished, by a timely setting.

For the genius of Emile Berliner, the early days of telephony and of the phonograph provided the timely environment. These arts had been created, respectively, by Alexander Graham Bell and Thomas A. Edison. For both arts, the stage was set by the existing knowledge of electricity, although both had resisted previous efforts of other inventors. To Bell had come the accomplishment of the telephone through a happy combination of clear thought and laboratory discovery—the latter arising from the transmission of the twang of a vibrating-reed armature and the former a recognition, which would be expressed in our modern terms by saying that a carrier current must be modulated in exact conformity to the speech significance which is to be transmitted.

The only carrier current of those days was that of zero frequency, being the direct current conveniently derived from batteries. Its modulation, as we now recognize, is possible whenever through speech there is correspondingly varied, in a circuit containing a battery, either inductance, resistance, or capacity. Capacity variation is relatively inefficient; and the development of a condenser-transmitter therefore awaited the more timely setting of the present days of vacuum tube amplifiers. Inductance variation is not nearly so inefficient, and with it no battery is required, provided what is varied is the reluctance of the magnetic path of a permanent magnet which links with the transmission circuit. This method—that of the electromagnetic transmitter—was Bell's earliest system; although insensitive, it was peculiarly adapted to his discovery, for the same mechanism may be used interchangeably to convert current variations into a relative motion of the magnet and its armature, that is, to act as an electromagnetic receiver.

Historically, modulation by varying the resistance of a circuit came last. In one form, however, it came promptly; for Bell's first complete sentence was effected by an electrolytic transmitter in which a plunger, actuated by the diaphragm of the transmitter, vibrated more or less deeply into an electrolyte. Such was the art when it aroused young Berliner to intensive experiment and eager study, who already had his time well filled with earning his living and with efforts to learn the manners, customs, and language of America. And he won through, with a variable-contact resistance and a conception of possible multiple contacts, which proved a patent of value because other and famous inventors were following similar lines. Edison, for example, he beat in filing date by thirteen days; but the story of his invention and its later litigation is too exciting and too well told to be abstracted.

A coincident contribution which Berliner made to the telephone may best be described in its modern terms as "carrier suppression in direct-current carrier circuits." Working for two-way transmission, and curiously enough, attempting to use his variable-contact resistance device both as a transmitter and as a receiver, he found it necessary to employ local batteries and to couple the local circuits through transformers to his main transmission line. The modulated direct current of the local transmitter circuit, therefore, induced in the main circuit an alternating current corresponding to the modulations; the transformer action eliminated the direct current. All this before the real days of alternating-current technique, at a time when transformers were induction coils used only as spark coils in giving shocks, setting off explosives, or demonstrating luminous effects of electricity. Ever since, the name "induction coil" has been used in telephone parlance for the transformer which passes the modulation of a transmitter out into the line.

After a time, Berliner left telephony and turned toward the phonograph art which Edison had initiated. In the latter's instrument, sound was recorded by a groove the depth of which was supposed to be proportional to the sound intensity. In other words, a narrow trench was dug into the wax by a cutting needle and the contour of the bottom of the trench was a succession of ups and downs, hills and valleys, the levels of which corresponded to the volume of the recorded sound, and the frequency, to its pitch. The graving tool was driven by a diaphragm upon which the sound waves impinged. Obviously, the mechanism of the system was faulty. As the diaphragm approached the end of its vibration it was required to dig most deeply into the wax; but that was impossible, because the force which it could exert grew less as the turning point of its vibration was approached.

Berliner solved the difficulty by causing the graver to trace a wavy line—in effect, an oscillograph of the sound. There was then a lateral cut of uniform depth, instead of a vertical cut of varying depth. Simultaneously, he solved the problem of the reproduction of phonograph records; for his graver cut its trace in a thin film of wax on a metal disc and thus permitted the etching of the exposed line of metal. For years, until superseded by electroplating methods, Berliner's photo-engraving process of making matrices for records was successfully employed; and that, with further developments, made the gramophone of "the gay 'nineties"—the precursor of the talking machine, which, by a cumulated series of developments, has become the Orthophonic of to-day.

JOHN MILLS.

Radio Prognostication

THE WEATHER FOR RADIO LISTENERS, BROADCASTERS, AND OTHERS: *By Eugene Van Cleef. Published by the Taylor Instrument Companies, Rochester, New York. 34 pages. 7 illustrations.* (*See booklet listed as No. 67, page 512.*)

THE conversation of two gentlemen of some literary attainments brought together at a party for the special benefit of their followers may serve to introduce a little booklet of more than passing interest on a subject of more than passing importance:

"Nice weather we're having," opened the conversation between the two.

"I never talk about the weather," was the stiff rejoinder.

"It's the only thing I ever talk about," replied the first, thereby closing the conversation permanently.

"The Weather for Radio Listeners, Broadcasters, and Others" is the booklet, and the author is Eugene Van Cleef, who needs no introduction to the readers of RADIO BROADCAST. The booklet is published by the Taylor Instrument Companies of Rochester, New York.

The weather, Mr. Van Cleef points out, as a topic of conversation should not be relegated to those who have nothing else to talk about, but should be considered as worthy of our best favored conversationalists. It is the common topic for talk among all peoples of the earth, and although most people have something to say about it, after reading Mr. Van Cleef's book, one need not be in the class mentioned by Mark Twain as those who talk a lot about the weather, but do not seem to do anything about it.

Weather affects radio reception as everyone knows, and a lot of us know that isobars, "lows", and "highs" have something to do with the matter too, but it remains for the Taylor Instrument Companies to try to explain, with Mr. Van Cleef's aid, what it is all about. This he does with considerable ability, not only stating the apparent relation between long distance reception and the barometric pressures existing over the country, but explaining something of the nature of static as well.

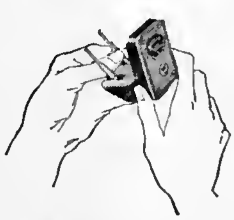
As a matter of fact, the burden of the little booklet is to interest listeners in the study of weather and its effect on radio, and it may be pointed out, for those who don't know, that the Taylor Instrument Companies have organized a vast group of widely distributed listeners who desire to have their share in undermining the secrets of good reception.

Even if one does not care to take an active part in collecting data on weather and radio, the booklet gives a good picture of how one can study weather maps with the object of prognosticating for himself the probabilities for good "DX".

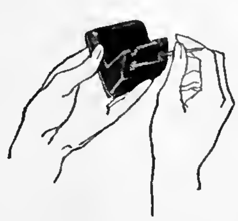
KEITH HENNEY.

This clever little "pin jack" voltmeter sets off your set!

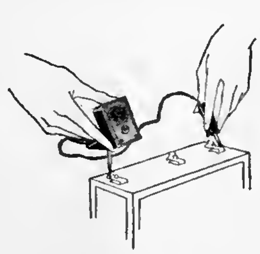
It's new, it's portable, it fits any arrangement of jacks—it's Westinghouse!



Pins screw in this way for jacks running horizontally.



Pins screw in this way for jacks running vertically.



For battery testing.

Here's a pin-jack voltmeter that really beautifies a fine set — a Radiola, a Brunswick, a Victrola, any one equipped with pin-jacks. It's the most accurate instrument of its type made. It shows you the way to long tube and battery life, and the clearest reception.

The voltmeter is attached by screwing in the pins and plugging them into the jacks of the radio. No matter how the jacks may be arranged—horizontally, vertically, or one above the other as in the Radiola 20—the pins can be set to fit them. The dial always peers up into your face—set at an angle for convenient reading.

There's no reason why a voltmeter should look like an alarm clock. There's no need for it to have leads running from the jacks to the top of your set. This one has a gold lettered dial, bronzed pointer and face plate. It is easily removable, for checking "A," "B" and "C" batteries, or for other purposes.

And how moderately priced! Two tubes prematurely burned out cost as much to replace as you would pay for a Westinghouse Voltmeter.

PRICE COMPLETE

RANGE	PRICE
(0-5 and 150) or (0-5 and 50)	$6.50
West of Rockies to Pacific Coast	$7.00

At your Dealer's.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY
Offices in all Principal Cities • Representatives Everywhere
Tune in with KDKA—KYW—WBZ—KFKX

Westinghouse

The *Radio Broadcast*

LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of RADIO BROADCAST *have until recently been answered either by letter or in "The Grid." The latter department has been discontinued. and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," appears this series of Laboratory Information Sheets. These sheets contain much the same type of information as formerly appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* RADIO BROADCAST *of much greater interest to our readers.*

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department. The first index appeared in November.

Those who wish to avail themsel ovesf the service formerly supplied by "The Grid," are requested to send their questions to the Technical Information Service of the Laboratory, using the coupon which appears on page 528 of this issue. Some of the former issues of RADIO BROADCAST, *in which appeared the first sets of Laboratory Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company at Garden City, New York.*

No. 73 — RADIO BROADCAST Laboratory Information Sheet — March, 1927

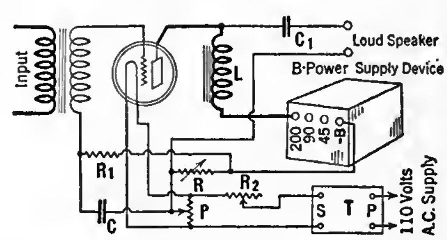
An A. C. Operated Power Amplifier

CONNECTION TO AN ORDINARY RECEIVER

MANY standard a.c. operated power-supply devices available at present are capable of supplying sufficient voltage for the proper operation of a 171 type tube. When this tube is used in conjunction with such a device in an ordinary receiver, the filament is usually lighted from a storage battery, and a dry cell is used to bias the grid of the tube. A few slight changes, however, will make it possible to light the filament of the 171 from an a.c. source and to obtain the necessary grid bias by means of a resistance in the plate circuit of the tube.

The following parts will be required:
T—An ordinary bell transformer giving about 6 volts on the secondary.
P—200-ohm potentiometer.
R—500- to 5000-ohm variable resistance.
R_1—25,000-ohm fixed resistance.
C_1—2- to 4-mfd. bypass condenser.
C—1-mfd. bypass condenser.
R_2—10-ohm rheostat.
L—Output choke coil.

A circuit arrangement such as is shown makes the one-stage power amplifier entirely independent of any local supply of energy, since all the necessary voltages are now being drawn from the a.c. power lines. In the operation of the unit, the potentiometer, P, should be adjusted to that point at which the hum in the output circuit is at a minimum. Generally it will be found that the center point of the potentiometer will give minimum hum.



The variable resistance, R, controlling the grid bias, should not be lowered to a value less than 1000 ohms. It should be adjusted to that value (something above 1000 ohms) which gives the best quality of reproduction.

No. 74 — RADIO BROADCAST Laboratory Information Sheet — March, 1927

Resistance-Coupled Amplifiers

GRID LEAK-CONDENSER COMBINATIONS

SOME information regarding resistance-coupled amplifiers is to be found in an article by Sylvan Harris published in the December, 1926, issue of the *Proceedings of the Institute of Radio Engineers*, and, incidentally, the data given in the proceedings confirm some calculations and measurements made by the Laboratory of RADIO BROADCAST about a year ago.

When a mathematical analysis is made of the resistance-coupled amplifier, it becomes evident that a very large coupling condenser need not necessarily be employed. It is the combination of the coupling condenser and the grid leak which determines the quality that can be obtained from such an amplifier. If the coupling condenser is made large, the grid leak resistance may be made small, and if the coupling condenser is small, the grid leak resistance can be increased a proportional amount, and the same frequency characteristic will be obtained in each case.

In the article in the Institute's organ, some curves were given showing the relationship between the value of the grid leak resistance and the size of the coupling condenser for a 201-A type tube. From these curves we can easily determine what value of coupling condenser must be used in conjunction with any particular grid leak, in order to obtain a certain definite frequency characteristic.

If a 100,000-ohm resistance is used in the plate circuit, the following combinations of grid leaks and coupling condenser may be used to obtain a practically flat characteristic curve down to 50 cycles:

GRID LEAK	COUPLING CONDENSER
0.2 megohm	0.06 mfd.
0.5 megohm	0.025 mfd.
1.0 megohm	0.012 mfd.
2.0 megohms	0.006 mfd.

The greatest trouble with resistance amplifiers is due to the blocking of the tubes which sometimes takes place. It is unlikely, however, that this blocking will occur unless one of the tubes is being overloaded. This makes it essential that the proper C-battery bias be used on the grids of the various tubes. It is possible to calculate the required value of the grid bias if the characteristics of the circuit and the amplification constants of the tubes are known. These calculations indicate that for a 20-mu tube the C battery bias on the first high-mu tube should not be more than 1 volt, and that 4 volts is about right on the grid of the second high-mu tube. These values are high enough to handle a grid swing of 40 volts peak value on a 171 type power tube in the last stage.

AT ONE • SPOT ONLY ON THE DIAL!

—FOR THE FIRST TIME IN RADIO HISTORY

AS EASY AS POINTING YOUR FINGER

Never before has positive *One • Spot* accuracy been combined with Greater Selectivity, Distance and Quality as in the

New

MADISON-MOORE *ONE • SPOT* TRANSFORMER

Our radio engineers have built into this marvelous transformer an intermediate frequency so high in value that reappearance of any station in the entire broadcast range is rendered impossible.

Each instrument carries the following guarantee: "It has been tested with finest apparatus under actual working conditions and is mechanically and electrically perfect. It is guaranteed indefinitely as long as the seal used in closing the case is unbroken, and will be replaced free of charge if found defective."

[*Ask your dealer. If he can't supply you, write or wire us.*]

MADISON-MOORE RADIO CORPORATION
2524 F Federal Boulevard
Denver, Colorado, U. S. A.

MADISON~MOORE

The Finest **RADIO APPARATUS** *in the World!*

No. 75 RADIO BROADCAST Laboratory Information Sheet March, 1927

Interference Finder

A PORTABLE RECEIVER

ON LABORATORY Sheet No. 76 is given a circuit diagram of a small portable receiver for use in locating sources of interference. In order to make up this receiver, the following apparatus is necessary:

L—Any standard loop, tapped at the center.
C_1—Variable condenser designed for operation with the loop that is used. Any value between 0.00025 mfd.and 0.0005 mfd. is satisfactory.
R_g—4-megohm grid leak.
C_2—0.00025-mfd. grid condenser.
C_3—Midget condenser, 0.00015 mfd. max.
T_1, T_2—Audio-frequency transformers.
J—Single-circuit filament control jack.
R—20-ohm rheostat.
L_2—Radio-frequency choke coil which may consist of 400 turns of No. 32 or smaller wire wound on an ordinary spool.

To operate this receiver the following accessory equipment is necessary:
Three ordinary dry cells for the filament circuit; one small 45-volt battery for the plate circuits of all three tubes.
Three 199 tubes.

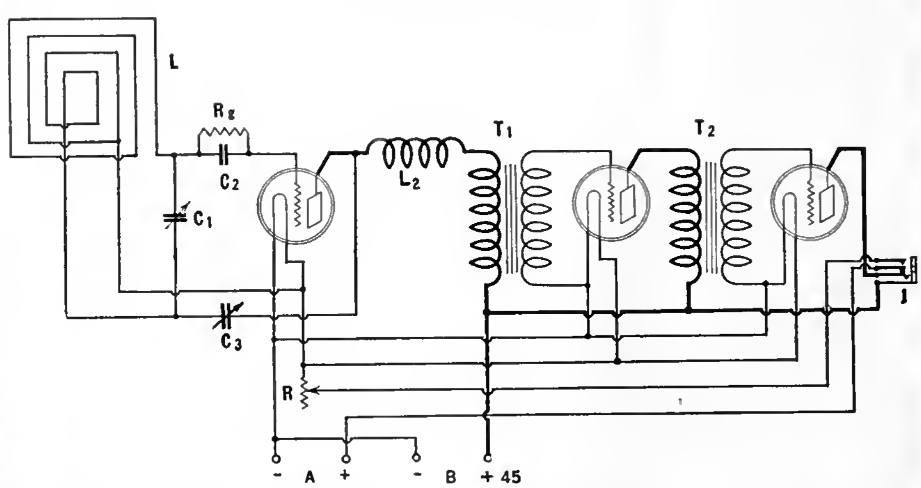
The receiver is of the ordinary regenerative type. The condenser, C_1, controls the tuning, while condenser C_3 controls the amount of regeneration. When C_3 is advanced near to its maximum position the detector tube will oscillate so that stations may be picked up by a heterodyning whistle.

The loop should be mounted so that it can be turned in any direction. It will be found that the loop is very directional and that, therefore, in interference investigations, the interference will be picked up loudest when the loop is pointing toward the source. In this way the actual source of interference can often be located.

The receiver should be made extremely portable and, for this reason, it is preferable to enclose the batteries and loop, as well as the receiver, in a small carrying case that can be easily handled. The receiver should be equipped with a jack into which a separate loop unit may be plugged,or the loop may be wound inside the case itself. The filament rheostat controlling the tubes should not be advanced further than necessary to obtain satisfactory reception since excessive filament voltage on the 199 tube is very detrimental. It will be found that three ordinary dry cells used for filament lighting will last for many months.

No. 76 RADIO BROADCAST Laboratory Information Sheet March, 1927

Interference Finder



No. 77 RADIO BROADCAST Laboratory Information Sheet March, 1927

Interference Elimination

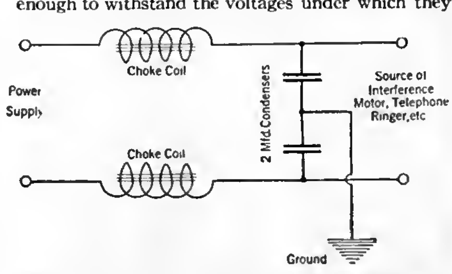
USE OF CONDENSERS AND CHOKES

WHEN interference is experienced from motors, telephone ringers, or other similar apparatus, it may frequently be eliminated by using some such circuit arrangement as is illustrated on this Sheet.

This circuit is called a filter, and can easily be connected to practically any piece of apparatus that is causing interference. If, for example, a motor is found to be causing the interference, such may be eliminated by connecting two condensers across the line terminals of the motor with the mid point grounded, as illustrated in the sketch. The values of the condensers should, in general, not be less than 2 mfd., although smaller size condensers will sometimes give satisfactory results.

In extreme cases of interference, where it is found that the condensers shunted across the line with their mid point grounded do not remedy the trouble, the inclusion of choke coils in series with the line is necessary. These choke coils must be fairly large and wound with wire large enough to carry the full current in the line. The shunting condensers and the choke coils, if they are used, should always be placed as close to the source of interference as possible. The source of interference is not always obvious, and, for that reason, it is advisable first to make some simple tests to make certain of the cause. In such an investigation the small portable receiver described on the Laboratory Sheets Nos. 75 and 76 will be found very useful.

Before installing any condensers, one should make certain that they have a rating sufficiently high enough to withstand the voltages under which they



must operate. There will be little difficulty in obtaining satisfactory condensers for use on direct-current circuits since there are many on the market rated at as high as 1000 volts d.c. Frequently these same condensers are not satisfactory for use on a. c. circuits, however, and consequently, if the device to be shunted is operated from a.c., make sure that the condensers used have a satisfactory a.c. rating.

FEATURING THE NEW GENERAL RADIO DOUBLE IMPEDANCE

A NEW Amplifier Unit

which provides for FAITHFUL REPRODUCTION of

FULL ORCHESTRATION

Type 373

Double Impedance Coupler

Price $6.50

(2 required)

Type 285D

Audio Transformer

Price $6.00

(1 required)

Type 387A

Speaker Filter

Price $6.00

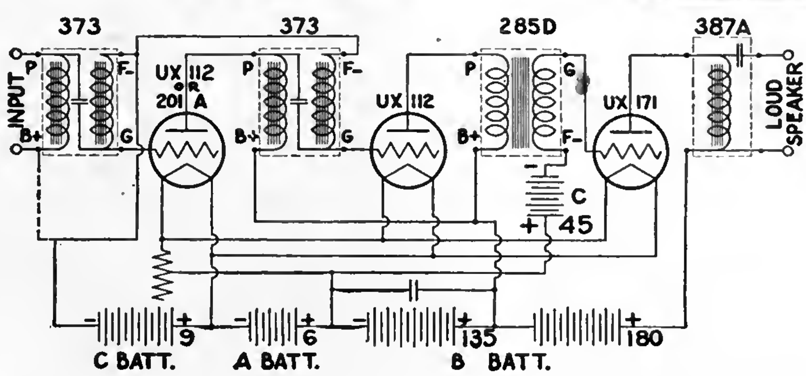
(1 required)

Type 349

UX Tube Socket

Price 50c

(3 required)



Type 401

Rheostat 6 ohms

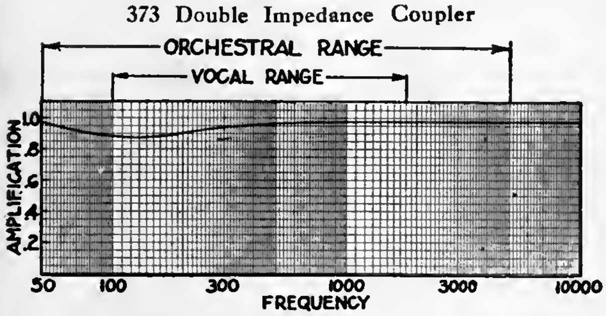
Price $1.25

(1 required)

A GRAPHIC REPRESENTATION OF

Vocal and Instrumental Tones

as they are amplified by the Type 373 Double Impedance Coupler



The extent is its range of even amplification is from appreciably below 60 cycles to over 10,000 cycles, with a gradual downward deviation of slightly less than 7% between 100 and 400 cycles. This deviation in an otherwise perfect amplification curve is so slight as to be practically negligible, because the ear of the average individual cannot detect a variation of intensity of much less than 25%.

The amplification curve, in fact, compares favorably with that generally obtained with resistance coupled systems which have the disadvantage of large sacrifices of plate voltages.

The above circuit diagram shows a combination of two stages of double impedance coupling and one stage of transformer coupling with speaker filter. While the use of double impedances is not new in principle, the General Radio Type 373 Double Impedance Coupler is unique in design and performance. To facilitate installation, the complete unit, consisting of two impedances and a fixed condenser, is contained within a metal shell. It is connected in an audio amplifier circuit in precisely the same manner as a transformer. The amplifier combination shown above may be readily adapted to any standard manufactured or home constructed receiver, and will produce a very noticeable improvement in tone quality.

Its high and even amplification extends over the range of FULL ORCHESTRATION. The deep bass tones of the tuba are brought out in full timbre as are the shrill notes of the piccolo. The range of the human voice is covered with pleasing clarity.

The above amplifier combination has the further advantage that it may be used with the General Radio Type 405 Raytheon Plate Supply Unit. By substituting two Type 373 Units for the transformers of a two stage transformer coupled amplifier the above combination may be completed and proper plate voltages provided by using the General Radio Type 400 Power Amplifier and Plate Supply.

Ask your dealer or write for folder 373

GENERAL RADIO CO. Cambridge, Mass.

GENERAL RADIO

PARTS AND ACCESSORIES

The General Radio Company has endeavored to make it possible for the experimenter to obtain its products with minimum of effort. A careful selection of distributors and dealers has been made. They are best suited to serve you. If, however, you are unable to obtain our products in your particular locality, they will be delivered to you, post paid, direct from the factory upon receipt of list price.

No. 78 Radio Broadcast Laboratory Information Sheet March, 1927

The Volt, Ampere, and Ohm

DEFINITIONS

We are giving below an explanation and meaning of the common terms, the volt, the ampere, and the ohm. Hydraulic analogies will be used in explaining the first two of these terms.

Ampere: A current of water in a pipe is measured by the amount of water that flows through the pipe in a second, such as 1 gallon per second, or 10 gallons per second, etc. Electricity is measured by the amount of current that flows along a wire in one second. This quantity is known as the coulomb, and if this term is used we would express the current as 1 coulomb per second or 10 coulombs per second, etc. In electricity, however, we have a special name for the rate of flow of 1 coulomb per second which we call 1 ampere. Thus, 8 amperes is the same as 8 coulombs per second. Ampere, then, is a term defining the quantity of current that is flowing per unit of time.

Volt: The number of gallons per second of water flowing in a pipe, or the number of amperes flowing in a wire, depends upon the pressure under which it flows. The electrical unit of pressure is the volt. A volt means the same thing in speaking of a current of electricity that a pound pressure means in speaking of a current of water. It follows then that the greater the pressure (voltage) at the supply, the greater will be the flow of current.

Ohm: There is no hydraulic unit which corresponds to the ohm, which is a measure of the resistance of a wire to the flow of current. A wire is said to have 1 ohm of resistance when a pressure of 1 volt will cause a current of 1 ampere to flow through it. If the resistance were doubled, the current would be halved, etc.

According to the definitions given on this Sheet, then, we see that amperes represent the amount of current, volts the pressure causing this current to flow, and ohms the resistance impeding the flow of current. These three units bear a definite relation to each other. This relationship, named after the scientist who discovered it, is known as Ohm's Law, which states that the number of amperes flowing in a circuit is equal to the voltage of the circuit divided by its resistance. An explanation of Ohm's Law is given on Laboratory Sheet No. 81.

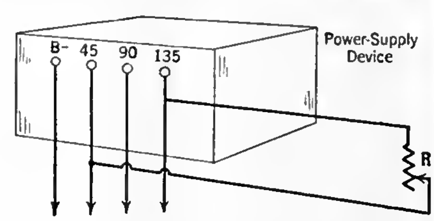
No. 79 Radio Broadcast Laboratory Information Sheet March, 1927

Regulating Voltage on B Power-Supply Device

USE OF RESISTOR

Many commercial a. c. operated power-supply devices are equipped with taps for supplying different voltages suitable for use in conjunction with the detector, amplifier, etc. The voltage obtained from any tap on such a device is not constant but varies with the amount of current that is drawn from it. If an unusually heavy load is drawn from any one of the taps, it will generally be found that the voltage is somewhat less than the specified amount. In such a case, it is possible to increase the voltage on the particular tap which is low by connecting an external resistance between the tap whose voltage is low and the maximum voltage tap on the device. The proper connections for this resistance are indicated in the diagram, and, by the proper variation of this resistance unit, it will be found possible to obtain any value of voltage that might be required. This method of increasing the voltage on any tap is very simple, since it does not require that the power-supply device be opened and the internal resistances varied.

It should be noted that the resistance does not connect between the two adjacent taps but that it is connected between the 45-volt tap and 135-volt tap which, in this particular case, is supposed to be the maximum voltage tap on the device. This method of increasing the voltage on any tap was suggested



in the December issue of the General Radio *Experimenter*.

The resistance should be variable between 5000 and 50,000 ohms, and must be of a type satisfactory for use in power-supply devices.

No. 80 Radio Broadcast Laboratory Information Sheet March, 1927

Characteristics of Tubes

MEASURING THE AMPLIFICATION CONSTANT

Laboratory Sheet No. 68 (February, 1927) gave some characteristic curves of the 171 type tube, and Sheet No. 67 explained how the plate impedance of the tube might be calculated using these curves. The present Sheet will explain how to calculate the amplification constant.

The amplification constant is the measure of the effect of the grid voltage on the plate voltage. Stated as a formula, the amplification constant equals:

$$\frac{\text{CHANGE IN PLATE VOLTAGE}}{\text{CORRESPONDING CHANGE IN GRID VOLTAGE}}$$

We are giving two examples below which will make simple the calculation of the amplification constant of any tube provided its characteristic curves are available.

Example 1: Calculate the amplification constant of a 171 using the curves given on Laboratory Sheet No. 68. In this example we shall use curves Nos. 2 and 3. Locate some point on curve No. 2; in this example we are taking the point corresponding to 100 volts, although any point might be taken provided we stay on the straight portion of the curve. We find that at this point, corresponding to 100 volts, the plate current is 12.5 milliamperes. Following across the horizontal line corresponding to this plate current until we come to curve No. 3, we find that the corresponding plate voltage on this curve is 128. We now have two voltages, 100 and 128, corresponding to two different grid biases, 16.5 and 27. Both of these values are for the same value of plate current. These values can be substituted in the above formula as follows:

$$\frac{128 - 100}{27 - 16.5} = \frac{28}{10.5}$$

Solving this formula, we get a value of 2.67, which is the amplification constant of this particular 171 type.

Example 2: Find some point on curve No. 4, taking that point corresponding to 160 volts as an example. In this case a plate current of 20.3 milliamperes is obtained. Following across to the corresponding plate current on curve No. 5 we find that the plate voltage is 179. The difference in plate voltage between these two points is 19 and the difference in grid bias is 40.5 minus 33, or 7.5. Dividing these two, we obtain a value of 2.54, the amplification constant of the 171.

It should be noted that this latter result is somewhat different from that given in the preceding example due to the fact that the tube was considered to be operating under different voltages. The amplification constant varies slightly for different plate voltages, but the variation over the operating range of plate and grid voltages is not usually more than 10 per cent.

Manufacturers' Booklets Available

A Varied List of Books Pertaining to Radio and Allied Subjects Which May Be Obtained Free by Using the Accompanying Coupon

As an additional service to Radio Broadcast *readers, we print below a list of booklets on radio subjects issued by various manufacturers. With this list appear many additions to the lists printed in this magazine for January, and February, 1927. This information supplements the other departments, such as the "Lab," data sheets, and the Periodical surveys, all of which have proved most popular with our readers. The publications listed below cover a wide range of subjects, and offer interesting reading to the radio enthusiast. The manufacturers issuing these publications have made great effort to collect interesting and accurate information.* Radio Broadcast *hopes, by listing these publications regularly, to keep its readers in touch with what the manufacturers are doing. Every publication listed below is supplied free. In ordering, the coupon printed on page 512 must be used. Order by number only.*—The Editor.

Parts

1. Filament Control—Problems of filament supply, voltage, regulation, and effect on various circuits. Radiall Company.

2. Hard Rubber Panels—Characteristics and properties of hard rubber as used in radio, with suggestions on how to "work" it. B. F. Goodrich Rubber Company.

3. Audio Transformers—A booklet giving data on input and output transformers. Pacent Electric Company.

4. Resistance-Coupled Amplifiers—A general discussion of resistance coupling with curves and circuit diagrams. Cole Radio Manufacturing Company.

5. Carborundum in Radio—A book giving pertinent data on the crystal as used for detection, with hook-ups, and a section giving information on the use of resistors. The Carborundum Company.

6. B-Eliminator Construction—Complete constructional data on how to build. American Electric Company

7. Transformer and Choke-Coupled Amplification—Circuit diagrams and discussion. All-American Radio Corporation.

8. Resistance Units—A data sheet of resistance units and their application. Ward-Leonard Electric Company.

9. Volume Control—A leaflet showing circuits for distortionless control of volume. Central Radio Laboratories.

10. Variable Resistances—As used in various circuits. Central Radio Laboratories.

11. Resistance Coupling—Resistors and their application to audio amplification, with circuit diagrams. DeJur Products Company.

12. Distortion and What Causes It—Hook-ups of resistance-coupled amplifiers with standard circuits. Allen-Bradley Company.

13. Materials for Screw Machine Products—Comparative costs of steel and brass with data and actual examples of how to specify. Bridgeport Brass Company.

14. Ordering the Right Kind of Sheet Brass—How to specify the proper grades for various purposes. Bridgeport Brass Company.

15. B-Eliminator and Power Amplifier—Instructions for assembly and operation using Raytheon tube. General Radio Company

15a. B-Eliminator and Power Amplifier—Instructions for assembly and operation using an R. C. A. rectifier. General Radio Company.

16. Variable Condensers—An ambitious description of the functions and characteristics of variable condensers with curves and specifications for their application to complete receivers. Allen D. Cardwell Manufacturing Company.

17. Bakelite—A description of various uses of bakelite in radio, its manufacture, and its properties. Bakelite Corporation.

18. Brass Rods—Details of manufacture together with tests and specifications. Bridgeport Brass Company.

19. Power Supply—A discussion on power supply with particular reference to lamp-socket operation. Theory and constructional data for building power supply devices. Acme Apparatus Company.

20. Audio Amplification—A booklet containing data on audio amplification together with hints to the constructor; also some general radio information. All-American Radio Corporation.

21. High-Frequency Driver and Short-Wave Wavemeter—Constructional data and application. Burgess Battery Company.

46. Audio Frequency Chokes—A pamphlet showing positions in the circuit where audio frequency chokes may be used. Samson Electric Company.

47. Radio Frequency Chokes—Circuit diagrams illustrating the use of chokes to keep out radio frequency currents from definite points. Samson Electric Company.

48. Transformer and Impedance Data—Tables giving the mechanical and electrical characteristics of transformers and impedances, together with a short description of their use in the circuit. Samson Electric Company.

49. Bypass Condensers—A description of the manufacture of bypass and filter condensers. Leslie F. Muter Company.

50. Audio Manual—Fifty questions which are often asked regarding audio amplification, and their answers. Amertran Sales Company, Incorporated.

51. Short-Wave Receiver—Constructional data on a receiver which, by the substitution of various coils, may be made to tune from a frequency of 16,660 kc. (18 meters) to 1999 kc. (150 meters). Silver-Marshall, Incorporated.

52. Audio Quality—A booklet dealing with audio-frequency amplification of various kinds and the application to well-known circuits. Silver-Marshall, Incorporated.

56. Variable Condensers—A bulletin giving an analysis of various condensers together with their characteristics. General Radio Company.

57. Filter Data—Facts about the filtering of direct current supplied by means of motor-generator outfits used with transmitters. Electric Specialty Company.

59. Resistance Coupling—A booklet giving some general information on the subject of radio and the application of resistors to a circuit. Daven Radio Corporation.

60. Resistors—A pamphlet giving some technical data on resistors which are capable of dissipating considerable energy; also data on the ordinary resistors used in resistance-coupled amplification. The Crescent Radio Supply Company.

62. Radio-Frequency Amplification—Constructional details of a five-tube receiver using a special design of radio-frequency transformer. Camfield Radio Manufacturing Company.

AMRAD

AMRAD CORPORATION Harold J. Power, *Pres.* Medford Hillside, Mass.

Here's a "B" Eliminator Equals fresh new "B" batteries

B ELIMINATORS usually fail to give reproduction qualities to your radio that come from fresh new B batteries. First class B eliminators are usually quiet in operation and supply proper voltage and current but the reproduction in the loud speaker is faulty because the capacity of the eliminator is not sufficient for the tremendous drain of current accessible loud or low notes demand. Such eliminators must draw the current all the way from the lamp socket through the filter choke into the receiver. The time element is appreciable so that the peaks of many notes are chopped off which causes distortion.

The Amrad B eliminator employs the famous Mershon Condenser as the principal capacity unit. This famous condenser has many times the capacity of any other eliminator condenser and constantly provides you with a sufficient supply of energy for the correct reproduction of any sounds that may come through your radio

Free from Break-downs

Paper condensers now used in B eliminators frequently break down. Here the Mershon has such a large capacity that any excessive voltage surge is eliminated, the charge being instantly absorbed. This also protects the receiver set against punctured parts or insulation break-down.

Won't get Noisy

Nor are there any variable adjustments to get out of order. All parts are readily accessible as no compound or other filler is used in its manufacture. The Amrad B power unit is mounted on a metal base and incased in steel box, black enamel finish.

This as well as the other products of the Amrad Corporation are a tribute to the engineering skill of the Amrad laboratories and the influence of mass production methods of Powel Crosley, Jr.

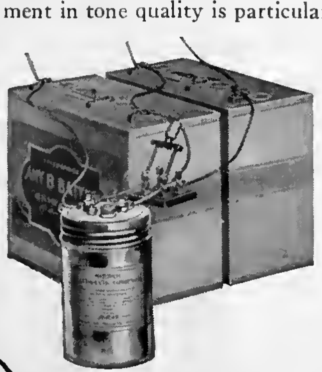
Write Dept. 2C7, for descriptive literature.

$35.

including the celebrated Amrad S-1 tube

The Mershon Condenser
freshens up old B eliminators and prolongs life in "B" batteries

The Mershon Condenser assists in more perfect filtering (straining) of the uneven current supplied by a lamp socket. It also acts as a reservoir to store a large amount of energy which is necessary for the continuous smooth flow demanded by incoming broadcasts. This energy such as fresh B batteries deliver must be on tap instantaneously for large substantial musical notes. The improvement in tone quality is particularly noticeable on low notes.



Mershon Condenser connected across B batteries (with a disconnecting switch) greatly prolongs useful life of these dry cells. It in itself does not wear out—can be used continuously.

$8.

63. FIVE-TUBE RECEIVER—Constructional data on building a receiver. AERO PRODUCTS, INCORPORATED.

64. AMPLIFICATION WITHOUT DISTORTION—Data and curves illustrating the use of various methods of amplification. Also data on how to build. ACME APPARATUS COMPANY.

65. RADIO HANDBOOK—A helpful booklet on the functions, selection, and use of radio apparatus for better reception. BENJAMIN ELECTRIC MANUFACTURING COMPANY.

66. SUPER-HETERODYNE—Constructional details of a seven-tube set. G. C. EVANS COMPANY.

70. IMPROVING THE AUDIO AMPLIFIER—Data on the characteristics of audio transformers, with a circuit diagram showing where chokes, resistors, and condensers can be used in an amplifying unit. AMERICAN TRANSFORMER COMPANY.

71. DISTORTIONLESS AMPLIFICATION—A discussion of the resistance-coupled amplifier used in conjunction with a transformer, impedance, or resistance input stage. Amplifier circuit diagrams and constants are given in detail for the constructor. AMSCO PRODUCTS INCORPORATED.

ACCESSORIES

22. A PRIMER OF ELECTRICITY—Fundamentals of electricity with special reference to the application of dry cells to radio and other uses. Constructional data on buzzers, automatic switches, alarms, etc. NATIONAL CARBON COMPANY.

23. AUTOMATIC RELAY CONNECTIONS—A data sheet showing how a relay may be used to control A and B circuits. YAXLEY MANUFACTURING COMPANY.

24. DETECTOR TUBES—A brief outline of tube operation. C. E. MANUFACTURING COMPANY.

25. ELECTROLYTIC RECTIFIER—Technical data on a new type of rectifier with operating curves. KODEL RADIO CORPORATION.

26. DRY CELLS FOR TRANSMITTERS—Actual tests given, well illustrated with curves showing exactly what may be expected of this type of B power. BURGESS BATTERY COMPANY.

27. DRY-CELL BATTERY CAPACITIES FOR RADIO TRANSMITTERS—Characteristic curves and data on discharge tests. BURGESS BATTERY COMPANY.

28. B BATTERY LIFE—Battery life curves with general curves on tube characteristics. BURGESS BATTERY COMPANY.

29. HOW TO MAKE YOUR SET WORK BETTER—A non-technical discussion of general radio subjects with hints on how reception may be bettered by using the right tubes. UNITED RADIO AND ELECTRIC CORPORATION.

30. TUBE CHARACTERISTICS—A data sheet giving constants of tubes. C. E. MANUFACTURING COMPANY.

31. FUNCTIONS OF THE LOUD SPEAKER—A short, non-technical general article on loud speakers. AMPLION CORPORATION OF AMERICA.

32. METERS FOR RADIO—A catalogue of meters used in radio with connecting diagrams. BURTON-ROGERS COMPANY.

33. SWITCHBOARD AND PORTABLE METERS—A booklet giving dimensions, specifications, and shunts used with various meters. BURTON-ROGERS COMPANY.

34. COST OF B BATTERIES—An interesting discussion of the relative merits of various sources of B supply. HARTFORD BATTERY MANUFACTURING COMPANY.

35. STORAGE BATTERY OPERATION—An illustrated booklet on the care and operation of the storage battery. GENERAL LEAD BATTERIES COMPANY.

36. CHARGING A AND B BATTERIES—Various ways of connecting up batteries for charging purposes. WESTINGHOUSE UNION BATTERY COMPANY.

37. CHOOSING THE RIGHT RADIO BATTERY—Advice on what dry cell battery to use; their application to radio, with wiring diagrams. NATIONAL CARBON COMPANY.

53. TUBE REACTIVATOR—Information on the care of vacuum tubes, with notes on how and when they should be reactivated. THE STERLING MANUFACTURING COMPANY.

54. ARRESTERS—Mechanical details and principles of the vacuum type of arrester. NATIONAL ELECTRIC SPECIALTY COMPANY.

55. CAPACITY CONNECTOR—Description of a new device for connecting up the various parts of a receiving set, and at the same time providing bypass condensers between the leads. KURZ-KASCH COMPANY.

61. DRY CELLS—Information on the construction and operation of dry cells with a description of the methods used in testing them. THE CARBON PRODUCTS COMPANY.

68. CHEMICAL RECTIFIER—Details of assembly, with wiring diagrams, showing how to use a chemical rectifier for charging batteries. CLEVELAND ENGINEERING LABORATORIES COMPANY.

69. VACUUM TUBES—A booklet giving the characteristics of the various tube types with a short description of where they may be used in the circuit. RADIO CORPORATION OF AMERICA.

MISCELLANEOUS

38. LOG SHEET—A list of broadcasting stations with columns for marking down dial settings. U. S. L. RADIO, INCORPORATED.

39. BEHIND THE SCENES IN A BROADCASTING STATION—Operation in general, and specific facts about WKRC. KODEL RADIO CORPORATION.

40. STATIC—A brief discussion of the disturbances which may cause trouble in a receiver. SUN MANUFACTURING COMPANY.

41. BABY RADIO TRANSMITTER OF 9XH-9EK—Description and circuit diagrams of dry-cell operated transmitter. BURGESS BATTERY COMPANY.

42. ARCTIC RADIO EQUIPMENT—Description and circuit details of short-wave receiver and transmitter used in Arctic exploration. BURGESS BATTERY COMPANY.

43. SHORT-WAVE RECEIVER OF 9XH-9EK—Complete directions for assembly and operation of the receiver. BURGESS BATTERY COMPANY.

44. ALUMINUM FOR RADIO—A booklet containing much radio information with hook-ups of basic circuits, with inductance-capacity tables and other pertinent data. ALUMINUM COMPANY OF AMERICA.

45. SHIELDING—A discussion on the application of shielding in radio circuits with special data on aluminum shields. ALUMINUM COMPANY OF AMERICA.

58. HOW TO SELECT A RECEIVER—A common sense booklet describing what a radio set is, and what you should expect from it, in language that any one can understand. DAY-FAN ELECTRIC COMPANY.

67. WEATHER FOR RADIO—A very interesting booklet on the relationship between weather and radio reception, with maps and data on forecasting the probable results. TAYLOR INSTRUMENT COMPANIES.

USE THIS COUPON

RADIO BROADCAST SERVICE DEPARTMENT
RADIO BROADCAST, *Garden City, New York.*
Please send me (at no expense) the following booklets indicated by numbers in the published list

. . . .

. . . .

. . . .

. . . .

Name . . . .

Address . . . .
(Number) *(Street)*

. . . .
(City) *(State)*

ORDER BY NUMBER ONLY
This coupon must accompany every request.
RB 327

Press, Weather, and Time Signals

Times and Wavelengths of Stations in All Parts of the World Transmitting the Above Signals

IN THE accompanying corrected table of transmissions of time, weather, and press intelligence, the scheduled times of transmission are given in Greenwich Mean Time, Eastern Standard Time, and Pacific Standard Time. This list, we feel sure, is as accurate as it is humanly possible to make it, but minor changes are often made at the stations concerned with little or no notice. PX in the last column stands for "Press"; WX for "Weather"; TFC for "Traffic Transmissions." This list supersedes that published in the December, 1926, RADIO BROADCAST.

TIME G. M. T.	TIME E. S. T.	TIME P. S. T.	CALL	LOCATION	WAVE IN METERS	FRE-QUENCY KCS.	REMARKS
00:30	7:30 P. M.	4:30 P. M.	YN	Lyons	15,100	19.86	Arc; Press.
02:00	9:00 P. M.	6:00 P. M.	NAH	Brooklyn	1500	199.9	Spark; WX, PX.*
02:15	9:15 P. M.	6:15 P. M.	VCE	Cape Race	600	499.7	Spark; Ice Reports, etc.
02:55	9:55 P. M.	6:55 P. M.	NAA	Arlington	2655	112.9	I. C. W.; WX, Time.
02:55	9:55 P. M.	6:55 P. M.	NAR	Key West	1463	205.0	I. C. W.; WX, Time.*
02:55	9:55 P. M.	6:55 P. M.	NSS	Annapolis	16,900	17.74	Arc; WX, Time.
03:00	10:00 P. M.	7:00 P. M.	NPM	Pearl Harbor	1500	199.9	Spark; Press.
03:05	10:05 P. M.	7:05 P. M.	VBT	Cape Race	2700	111.0	C. W.; Press.
03:30	10:30 P. M.	7:30 P. M.	UA	Nantes, Fr.	2400	124.9	Spark; Press.*
03:48	10:48 P. M.	7:48 P. M.	GBR	Rugby	18,740	15.98	C. W.; Press.
03:50	10:50 P. M.	7:50 P. M.	WSH	New York	2478	120.9	Arc; Press.
04:30	11:30 P. M.	8:30 P. M.	WNU	New Orleans	3331	90.04	C. W.; WX, TFC, and PX.
05:15	12:15 A. M.	9:15 P. M.	WRQ	Marion	12,500	23.09	C. W.; Press.
05:40	12:40 A. M.	9:40 P. M.	NPL	San Diego	13,300	22.54	Arc; Press.
06:00	1:00 A. M.	10:00 P. M.	BZL	Demerra	1300	230.6	Spark; Press.†
07:00	2:00 A. M.	11:00 P. M.	GPH	Guayaquil	750	399.8	Spark; Press.†
07:30	2:30 A. M.	11:30 P. M.	BZM	St. Johns, Nfd.	1500	199.9	Spark; Press.
08:00	3:00 A. M.	12 Mid.	YN	Lyons, Fr.	5000	59.96	Arc; Press.
08:00	3:00 A. M.	12 Mid.	VCU	Barrington	1500	199.9	Spark; Press.
08:00	3:00 A. M.	12 Mid.	NPL	San Diego	13,300	22.54	Arc; Press.
08:00	3:00 A. M.	12 Mid.	NAH	Brooklyn	1500	199.9	Spark; Press.*
08:00	3:00 A. M.	12 Mid.	NBD	Bar Harbor	1900	157.8	Spark; Press.
08:00	3:00 A. M.	12 Mid.	KPH	San Francisco	2300	130.4	C. W.; Press.
09:00	4:00 A. M.	1:00 A. M.	GFA	London	4200	71.39	C. W.; WX.
09:30	4:30 A. M.	1:30 A. M.	FL	Eiffel Tower	2700	111.0	Spark; Time.‡
09:45	4:45 A. M.	1:45 A. M.	GCK	Valentia	600	499.7	Spark; WX.
09:55	4:55 A. M.	1:55 A. M.	NAX	Colon	1800	166.6	I. C. W.; Time.*
09:55	4:55 A. M.	1:55 A. M.	NBA	Balboa	7000	42.83	Arc; Time, PX.†
10:30	5:30 A. M.	2:30 A. M.	NBA	Balboa	7000	42.83	Arc; Press.†
11:00	6:00 A. M.	3:00 A. M.	GPH	Guayaquil	750	399.8	Spark; Press.
11:18	6:18 A. M.	3:18 A. M.	GBR	Rugby	18,740	15.98	C. W.; Press.
11:30	6:30 A. M.	3:30 A. M.	VMG	Apia, Samoa	2000	149.9	Spark; Press.
12 Nn.	7:00 A. M.	4:00 A. M.	POZ	Nauen	18,500	16.21	Arc; Time.
12 Nn.	7:00 A. M.	4:00 A. M.	GBR	Rugby	18,740	15.98	C. W.; Press.
14:15	9:15 A. M.	6:15 A. M.	VCE	Cape Race	600	499.7	Spark; Ice Reports, etc.
15:15	10:15 A. M.	7:15 A. M.	BZI	Durban, S. A.	2000	149.9	Spark; Press.
15:30	10:30 A. M.	7:30 A. M.	VIS	Sydney, Aus.	2000	149.9	Spark; Press.
16:00	11:00 A. M.	8:00 A. M.	FL	Eiffel Tower	2500	119.9	Spark; WX.
16:30	11:30 A. M.	8:30 A. M.	VIP	Perth, Aus.	1500	199.9	Spark; Press.
16:30	11:30 A. M.	8:30 A. M.	WNU	New Orleans	3331	90.04	C. W.; WX, TFC, and PX.
16:55	11:55 A. M.	8:55 A. M.	NAA	Arlington	2400	124.9	C. W.; Time etc.
16:55	11:55 A. M.	8:55 A. M.	NAR	Key West	1463	205.0	I. C. W.; Time.
16:55	11:55 A. M.	8:55 A. M.	NSS	Annapolis	16,900	17.74	Arc; Time.
16:55	11:55 A. M.	8:55 A. M.	NAT	New Orleans	2700	111.0	I. C. W.; Time.
17:00	12 Nn.	9:00 A. M.	NPL	San Diego	13,300	22.54	Arc; Press.
17:55	12:55 P. M.	9:55 A. M.	NAX	Colon	1800	166.6	I. C. W.; Time.*
17:55	12:55 P. M.	9:55 A. M.	NBA	Balboa	6663	45.02	Arc.; Time.
18:00	1:00 P. M.	10:00 A. M.	VAS	Louisburg	2700	111.0	C. W.; Press.
18:00	1:00 P. M.	10:00 A. M.	VJZ	Rabaul, Aus.	2900	103.4	Spark; Press.
18:30	1:30 P. M.	10:30 A. M.	VID	Darwin, Aus.	850	352.7	Spark; Press.
19:00	2:00 P. M.	11:00 A. M.	XDA	Mexico City	2700	111.0	C. W.; Time, WX.
19:55	2:55 P. M.	11:55 A. M.	NPL	San Diego	9800	30.59	Arc.; Time.
20:00	3:00 P. M.	12 Nn.	BYZ	Rinella	4200	71.39	Arc.; Press.
20:00	3:00 P. M.	12 Nn.	NBA	Balboa	2400	124.9	Spark; Press.
20:00	3:00 P. M.	12 Nn.	LY	Bordeaux	18,600	16.12	C. W.; Time.
20:00	3:00 P. M.	12 Nn.	GFA	London	4200	71.39	C. W.; WX.
20:00	3:00 P. M.	12 Nn.	KAV	Norddeich	1800	166.6	Spark; Press (German).
20:00	3:00 P. M.	12 Nn.	GBR	Rugby	18,740	15.98	C. W.; Press.
20:48	3:48 P. M.	12:48 P. M.	GCK	Valentia	600	499.7	Spark; WX.
21:45	4:15 P. M.	1:15 P. M.	BXW	Singapore	2000	149.9	Spark; Press.
21:45	4:45 P. M.	1:45 P. M.	BXY	Hong Kong	2000	149.9	Spark; Press.
22:15	5:15 P. M.	2:15 P. M.	IDO	Rome	10,000	29.98	Arc; Press.
22:30	5:30 P. M.	2:30 P. M.	BZG	Mauritius	2000	149.9	Spark; Press.
22:45	5:45 P. M.	2:45 P. M.	FL	Eiffel Tower	2700	111.0	Spark; Time.
24:00	7:00 P. M.	4:00 P. M.	NPM	Pearl Harbor	11,200	26.77	Arc; Time.
24:00	7:00 P. M.	4:00 P. M.	PRG	Prague	9300	32.24	Arc; Press.§
24:00	7:00 P. M.	4:00 P. M.	POZ	Nauen	18,500	16.21	C. W.; Time.
24:00	7:00 P. M.	4:00 P. M.	GBR	Rugby	18,740	15.98	C. W.; Press.

*Possibly changed to c.w. May have been discontinued, or details uncertain.
†Uncertain of wavelength.
‡This weather sent in code form. Useless unless you have reference code book.
§English press sent on 4100 meters (73.13 kc.).

Practically all of the above stations, it will be seen, transmit on wavelengths too long to be covered by the ordinary broadcast receiver. Experimenters desirous of listening to the above signals might very well employ a simple regenerative circuit for this purpose. RADIO BROADCAST Laboratory Information Sheet No. 19, which was printed in the August, 1926, issue, gives a suitable circuit, together with data for the coils.

The Problems of A. C. Filament Lighting

Why It Is Simpler to Obtain B Supply than A Current from the A. C. Mains—Series Connection of 199 Tubes Offered as Remedy

By C. T. BURKE

Engineering Dept., General Radio Company

THE problem of filament supply from alternating current is essentially different from that of plate supply. It is not a question of the power supplied, but the voltage at which it is supplied. The power required for filament supply ranges from 0.18 watt for the dry-cell tubes to 9.5 watts for the UX-210, while the plate power for these tubes is 0.2 watt and 9 watts, respectively. The average set draws a filament load of about 7 watts and a plate load of perhaps 4 watts. There is not enough difference between the wattage requirements of plate and filament to involve great difficulty.

The essential difference between the plate and filament requirements is the supply voltage, which is about 100 for the plate as compared to 5 for the filament. As power in watts is equal to the current supplied times the supply voltage, roughly twenty times the current is required to supply a given number of watts to the filament as would be required at the plate. The great difference then, between the demands of filament and plate supplies is not of power, but of current. Plate current supply devices are not called on to deliver more than about 50 milliamperes, while the filament may draw two or more amperes.

Direct-current power differs from alternating in that power at high voltage and low current cannot be transferred into power at low voltage and high current without the use of rather expensive equipment. It is, therefore, necessary to use the d. c. power at the current and voltage supplied by the rectifier.

Rectification and filtering is generally necessary in order to use alternating current for filament supply. The last stage of audio amplification can be run with alternating current on the filament with excellent results. When the slight hum resulting from a. c. on the filament is amplified through successive tubes, it reaches an objectionable magnitude. Thus, the use of raw a. c. is confined to the last tube. This is generally a power tube, and requires a greater filament supply than the others. Under certain conditions, where some hum is not objectionable, it may be possible to operate two stages of audio amplification on alternating current. The detector tube must, however, have a supply of well-filtered direct current.

The maximum current available from a single rectifier tube of the kind popularly used in plate supply devices, is about 85 milliamperes. This is the current required by a one-tube set, employing an UX-199 type tube. It is delivered at high voltage. If the set is so wired that the tubes are in series, any number (up to 50) UX-199 type tubes, may be operated from such a rectifier tube when supplied with a suitable transformer and filter. As the same unit is generally used for both A and B supply, it would be necessary to design transformers and chokes to deliver this current at about 220 volts in order to take care of the plate and grid voltage of the UX-171 type tube. This is somewhat expensive, but by no means impossible. A rheostat of sufficient resistance and current carrying capacity is also required.

It will be seen that A elimination for UX-199 type tubes is feasible. So far as the writer knows, however, there is no commercial eliminator for this service available. The field for such a device would be very limited, first because of the comparatively few sets using 60-mil. tubes, and secondly, because rewiring of the set is generally required. The making of individual installations of this kind, however, including building the unit, and rewiring the set, should prove a source of considerable profit to those dealers and service stations who undertake it. The same type of installation would not be entirely beyond the bounds of practicability with 201-A type tubes if a rectifier tube were available supplying 250 milliamperes. The chokes and resistances for this arrangement would present considerable difficulty. This would result in greater bulk, and materially greater expense than would the equipment for 199 type tubes.

There are a number of low-voltage rectifiers available which are used to charge batteries. The output of these units is ample to supply the filament currect drain of any set, and they would be suitable for a general purpose filament supply. The great obstacle in this case is filtering. The condensers in the filter act as reservoirs, storing surplus current during one part of the cycle and feeding it to the load at another. The large current required by the filament supply would require condensers of many times the capacity now required on plate supply units. The filter inductances also present a serious problem. The low voltage available from high-current rectifying devices permits a very small drop in the filter system. This requires chokes having very large wire and few turns. In order to get the proper inductances, and avoid saturation, the cores would have to be of very large cross section, and would require air gaps. Fortunately, as the current drain increases, the amount of inductance required for a given degree of smoothing decreases somewhat. Even allowing for this, the filter choke for a filament power supply to furnish 2 amperes would cost much more than do those for a plate supply. The condenser cost would be multiplied by an even greater proportion unless electrolytic condensers were used.

The cost of a storage battery is, of course, many times less than that of such a filter. This brings us to the trickle charger-battery combinations, which, while not battery substitutes, do provide a reliable filament source from the alternating-current line. The trickle charger combination is probably at present, and likely to remain for some time, the most satisfactory general purpose filament supply. The use of UX-199 type tubes in series will, however, prove interesting to the experimenter and to the service man.

Another type of A device, in which dry batteries are used as filter condensers, is appearing this year. In this type a tungar rectifier is generally used. The filter consists of a choke of small inductance which can, therefore, be made with low resistance and dry cells in place of the filter condensers. A number of these devices will be on the market this year, and they offer interesting possibilities. Meanwhile, tube manufacturers are at work on the problem of developing tubes which will not require A batteries.

RADIO BROADCAST R·F·A· LABORATORY RECEIVER

Radio Broadcast Laboratory Staff

Coast to Coast!

able home-constructors, that claims of this nature may be true only in isolated cases.

The "Lab" Receiver employs an unusually well-designed radio frequency amplifier circuit and is, in addition, perfectly neutralized. From rather elaborate experiments and tests, it would appear that the four-tube "Lab" Receiver delivers a stronger signal than many Receivers employing many more than four tubes. It is a decidedly inexpensive Receiver both from a constructional and operation standpoint. Several innovations in design amplify the construction and present a departure from what has come to be regarded as the conventional method of set building.

WCCO MINNEAPOLIS

WJZ NEW YORK

Yet it is extremely simple to construct. Good design insures selectivity; it has real distance-getting ability, i.e., it is sensitive; it delivers a signal of strength and of high quality; it is inexpensive to operate; presents a neat appearance; and employs but four tubes. These characteristics of the "Lab" Receiver are possible because the Receiver is designed and built on sound principles.

In order to facilitate your building of the "Lab" Receiver, actual size blue prints along with reprinted constructional data has been prepared. This material may be had free of charge by writing to any of the manufacturers listed, to the business offices of Radio Broadcast, or to Allen-Rogers Company, 118 East 28th Street, N. Y. C.

(Write Radio Broadcast, 285 Madison Avenue, N. Y., for Constructional Data)

Complete Kits from Allen-Rogers, 128 E. 18th St., New York City

Tobe

Airgap

Westinghouse

AmerTran

CARDWELL-ELECTRAD-PRECISE
GEN·WIN·-MARCO-AMERTRAN-BRACH

These names your guarantee Quality Products

TOBE DEUTSCHMANN-SAMSON
WESTINGHOUSE-MICARTA-AIRGAP

A KEY TO RECENT RADIO ARTICLES

By E. G. SHALKHAUSER

THIS is the seventeenth installment of references to articles which have appeared recently in various radio periodicals. Each separate reference should be cut out and pasted on cards for filing, or pasted in a scrap book either alphabetically or numerically. An outline of the Dewey Decimal System (employed here) appeared last in the January, Radio Broadcast, *and will be reprinted in an early number.*

R582. Transmission of Photographs. Television.
Radio News. Nov., 1926. Pp. 466ff.
"Television Enroute," P. J. G. Fischel.
A new principle of photo-telegraphy, known as the Telefunken system, and discovered by a German, Count Arco, is described. It is said that the transmission is practically independent of atmospheric disturbances and that photographs may be used for reproduction without retouching. A new ring-shaped photo-electric cell is used. A light relay, called the Karolus Cell, makes possible the high speed and good quality of reception. The operation, circuit diagrams, and photographs of the apparatus are explained.

R592. British Empire; Radio Developments. British
Rodio News. Nov., 1926. Pp 474ff. Broadcasting Co.
"The B. B. C. in the Melting Pot," A. Dinsdale.
Present conditions concerning the broadcasting situation in Great Britain are related. In view of the fact that the arrangements, under which broadcasting stations are operated at present, terminate on December, 31st, 1926, and the suggested appointment of a commission to control matters has been delayed, the situation seems to be very much in the air. Conditions at present are related.

R800 (621.354) Batteries. Batteries.
Radio News. Nov., 1926. Pp. 476ff.
"Radio Batteries and Their Care," M. L. Muhleman.
It is the purpose of the article to present simple and intelligent information on dry cells and secondary batteries their common ills and their prevention. Such information as time of recharge, size and type to choose for various sets, use and importance of the battery, test of specific gravity, etc., are considered.

343. Electron-Tube Receiving Sets. Receiver,
Radio News. Nov., 1926. Pp. 500 ff. *Browning-Drake.*
"A Lamp-Socket Operated Browning-Drake Receiver," A. H. Lynch.
The receiver described uses the Browning-Drake circuit in connection with a battery substitute. The audio amplifier is of the resistance-capacity-coupled type with one stage of power amplification. Construction and operation data are given, together with a list of parts required.

R342. 15. Amplifier Transformer. Transformers,
Radio News. Nov., 1926. Pp. 511ff. *Audio.*
"Transformer-Coupled Amplifiers," S. Harris.
In analyzing the action of audio transformer-coupling in vacuum-tube circuits, the author shows how the theory of primary to secondary coupling applies, how the primary to secondary flux determines the "degree of coupling," how the primary impedance affects amplification and reproduction, and the relation between frequency and amplification functions (plotted graphically). He also gives the relations between frequency, plate current, and amplification.

R142. Coupled Circuits. Coupling.
Proc. I. R. E., Oct. 1926. Pp. 605-611. *Cap. and Ind.*
"Combined Electromagnetic and Electrostatic Coupling and Some Uses of the Combination," E. H. Loftin and S. Y. White.
The paper presents a method of combining electromagnetic and electrostatic coupling in radio-frequency amplifier circuits of vacuum-tube receivers for the purpose of increasing the efficiency and reducing the objectionable effects of oscillation in these circuits. The elementary principle of reactance in a simple circuit, and its application to the circuits in question, is explained.

R281.71. Quartz. Quartz
Radio Broadcast. Jan., 1927. Pp. 263-265. Crystals.
"Piezo-Electric Crystals," M. T. Dow.
The general properties of quartz crystals, their structure, and their application to radio, are discussed. A crystal is said to act as an impedance (coil and condenser combination) when connected into its usual place in a tube circuit. Its elongation and contraction when potentials are applied on oppisite sides occur at a very definite frequency. It is difficult to produce changes as large as one cycle in a thousand per second without stopping oscillations. A temperature difference of one degree will change the frequency only about one cycle in 30,000 per second.
Crystals oscillate at various frequencies, these points of oscillation being related in accordance with complicated laws. Since oscillating circuits have a good many harmonics it is possible to determine many frequencies with one crystal.

R330. Electron Tubes. Cathode
Radio Broadcast. Jan., 1927. Pp. 251-254. Ray, *New.*
"The Hundred-Billion-Dollar Vacuum Tube," J. Stockley.
A new Cathode ray tube has been developed by Doctor Coolidge which shoots electrons into the outside atmosphere through a thin nickel window. A potential of 350,000 volts is used on the tube. It is stated that its electron emission is equivalent to that given out by more than one ton of radium. The many peculiar and startling experiments, such as crystals being made to glow for some period after exposure to these electrons, the electrification of wax, the solidification of gas, and the effects on bacteria, indicate its many future possibilities.

(Continued on page 522)

This is a good time to subscribe for

RADIO BROADCAST

Through your dealer or direct by the year, only $4.00

DOUBLEDAY, PAGE & CO. GARDEN CITY, NEW YORK

381. CONDENSERS. CONDENSERS, *Fixed*.
Radio News. Nov., 1926. Pp. 481ff.
"A Visit to a Condenser Factory."
Details relating to the manufacture of fixed condensers are given. Photographs are shown of the vacuum tanks used for impregnating with paraffin, power winding machines, vacuum dryer container, and testing apparatus.

R343.5. HETERODYNE SETS. SUPER-HETERODYNE.
RADIO BROADCAST. Jan., 1927. Pp. 260–262.
"A Six-Tube Supe -Heterodyne," K. Clough.
This six-tube super-heterodyne, consisting of regenerative detector, oscillator, two stages intermediate, second detector, and one stage audio amplification, has its detector and oscillator shielded. Detailed constructional data are given with a list of the parts required.

R140. RADIO CIRCUITS. GRIMES, *Inverse Duplex*.
RADIO BROADCAST. Jan., 1927. Pp. 266–268.
"The New Inverse Duplex System," David Grimes.
A new inverse duplex system features the following advantages over the old circuit known by the same name: (1) Excellent radio-frequency selectivity at all wavelengths. (2) Substantially equal radio-frequency amplification at all wavelengths. (3) Several special arrangements to secure real tone quality in the audio-amplifying circuits. (4) Means for preventing detector-tube overload, thus retaining the bass notes on local stations. (5) Elimination of direct current from the loud speaker windings, reducing burn-out tendencies. (6) Straight line volume control for smooth and gradual adjustment from a whisper up to the choking point of the tubes. (7) Long tube life because of the negative C battery bias on all amplifying tubes, radio frequency as well as audio frequency. (8) Small B-battery drain due to the reasonable number of tubes used and the fact that all amplifying tubes are operated with the standard negative C bias on the grids. (9) Unique grid arrangement on first audio tube to overcome hand hum, prevent the audio whistling caused by the A type tubes, and to permit the second and third condensers to be run on the same grounded shaft, if desired. (10) Certain circuit designs to permit the use of the new UX-171 type power tube and the new UX-200-A detector. (11) Determination of audio phases for reducing the radio frequency modulating effect on excessive signal strengths.
It is shown how the problem of equal amplification over the present broadcast band is accomplished through the use of a correct radio-frequency filter circuit. Greater selectivity on the lower frequencies is obtained through a feedback arrangement, equivalent to a reduction in resistance. Body capacity and other squealing noises have been eliminated by proper separation of radio and audio frequency currents in the circuit. Succeeding articles on the Inverse Duplex receiver will appear in the February and March issues of RADIO BROADCAST.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER, *Hammarlund-Roberts*
RADIO BROADCAST. Jan., 1927. Pp. 274–276.
"The 'Hi-Q' Receiver," L. G. Biles.
An improved Hammarlund-Roberts receiver, having two tuned radio frequency stages instead of one, incorporates the following features: (1) Dual tuning whereby three tuned radio-frequency circuits are controlled by only two dials. (2) Complete shielding of the radio-frequency circuits so as to prevent direct pickup by the coils, and unwanted interstage coupling. (3) Automatic variation of the coupling between the primary and secondary coils of the radio-frequency transformers so as to obtain high efficiency. (4) A high-efficiency detector circuit which permits the use of the new type 200-A detector tube. (5) Arrangement of the circuit so as to permit the use of a semi-power tube in the output.
These points are discussed and data are presented on the construction and assembly.

R344.5. ALTERNATING CURRENT SUPPLY. A. C. POWER.
RADIO BROADCAST. Jan., 1927. Pp. 284–288.
"A Combined Amplifier and A. C. Operated Power-Supply Unit," J. Millen.
A unit is described consisting of three stages of audio amplification, the first impedance-coupled, and the other two resistance-coupled. The plate potential is obtained from a Raytheon rectifier tube. A description of the layout and the unit's operation are outlined, with the necessary photographs for details.

R140. RADIO CIRCUITS. HARTLEY CIRCUIT.
QST. Dec., 1926. Pp. 9–13.
"How Our Tube Circuits Work. No. 1—The Hartley Circuit," R. S. Kruse.
It is the purpose of this series of articles to explain in simple terms some of the few standard circuits, such as the Hartley, the Colpitts, and others. The development of the Hartley circuit into other arrangements is explained, and a series of other circuits are shown. In the final analysis, it is said all come from the same source, and operate on the same principle as the Hartley. The development of practical receiving and transmitting circuits from the Hartley, the difference between series and shunt feed, and the operation of the hook-ups, is discussed.

R134. DETECTOR ACTION. DETECTOR ACTION.
QST. Dec., 1926. Pp. 14–17.
"Detector Action in High-Vacuum Tubes," L. P. Smith.
Detector action in vacuum tubes is taken up from the standpoint of the grid and its potential, relative to the filament. Two common methods of detection are discussed, namely the grid leak—condenser method and the battery bias method. Curves of grid voltage and grid current for the 201-A type tube and detection characteristics for the 201-A type as well as the 200-A type tubes are given and explained.

R144. HIGH-FREQUENCY RESISTANCE. LOSSES.
QST. Dec., 1926. Pp. 21–24.
"The Relative Importance of Losses in Radio Receiving Systems," W. W. Harper.
A discussion of the desirability of having some standards for transformers, from which operating results may be predicted, is presented. The conclusion seems to be that standards cannot be determined so long as other component parts have not been standardized. The question of losses in coils is discussed at some length, the *natural* and the *operational* power factors being quite different, thus leading to wrong conclusions as to the operation of receivers.

Order your copy of *Radio Broadcast* from your news dealer or radio store. Make sure that he reserves a copy for you each month. If your favorite radio store does not stock the magazine write us giving name of radio dealer and address.

R343. Electron-Tube Receiving Set. Receiver, Short-Wave.
QST. Dec., 1926. Pp. 37–40. "A Shielded Short-Wave Receiver," F. J. Marco.
The desirability of using shielding on short-wave receivers is explained, especially where troubles such as power-leaks, local broadcast station fields, sixty-cycle induction from lighting lines, and body capacity, are experienced. Possible antenna, shield connections, and trap circuits for eliminating broadcast transmitter troubles are discussed.

R343. Electron-Tube Receiving Sets. Receiver, Counterphase.
Radio. Dec., 1926. Pp. 35ff. "The Counterphase Power Six," G. M. Best.
The Bremer-Tully Counterphase Six is described, with illustrations, circuit diagrams, constructional details, and operating data.

R132. Amplifying Action. Amplifier, Infradyne.
Radio. Dec., 1926. Pp. 39ff. "The Infradyne Amplifier," E. M. Sargent.
In the nfradyne receiver the main consideration is given to the three stages of tuned radio-frequency amplification operating on 3486 kc. (86 meters). The development of intermediate stages from the first experiments using a Hazeltine neutralizing circuit down to the present circuit is described.

R800 (347.7) Patent Practice. Patents.
Radio. Dec., 1926. Pp. 41ff. "The Maze of Radio Patents," John Flamm.
The radio patent situation is discussed in general, such patents as thos. pertaining to tuned radio frequency, th grid leak, regeneration, the super-heterodyne, the tube, and others, being mentioned. The author, in taking up this subject of patents, states that the patent office issues many invalid and baseless patents and many are won or lost only through court action. He mentions the DeForest and the Armstrong regenerative patents as examples.

R382. Inductors. Toroids.
Radio. Dec., 1926. Pp. 43ff. "The 'Mindector,'" O. C. Roos.
A constructional article is presented concerning the design and overall efficiency of toroidal coils. In order to have a coil with a given inductance and the least wire, a definite coil dimension must be used. Such a coil has been designed and called the "Minimum Decrement Toroid" or, for short, "Mindector." Data on construction are given for coils having 1.66, 16.6. and 166 microhenries inductance.

R351. Simple Oscillators. Oscillators.
Radio. Dec., 1926. Pp. 46. "An Oscillator That Holds Calibration," L. W. Hatry.
An oscillator, illustrated and described, is said to have such advantages as: (1) Controllable pickup; (2) Range covering entire waveband; (3) portable and flexible; (4) permanent in calibration. Uses for the instrument are suggested.

R201. General Methods and Apparatus for Measurements. Radio Measurements.
Radio. Dec., 1926. Pp. 47–48. "An 'LCR' Measuring Box," S. Harris.
The author describes the construction and use of a measuring instrument for determining wavelength, capacity, inductance, coupling coefficient, high-frequency resistance, and measurements which are commonly made in every experimental laboratory. Typical set-ups in making such measurements are shown and explained. A simple means of determining the coupling coefficient is mathematically outlined.

R113.5 Meteorological Phenomena. Meteorology.
Popular Radio. Dec., 1926. Pp. 763ff. "The Effect of Temperature on Signal Strength," E. E. Free.
The discussion pertains to the relation of signal strength to variations in temperature throughout the year. An explanation is offered based on the possible variation of warm and cold waves and the relative ionic content of the atmosphere during such temperature changes. In cold weather the number of ions present per unit area is less than in warm weather, and therefore the friction between them is decreased. This may account for less static.

The "Lightning Jerker"

COMPLAINTS of non-delivery of correspondence addressed to our excellent contemporary the *Lightning Jerker* have been recorded by several correspondents. This was due to a change of address of the editorial offices of that publication, of which the post office apparently was not cognizant. Letters, instead of being addressed to the old Avers Avenue location, should be sent to 1110 Capitol Building, Chicago, Illinois. The *Lightning Jerker* has a Pacific Coast address at Seattle, Washington—P. O. Box 2123.

Erratum

ON PAGE 261 of the January Radio Broadcast there appeared a diagram of a super-heterodyne designed by Mr. Kendall Clough. In error, a single-circuit jack, J, was shown in the plate circuit of the oscillator tube; the jack should have been of the closed circuit type so that the plate circuit is completed through the jack when the plug is removed. Also, the rotor of the oscillator tuning condenser C_3 should connect directly to the shield and not to terminal four of the socket as indicated.

BROADCASTING From The INSIDE

EVERY month in RADIO BROADCAST appears the department, "As the Broadcaster Sees It," written by Carl Dreher, one of the best known broadcast engineers in the country. Alive with humor, news, apt and searching comment, Mr. Dreher's writings have become one of the most popular features of radio writing anywhere. Are you reading it? Subscribe by the year and make sure of not missing a single issue. Mail your check for $4.00 to Subscription Department, Doubleday, Page & Co., Garden City, N. Y.

RADIO BROADCAST

WILLIS K. WING, Editor

APRIL, 1927

KEITH HENNEY
Director of the Laboratory

JOHN B. BRENNAN
Technical Editor

EDGAR H. FELIX, Contributing Editor

Vol. X, No. 6

CONTENTS

AMONG OTHER THINGS. . .

WITH the signing of the "Radio Act of 1927," by President Coolidge, on February 23, the hopes of the country for an improvement in radio conditions take definite shape. However, there is much to be done. At this writing, the Radio Commissioners are not yet appointed, or confirmed by the Senate—a necessary procedure. And even were the Commissioners functioning this minute, their task is so stupendous that it will take many months to solve the complex problems that are theirs. Everything depends on the character and ability of these Commissioners, for the mere existence of the Radio Act does not mean that conditions will automatically be remedied. Although radio programs have never been so good as they are now, the listener and the entire industry alike have suffered tremendously from the unfortunate interregnum in radio control in this country since last June. The United States has been laughed at by the entire radio world. In Canada especially, that laugh has been a bitter one, for the broadcasters and listeners alike in our sister nation have had to suffer for the sins of our own selfish citizens who clamored to broadcast, willy nilly. The leading editorial on page 555—since it had to go to press before the Bill became a law—perforce reads somewhat innacurately in its references to the status of the Bill, but it is correct in every other respect.

THIS number of RADIO BROADCAST contains a breadth of subject which gives it a strong appeal to every sort and condition of radio man. The amateur will be interested in Keith Henney's description of an a. c. short-wave transmitter, and in the exclusive story by Austin G. Cooley on his experiences with the MacMillan expedition. The general reader, too, should find Mr. Cooley's narrative fascinating. How the air can be cleared and what it means to the listener is clearly shown by the editorial and accompanying chart on pages 555-6. Additional data from the listeners' questionnaire appear in "The Listeners' Point of View," and more will appear in our May issue. The consumer and dealer alike will find much solid meat in Edgar Felix's article, "Judging the Tubes You Buy," on page 574. Our many readers who have requested data on d. c. socket-power devices will find James Millen's article on page 580 exactly what they have long awaited.

PRINTER'S *Ink* for February 10th shows that RADIO BROADCAST printed in its February number a total of 23,222 lines of advertising, being exceeded only by *Radio News* with 26,934 lines. The record of other contemporaries for February is as follows: *Popular Radio*, 18,089; *Radio*, 16,597.

AT THE last moment, Ross Gunn's article on coils, announced for April, had to be omitted. It will appear in our May issue. Other features which are coming include: A series of new tube articles by Keith Henney, the first of which deals with modern tubes, how they are measured and what the measurements mean; the first article of a series by Roland F. Beers, dealing with the problems of running tube filaments in series; data on a new type of short-wave receiver; a description of a home-made baffle-board loud speaker; instructions on how to electrify your phonograph, and many other important articles from the Laboratory and from the best writers in the radio field.

—WILLIS K. WING.

Doubleday, Page & Co.
MAGAZINES
COUNTRY LIFE
WORLD'S WORK
GARDEN & HOME BUILDER
RADIO BROADCAST
SHORT STORIES
EDUCATIONAL REVIEW
LE PETIT JOURNAL
EL ECO
FRONTIER STORIES
WEST

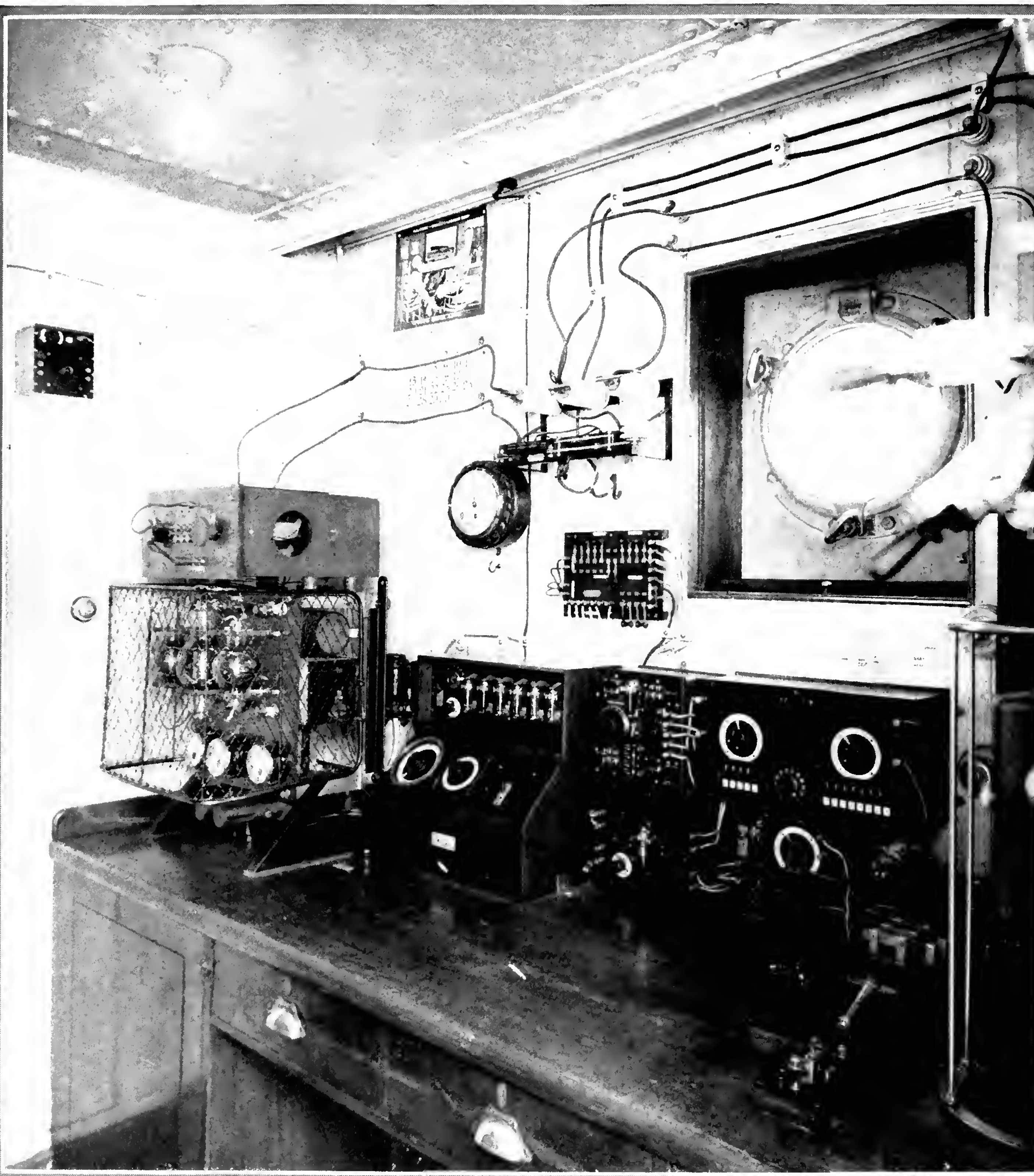
Doubleday, Page & Co.
BOOK SHOPS
(Books of all Publishers)
NEW YORK: LORD & TAYLOR; PENNSYLVANIA TERMINAL (2 Shops); GRAND CENTRAL TERMINAL; 38 WALL ST. and 526 LEXINGTON AVE.; 848 MADISON AVE. and 166 WEST 32ND ST.
ST LOUIS: 223 N. 8TH ST. and 4914 MARYLAND AVE.
KANSAS CITY: 920 GRAND AVE. and 206 W. 47TH ST.
CLEVELAND: HIGBEE CO.
SPRINGFIELD, MASS.: MEEKINS, PACKARD & WHEAT

Doubleday, Page & Co.
OFFICES
GARDEN CITY, N. Y.
NEW YORK: 285 MADISON AVE.
BOSTON: PARK SQUARE BUILDING
CHICAGO: PEOPLES GAS BUILDING
SANTA BARBARA, CAL.
LONDON: WM. HEINEMANN LTD.
TORONTO: OXFORD UNIVERSITY PRESS

Doubleday, Page & Co.
OFFICERS
F. N. DOUBLEDAY, *President*
NELSON DOUBLEDAY, *Vice-President*
S. A. EVERITT, *Vice-President*
RUSSELL DOUBLEDAY, *Secretary*
JOHN J. HESSIAN, *Treasurer*
L. A. COMSTOCK, *Asst. Secretary*
L. J. MCNAUGHTON, *Asst. Treasurer*

DOUBLEDAY, PAGE & COMPANY, Garden City, New York

TERMS: $4.00 a year; single copies 35 cents.



RADIO APPARATUS ABOARD A TRANSATLANTIC LINER

The illustration shows the radio cabin of the SS. "Minnetonka," of the Atlantic Transport Line. At the left is the 750-watt continuous-wave tube transmitter, next is the radio compass, then the main receiver which consists of radio-frequency amplifier, tuner, and local oscillator; to the right is a small emergency transmitter and at the extreme right, not shown in the illustration, is a 500-watt spark transmitter

RADIO BROADCAST

VOLUME X NUMBER 6

APRIL, 1927

With MacMillan to the Arctic

Pages from the Diary of the Radio Operator Aboard the* Sachem *of the MacMillan Arctic Expedition—A Triumph for Short Waves

By AUSTIN C. COOLEY

MUCH progress in short-wave radio communication has been due to Commander Donald B. MacMillan who demonstrated from the arctic regions the merits of low-power short-wave equipment before any similar or commercial application of the new science had been made. Every trip this noted explorer makes into the Arctic means added knowledge to the radio art as well as to many other sciences.

The *Bowdoin* and *Sachem* were the two schooners to carry the members of the expedition made during the summer of 1926. The former is already famous in connection with the exploration work made under the command of MacMillan, while the *Sachem* is a new boat built and fitted especially for the 1926 trip by Commodore Rowe B. Metcalf, a Providence financier. Fitting for the trip included the installation of short-wave radio equipment and the selection of an operator, and Commodore Metcalf put these problems in the hands of RADIO BROADCAST.

As the one chosen for the work, the writer had an interesting time trying to design the radio apparatus to fit the small space allowed by the builder of the vessel. The lack of room on the boat caused many other similar problems, especially in regard to the antenna, so it was necessary to go to the ship and build the radio equipment to fit it. A short-wave receiver for the *Sachem* had, however, already been constructed in the Laboratories of RADIO BROADCAST, and a honeycomb-coil receiver by Frank J. Curtin and Wade Marten, students at Columbia University.

Three weeks before sailing date, I arrived at Thomaston, Maine, where the finishing touches were being applied to the *Sachem* before leaving the builder's yards. The radio work to be done included the building of the transmitter and a common amplifier for the two receiving sets mentioned above.

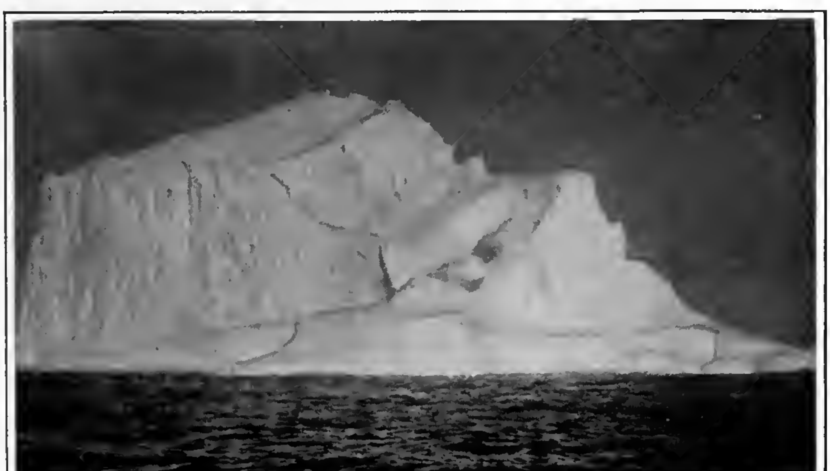
In preparing for the trip, there were many diversions from the radio installation work, such as taking a few practical lessons in handling the ship at sea, and working on air compressors for starting the engine. I readily found that handling the sails in a stiff breeze was no ladies' job, especially at a time when we were running on a skeleton crew while the ship was run from Thomaston to Rockland, Maine, for a general cleaning up of the hull.

From Rockland we went to Wiscasset, Maine, where we loaded stores and became acquainted with our shipmates, who kept arriving daily until the full crew of fourteen had reported. Included in the fourteen were three women, Mrs. Rowe B. Metcalf and two friends, the Misses Maude B. Fisher and Marion Smith. Dr. J. H. C. Martens, geologist, occupied one of the bunks in the forecastle and Novio Bertrand, taxidermist, occupied the bunk below his. Bertrand's was a very unhealthy place because Martens generally had his bunk loaded with rocks to the capacity limit. I had batteries stowed under my mattress, but it was a lower bunk so no one was endangered.

The cabin boy, Henry Sewall, occupied the bunk above mine and the remaining two in the forecastle were selected by Robert Mazet, Jr., the ship's doctor, and Peter Surett, the cook, who had served many years at sea in Gloucester and Nova Scotia fishing schooners. Commodore Metcalf was anxious to get a cook who would not get seasick. Peter had the credentials, for he claimed he had wrung more salt water out of his whiskers than most of us had sailed in!

Just aft of the forecastle is the galley, an unusually large one with a spacious pantry and ice box. Further aft is the saloon, and then a bath room and two state rooms, one occupied by the Commodore and the other by the three ladies. A water-tight bulkhead separates these rooms from the engine room. A seventy-five horse power, six-cylinder Cummins Diesel engine supplied the driving power and two generators driven by gas engines supply the electrical power for charging a 32-volt bank of batteries. Each generator has a $2\frac{1}{2}$-kw. capacity.

Aft of the engine room were quarters to accommodate the remaining four in the crew: Paul B. Warren, Mate; Chas. C. Sewall, Botanist; Egbert Sewall, Chief Engineer; and Captain John



A NATIVE OF THE GREENLAND COAST
One ninth of a native, we should say, for it is well known that eight ninths of an iceberg do not show above the water. This particular one was photographed by the MacMillan Expedition at Godhaven, Disko Island

T. Crowell, of Gloucester, Massachusetts, who proved to be an excellent skipper.

When the radio installation neared completion, tests were carried out daily with radio 2 GY, operated by RADIO BROADCAST Laboratory in Garden City, Long Island. As soon as these tests were begun, a detailed log was kept of all transmission and reception work. In reviewing this log the following entry appears very conspicuously: "G. E. meter resistor, used as grid leak, opens as plate voltage is increased (to 2200 volts)." The entry was made, shortly after the fireworks and smoke cleared up, by "Dynamite", or, G. V. Dillenback, Jr., a friend who had gone through much similar grief with me at radio station 1 XM at the Massachusetts Institute of Technology. We managed to improvise another grid leak for the transmitter after considerable delay and re-established connections with 2 GY.

Grid leak trouble seemed quite important at the time because of the difficulty in obtaining suitable units in New York or Boston. The entry about the grid leak blowing up was made only three days before the sailing date, June 19th.

It was necessary for me to go to Boston and New York before sailing with the expedition, and while I made this trip, "Dynamite" stayed with the ship to clean things up for sailing and do some work tuning up a Conrad antenna (sometimes known as a "Hertz" or a "tuned loop" antenna) which we were experimenting with.

I missed what I imagined to be the best part of the trip—the beginning. At the time of sailing, I was in New York, and could not get away for two days. According to schedule, I was to take the Bar Harbor Express Monday night, June 21st, and join the expedition at Bar Harbor, Maine.

The Bar Harbor Express does not go quite all the way to Bar Harbor. The trip has to be completed by steamer. There was a strong wind and a moderate sea running Tuesday afternoon when I made this part of the trip. In the distance I could see, from the steamer, what appeared to be two small sailing boats. I could not conceive of any reason for boats of their size being out in such rough weather. As the steamer neared Bar Harbor I could see these two boats coming to anchor in the Harbor. They were the schooners *Bowdoin* and *Sachem!*

"Dynamite's" report on the first leg of the voyage did not seem encouraging. The interference noises on short waves appeared to be very bad when the engines were running, and he found it difficult to work 2 GY while the ship was under way. The movement of any piece of metal on board seemed to cause static on forty meters.

From Bar Harbor to the Arctic and back again, I had to do the worrying about the static alone, for "Dynamite" left the ship and returned to his home in Albany.

THE FIRST THREE DAYS AT SEA

THE next port of call was to be Yarmouth, Nova Scotia. The weather for the first twelve hours out of Bar Harbor was fine—the kind that is too good to last. Before turning to go into Yarmouth, Commander MacMillan radioed the following instructions to us: "Weather so good and night so perfect I think we had better round Cape Sable and go down coast instead of going into Yarmouth. If we become separated. . . ."

We rounded Cape Sable, we became separated, and the weather was not so perfect. A moderate sea came up and a thick fog set in. The sea kept getting rougher and the fog thicker. Frequently fishing schooners loomed up through the fog only a short distance away. At times the fog was so thick we could hardly see a hundred feet. We were headed for Sydney, right up at the farthest end of Nova Scotia.

At times we ran as close to shore as we dared so that we could pick up the buoys and fog horns but their significance was none too definite until we obtained the navigating data from the *Bowdoin*. Paul J. McGee, the radio operator on the *Bowdoin*, frequently had to look up these data himself for us because Commander MacMillan and the mate, Ralph P. Robinson, were more than busy handling the ship with an inexperienced crew on watch.

One time, just as I was signing off with WNP, the *Bowdoin*, I heard an unusual commotion on our deck and a general ringing of engine room signals. I went on deck

Circle: Commodore Metcalf despite the fact that he was a long way from home at the time of this pose, finds time to indulge in a genial smile. *Above, left:* One of the most beautiful sights of the trip was supplied by the almost endless panorama of scintillating floes seen at various intervals of the trip

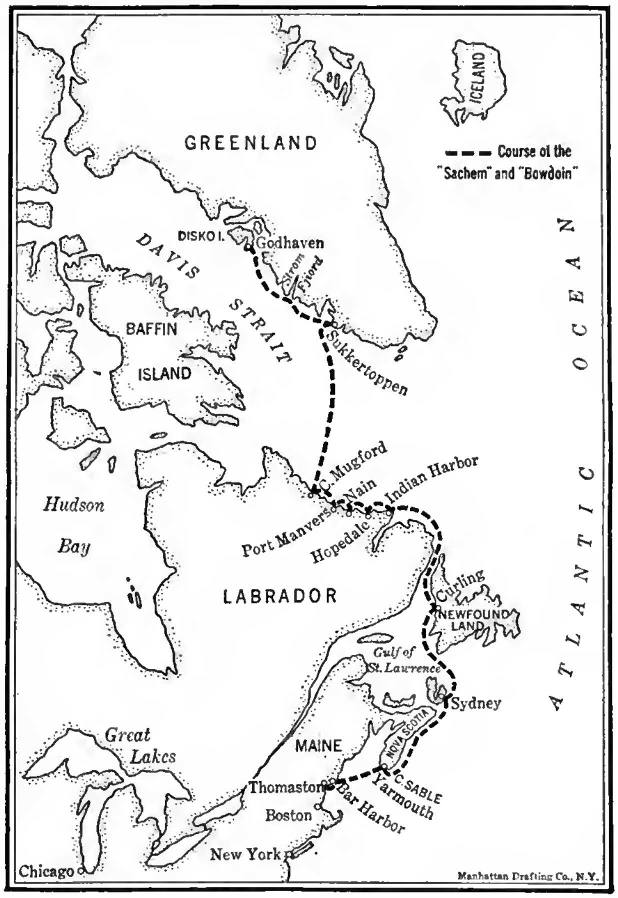
Above, right: Mrs. Metcalf, too, was on the trip—was one of the several women who forsook southern climes in the hope, we suggest, of picking her own sealskin for use in the winter months. *Left:* This minute craft, not a sister ship to the *Leviathan*, is the *Bowdoin*, anchored near Sukkertoppen. She is a seventy-five tonner to help with the sails and to satisfy my curiosity. I found that we had almost run on to some rocks. It required a little fast work to keep the ship clear. One of the girls appeared on deck to find out what all the noise was about. "Get those damned women below!" was the order immediately issued by Commodore Metcalf.

Running the radio was not much easier than running the ship. The fog and sea water on the rigging set up a small amount of electrolysis that sounded like a thunderstorm in the receivers. The sails were slapping against the antenna, and the ship was rolling badly, so my signals stood little chance of getting through without swinging. The signals from WNP had a bad swing too, so we even had difficulty working the short distance between us. After the first day of this run I was unable to handle traffic with 2 GY on account of the heavy roar in the receivers. At 2 GY, reports show that our signals could be heard but the swinging was so great that ours were difficult to copy.

Many of our messages to the *Bowdoin* contained information to the effect that we had no charts, that we ran close to the buoy over certain rocks, etc. The operators at 2 GY in Garden City were trying to copy everything but were only able to get occasional words and fragments of sentences. It so happened that what they received tended to indicate we were in danger and had run on to rocks in the thick fog. This naturally caused them considerable anxiety.

After three days of this kind of traveling, we arrived at Sydney. The trip was uncomfortable because of the cold and dampness due to fog, but the ship rode the seas nicely and took very little sea water on deck. Much to my surprise, the motion of the ship in moderate seas did not seem as bad as on a large vessel. There were a few mild cases of seasickness aboard the two boats but nearly everyone was able to stand his watches. I felt rather miserable most of the time and was a little ashamed to admit it because all on the *Sachem* who had not been to sea before failed to get the least bit sick.

The trip north to Battle Harbor, Labrador, was more comfortable and quite enjoyable. On the way up we stopped at Curling, Newfoundland, for a day. We remember this place because we all tried to figure out how the clocks should be set to conform with Newfoundland time. It is known as "John Anderson" time, and is described by Austin H. MacCormick, who made the trip with us to that point, as "sort of a double distilled daylight saving time."



FROM MAINE TO GREENLAND
The route of the two schooners, *Sachem* and *Bowdoin*, is traced on this map

We passed through fields of large icebergs during the twelve hours preceding our arrival at Battle Harbor on July 3rd. The entrance to the harbor was blocked in places with large 'bergs that had grounded. The weather was clear but cold. Our first glimpse of Labrador was a dismal sight—nothing but hills of solid rock with no trees or shrubbery.

A FEW DETAILS ABOUT THE RADIO

RADIO communication north of Sydney was easier because the rigging was dryer and the ship steadier. At Battle Harbor I made some modifications in the transmitter which helped to steady the wave and improve the signal strength.

At another stop on the Labrador coast—Indian Harbor—I had time to do considerable experimental work as we were ice-bound there for a week. A slight change in the receiver reduced the ratio of ship static to signal strength to such an extent that I was never seriously bothered again during the trip. The connecting together of many of the cables in the rigging and grounding them also helped considerably in reducing the leaks and electrolysis that had been so bothersome.

Difficulties of a swinging wave were fully anticipated before leaving Maine, so plans were made for a crystal control system. A very good crystal had been presented for the work by Mr. H. S. Shaw, of the General Radio Company. This crystal was ground to oscillate at 1359 kc. (220 meters). To operate on 8154 kc. (36.8 meters), it was necessary to multiply the frequency six times. The plans were to amplify the third harmonic of the crystal then double the frequency in the 250-watt power amplifier.

With only two stages of amplification between the crystal and the 250-watt tube, I was not able to obtain sufficient power to properly control the last stage of amplification. Much time was spent during the entire trip trying to get this working properly but sufficient equipment and space were not available for an additional stage of amplification, which probably would have remedied the matter.

The space available between the two masts for the Conrad antenna was so limited that it was necessary to use considerable loading inductance to bring the natural period of this antenna up to 8154 kc. (36.8 meters). When using only 600 volts on the plate of the 250-watt oscillator tube instead of the rated 2000, it was possible to obtain a current of 2.5 amperes in the Conrad antenna. Every time the plate voltage was increased, the transmitter cabinet resembled a Fourth of July celebration. After considerable effort to operate this antenna properly with full power I compromised by tuning the antenna a little below the 36.8-meter point, and used its feeder as an antenna also. The results were quite satisfactory. This was done to avoid the risk of causing damage to some of the transmitting apparatus.

Regular communication with 2 GY was being maintained on a schedule of three nights a week. Generally we were so close to the *Bowdoin* that it was difficult for one to receive while the other was sending so we divided up the available time for communicating with the States in a way that was proportional to the amount and importance of messages to be handled.

THREE MODERN MUSKETEERS
A "snap" taken in the North. From left to right we have: Egbert Sewall, engineer; Commodore Metcalf; and Austin Cooley, radio operator, assistant to the engineer, camera man, night watchman, etc.

We had no restrictions on the hours of operation during the day so there was an opportunity to carry on some tests with 2 GY on 13,630 kc. (22 meters). While we were on the Labrador Coast, the 22-meter signals could be heard at 2 GY during the day but they were too weak to be used in the handling of messages.

WE CONTINUE OUR TRIP UP THE LABRADOR COAST

AFTER an impatient wait at Indian Harbor, we pounded and cut our way through the heaviest ice pack on the Labrador Coast that Commander MacMillan had ever seen. We made a short stop at Hopedale, the most southern Moravian Mission Station, then went on to Jack Lane's Bay to pick up Abe Bromfield, MacMillan's Eskimo interpreter. Plans were to proceed from there across Davis Straits to Greenland but the ice pack off shore appeared so solid that the Commander decided to take us further up along the Labrador Coast through an inside passage hoping we might work to the north of the pack that had been rapidly moving to the southward.

We made two other stops on the Labrador Coast, one at Nain, a Moravian Mission station, and one at Port Manvers where Commander MacMillan and a party made an inspection of some ruins of stone constructed dwellings thought to have been built by Norsemen. From Port Manvers we worked our way up the coast to Cape Mugford, the highest peak on the Labrador Coast, then turned out through the heavy ice fields toward Greenland.

A view from the cross trees of the masts as we sailed through this field of ice offered a sensation impressive enough to appear as one of the outstanding features of the trip. I borrowed Commodore Metcalf's Graflex and took a "shot" from the cross-tree of the mainmast. This was my first attempt at operating a Graflex. As a result, the Commodore assigned me the responsibility of using his Graflex and two movie cameras the rest of the trip. I had practically no experience in the art of photography, so he expected the results that most beginners produce.

In addition to being radio operator and photographer, I was supposed to be Assistant Engineer, but the Chief Engineer was such a hound for work he required very little assistance. On the run between Bar Harbor and Sydney, I stood a couple of watches in the engine room, and I squirted a little oil around the engines on the run to Greenland.

OUR ARRIVAL AT GREENLAND

THE trip across to Greenland represented three days of ordinary sea travel. The seas were moderate most of the time and generally there was some fog. This caused us to become separated from the *Bowdoin* after the first day out from the Labrador Coast. After we left the Coast, we encountered no more ice until we came within a hundred miles or so of Greenland. As we approached the Greenland Coast, a thick fog was encountered.

At twenty minutes after noon, land loomed up off the starboard bow only a few hundred feet away. From here we cautiously sailed south, keeping in sight of land so that we might pick up the beacons marking the entrance to Sukkertoppen. Our chart consisted of a pencil sketch with no scale of miles. After only a short run of twelve miles, we were welcomed by a fleet of kyaks manned by Eskimos who came out to meet us and point out the channel into the harbor.

Commander MacMillan took the *Bowdoin* to the south of Sukkertoppen then anchored and waited a day for the fog to lift so that he could determine his position and then proceed into Sukkertoppen without taking the risk of running through unknown waters full of dangerous rocks and ledges.

The absence of the *Bowdoin* in the Sukkertoppen Harbor the first night of our arrival gave me an opportunity to operate the radio during the entire night and test it out for distance. The evening started off pleasantly by hooking up with 1 AKZ (A. Hurnan, Gardner, Massachusetts). He showed signs of being an excellent operator in the way he took a large file of messages in a very short time. Station 1 AKZ proved to be a very valuable relay station a number of times after that. Before giving the crew of the *Sachem* a rest from the intermittent wail of the radio generator, I worked 9 DMZ (Kansas City, Kansas), 9 AEK (Topeka, Kansas), and 6 VR (San Francisco, California).

In reply to a call from VOQ, the schooner *Morrissey* of the Putnam Expedition, on July 26th, I received the following: "Aground Northumberland Island, Whale Sound, Greenland. If possible tell 2 UO (New York *Times* Station) or any U. S. station please listen for low-power set." After additional conversation with VOQ, I sent out a QST notifying the Amateur Radio Relay League Stations of VOQ's situation.

Because our wavelength was below the amateur band I had some difficulty in raising anyone in the States who could take a message for the New York *Times*. Shortly after three A. M., 3 ZO (H. A. Beale, Jr., Parkesburg, Pennsylvania) answered my call. It was not long before the signals faded out so we were no longer able to communicate but we were fortunate in getting through the essential news of the condition of the Schooner *Morrissey* and its crew before the fading set in.

Our trip north from Sukkertoppen included a long run into Strom Fjord, which crosses the Arctic Circle. Just as we were approaching this invisible line, the *Bowdoin* went hard aground while running at full speed. A strong wind was blowing down between the mountains that bordered the Fjiord so it was difficult to handle the *Sachem* and get a line to the *Bowdoin*. After considerable effort and fast work this was accomplished but, before we could clear the *Bowdoin*, we also went hard aground on the Arctic Circle. To be a little more exact, we were about three thousand feet from the Arctic Circle. For a while it did not look like a very pleasant situation but after a good struggle both the *Bowdoin* and *Sachem* managed to get clear, and that night we learned that the *Morrissey* had also floated herself off the rocks. In trying to clear ourselves, the great power from the engine was more than the reverse gear could stand, and it gave way.

Resting at anchor almost on the Arctic Circle, and locked in by high mountains except for a narrow opening in the Fjord, we had a very successful night with the radio. The signals were received in the New England States with considerable strength although they were weak in the New York district. The signals from the 50-watt transmitter of 2 GY, at Garden City, came through well enough so that I was able to copy six messages in a row without missing a word.

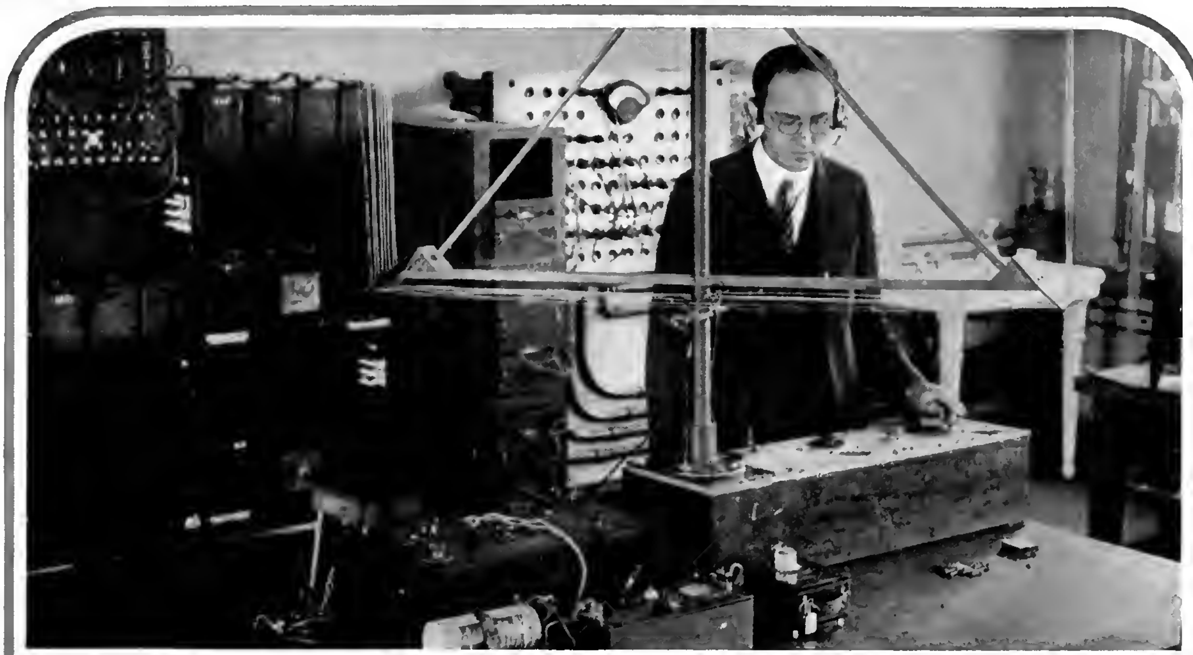
Our most northern stop was at Godhaven, on the Island of Disko. It was a real surprise to find here an excellent modern radio installation that consisted of a thousand-watt tube transmitter for long waves. The equipment was built up and installed in as neat a manner as will be found in any American broadcast station. Direct communication with Denmark is accomplished daily by this station as well as is contact with a series of other stations in Greenland.

Godhaven has another institution of modern science. It has a terrestrial magnetic observatory operated by the Danish Government. I had the pleasure of a long conversation with Mr. Olsen, who is in charge of the work, and was given the opportunity of helping him in a way by letting him have a few of my spare Ray-O-Vac batteries.

The difficulty of getting signals through to the New York district kept increasing, so a regular schedule with one of the most reliable stations in New England was established. This station was 1 AAY, owned and operated by Kenneth M. Gold, at Holyoke, Massachusetts. The *Bowdoin*, WNP, was using 1 ZK, M. L. MacAdam, at Wollaston, Massachusetts, as a regular relay station although 1 AAY also handled a good portion of WNP's traffic, especially during the first part of the trip. Stations 1 ZK and 1 FL, D. G. Meserve, Hudson, Massachusetts, also handled a number of the messages from KGBB, the *Sachem*.

Press was received regularly from the New York *Times* Station, 2 UO. His signals came through strong and steady regardless of heavy seas and ship static, and I always found it easy to copy him on my Corona, which had been fitted up with a telegrapher's keyboard.

Our trip home was found to be as mucn or even more interesting than the outward trip. An account of it, including information on some important observations made of radio phenomena during magnetic storms, will appear in a later issue of RADIO BROADCAST.



THE MARCH OF RADIO

News and Interpretation of Current Radio Events

Welcome to the Radio Commission

A ROUSING welcome to the new Radio Commission is in order. Although, at this writing, the radio law is not yet passed, we have such definite and reassuring information that the compromise bill will become the law of the land that we do not hesitate to give three cheers of encouragement to speed the Commission to its arduous labors.

The Radio Commission will have full power for one year, during which time it is supposed to undo the present broadcasting knot and to formulate rules and regulations to guide the Department of Commerce's administration of radio matters. At the end of the year, the Commission becomes an appellate body, reviewing the decisions of the Department of Commerce and hearing the appeals of irate broadcasters. The law is, as we predicted, a political compromise between the administration and the opposition radio bills.

Congress having thus, in effect, delegated its legislative powers to a committee of five men, much depends upon their individual and collective qualifications. Indeed, being guided by no principles established in the law, these five men have it in their power to make or break radio. The entire industry and, more important, broadcast listeners, should rally to their aid.

To solve broadcasting problems effectively, requires more than an ardent spirit of public service and an enthusiastic interest in broadcasting. These qualifications can be easily assumed by any politician out of a job. In addition, every member of the Commission must be sufficiently expert in radio matters to understand the basic principles of frequency allocation and the selectivity limitations of receiving sets. Each must think clearly in terms of "frequency channels," "kilocycles," "service areas," "heterodyning" and "carrier range." Each must forget the misleading term "wavelength" and all the distortion of the situation which its use brings.

The first task of the Commission will be a comprehensive study of the existing situation. How rapidly it will be able to dispose of such dangerous propositions as the pressure to extend the broadcast band downward, brought by short-sighted would-be broadcasters and selfish set manufacturers, seeking to create an artificial market for short-wave receivers; the fatuous claims of the more recently licensed stations to a place in the ether; and the uneconomic proposals to split time on the air rather than eliminate excess stations wholesale, depends on the background of knowledge and experience which the individual members have in broadcasting matters.

Deliver Us from Excess Broadcasting Stations

THE principle must be recognized that the fewer broadcasting stations there are on the air, the more stations the listener can enjoy. Freedom of the air does not require that everyone who wishes to impress himself on the radio audience need have his private microphone to do so. Indeed he would be much better served, if he is now operating his own station for that purpose, to combine it with four or five others in order to form a really important unit in the broadcasting system. The leadership in combining stations is a negotiation which is best undertaken by the radio manufacturing industry rather than a political commission. In consolidation of stations lies the only salvation of broadcasting.

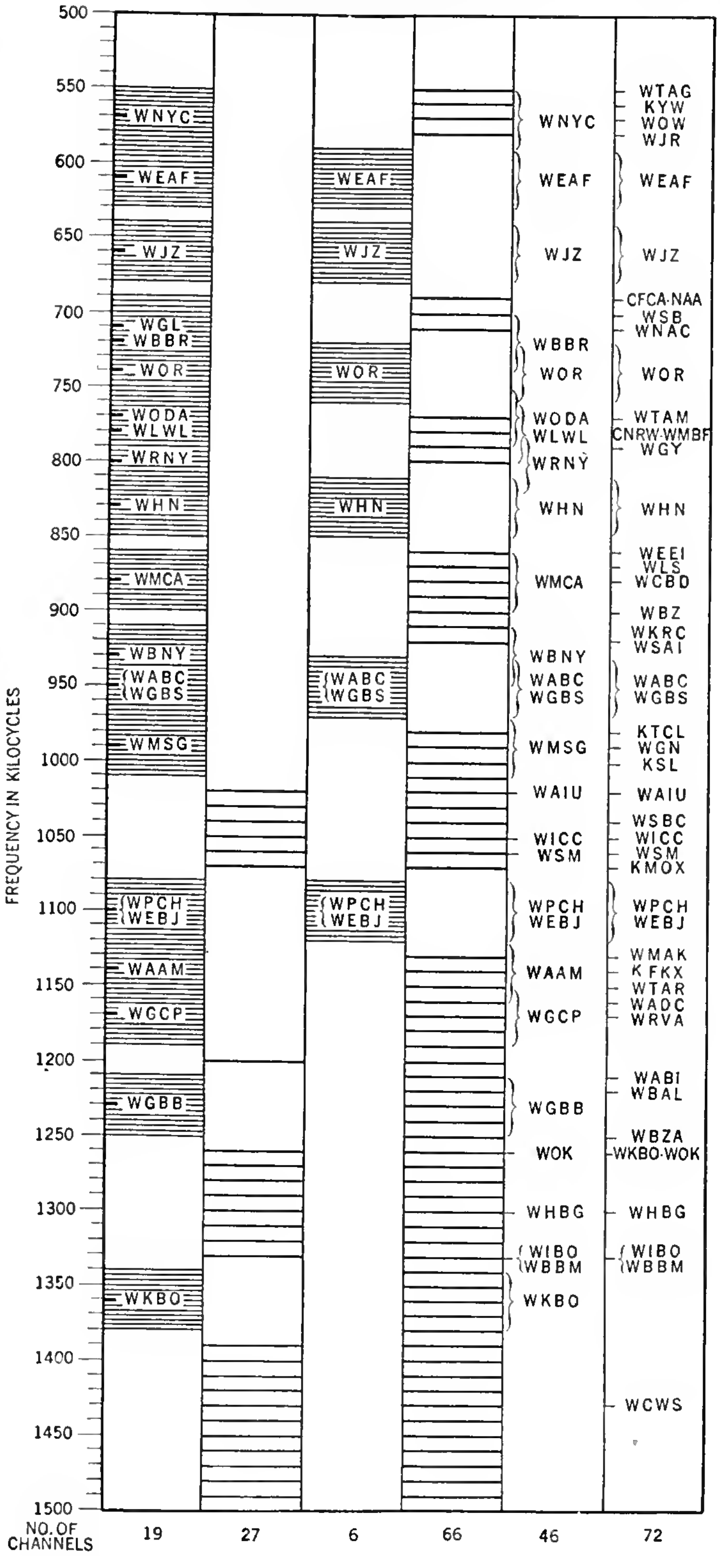
We now have about one hundred, high-grade, key stations, which are rendering excellent service and are recognized as favorites by broadcast listeners. We have five hundred additional stations vainly struggling for the position of key stations but, because of their excessive numbers and

---

The illustration forming the heading this month shows apparatus used at the Bureau of Standards, at Washington, to determine the distance over which radio receivers may be expected to give service under all kinds of conditions (© Harris & Ewing congestion, unable to make any material progress in that direction. If each five of these combined to form a single station, it would reduce the number of stations to the point giving the listener the best possible service. Not only would consolidation increase potential audiences of remaining stations fivefold, but actually tenfold, because the elimination of congestion would considerably increase their service ranges. The individual share of maintenance cost of each station sponsor would be reduced by eighty per cent. by combination with four others, thus enabling him to employ talent rivalling the best of stations. Instead of owning a joke of a station of his own, a station sponsor would have an interest in a real, high-power, broadcasting station, with a substantial audience. Under these conditions, the monopoly of good broadcasting now held by the chain system would at last be faced with real and sorely needed competition.

Consolidation and bigger investment in station facilities, however, cannot be hoped for until the individual broadcasting organization is protected in its ether franchise. When the Government faces the problem of dispensing privileges, such as public lands, railway franchises, or ether channels, which can be accorded only to a limited number, private capital is offered it in return for accepting the obligation to perform a public service of a definite standard. In return for the investment, the holders of such franchises are protected from destructive competition. Broadcasting station investments deserve the same protection. If it is not accorded to them, then the risk of capital expenditure in broadcasting becomes too great and the progress of the art is consequently hampered by hesitancy of capital.

Before consideration can be given to the rights of individual stations, the principle of length of service on the wavelength now being used by a station should be established as the basis for determining the claims of rival stations to the same frequency. Station KDKA, for example, has broadcast for about six years on its present wavelength. Had it been one of those stations which upset conditions by shifting their wavelengths upward three or four months ago, its priority to its present wavelength would then be, by all sound reasoning, only on the basis of three months of service.



THE EFFECT OF REDUCING NEW YORK LOCAL STATIONS

Reception in the New York City district would be greatly improved by the consolidation into six main stations of the many broadcasters now licensed to operate in that area. This chart, prepared by Edgar Felix, gives a visual indication of the result of such a consolidation. In column No. 1 are listed the more important of the forty odd local stations which may be heard with an average four-or five-tube receiver. Column No. 2 indicates just what outside channels may now be tuned-in through the locals, the assumption being that a local station blankets out stations on two bands above and below its allotted frequency. Column No. 3 shows the proposed consolidated stations, no attempt being made to re-space them equally in the frequency spectrum made available by the discontinuance of the many lesser stations. Column No. 4 shows that the number of outside channels made free by cutting down the locals has been more than doubled. The fifth column is a typical log made in the early evening when all of the locals are on the air, while column No. 6 is an imaginary yet conservative log supposing the suggested consolidation to have gone into effect. An expensive, highly selective receiver is now capable of tuning-in more outside stations than are shown in columns No. 2 and 5, probably to the extent of a dozen or so.

Wavelength jumpers, who abused the broadcasting privilege, should not receive the same consideration as those who rendered faithful and orderly service on their assigned wavelength throughout the broadcasting dark ages, the only course which decency and honor dictated. Stations which pilfered Canadian wavelengths should be forever banned from the ether.

A list of all stations now operating, and their present wavelengths, arranged in the order of date on which these wavelengths were adopted, should be prepared for the Radio Commission. The first hundred stations are the pioneers who advanced broadcasting to its present high standing and they should be given permanent licenses with a minimum of delay.

Naturally, acceptance of the principle of priority will bring loud howls of protest on the part of those who discovered broadcasting in 1926 and invested a few thousand dollars in the face of repeated public warnings that there was no room for them in the ether. Unfortunately, some of these persons have considerable political influence and, by taking advantage of the facilities of the gullible press, they can make loud shouts about discrimination in favor of the interests of huge monopolies. The smallest of these protesting broadcasters has interests just as selfish as those of the most hardened trust. He has some product, carburetors, cartridges, or calliopes, to thrust on the public, which could be exploited more efficiently through a good and established broadcasting station. The duplication of broadcasting facilities is not a public benefit and should not be tolerated to accommodate lusty-lunged publicity seekers who have made no contribution to the advancement of the broadcasting art.

The foundation of the Commission's work should be a basis of frequency allocation which permits every station to be heard without interference to the limit of its service range. Such a basis means that a maximum number of stations can be heard by every receiving set, and this entails reducing the present number of stations by about four hundred.

Whether the Commission will

have the courage, foresight, and backing of the radio public and the radio industry to bring about such a healthy weeding out of stations is doubtful. If the radio industry, however, is to grow to its fullest strength, wholesale station reduction is absolutely necessary. Although the average cost of a radio set is under $150, there are only one third as many sets in operation as there are pleasure automobiles. The radio industry has sold to only a fourth of its potential customers. The only reason the radio market has not come to its own is because of lamentable broadcasting conditions. The industry could well afford to establish a fund of several million dollars to negotiate and encourage the consolidation of stations; It would be promptly repaid by vastly increased sales.

We offer our concrete suggestions as to how curtailment and consolidation of stations could be worked out—in the New York area, for example. The accompanying chart is calibrated in ten-kilocycle frequency channels. The first column shows a typical list of some of the stations now licensed and in operation within twenty-five miles of New York and which may be received with an average set—and the frequency band which they occupy; the second, the number of out-of-town channels which can now be tuned-in by an average five-tube receiver; the third, the maximum number of stations which should be established in the New York area by combination of three or four existing stations if the rest of the country is to have an adequate number of channels and New York itself interference-free reception; the fourth, the greatly increased number of out-of-town channels which can be tuned-in under the proposed allocation plan; the fifth, the stations now heard with an average receiver operated near New York; and the sixth, some of the stations within reach of New York, which, under good conditions, could be tuned-in by a good five-tube receiver.

A local station usually excludes out-of-town stations on each of the two channels above and below its own frequency as well as those on its assigned channel. A station more than fifty miles away rarely, if ever, covers more than its ten-kilocycle channel, however. Every local station eliminated, therefore, means perhaps five additional stations for the broadcast listener. The chart shows that consolidating the New York stations to six, will, under good conditions, make available sixty-six out-of-town channels through local broadcasting, instead of twenty-seven.

It is not possible to list in the first column every one of the local stations which are heard under all and sundry conditions, but the list, as presented, serves to show the contrast between the present system and that suggested here.

Station WNYC should be discontinued because its program standards are hopelessly below par and will remain so unless the city appropriates a million dollars a year for talent. The station, furthermore, is not being used entirely for broadcasting purposes; its point-to-point communication for broadcasting police alarms is misuse of the broadcasting band.

FRANK A. ARNOLD

Mr. Arnold recently joined the National Broadcasting Company as director of development. For the past nine years he has been an officer in the Frank Seaman advertising agency. His work in the N. B. C. will present an interesting opportunity to combine his experience with visual mediums with radio—the aural medium

Stations WEAF and WJZ are the acknowledged leaders in the New York area and both deserve a place in the ultimate line-up of stations. The character of programs of WEAF and WJZ should, however, be more consistently planned to appeal to different audiences. Two similar programs should not be broadcast at the same time by these two or any other two stations in the same area. If extensive curtailment of stations along the lines suggested herein is carried out, every station in a given area should be compelled to formulate a policy appealing to the taste of a special audience.

Newark's WOR has endeared itself to a large audience, but it should be the only New Jersey representative in the metropolitan area. It should absorb WNJ, WAAM, WKBO, and WODA, etc., now contributing nothing but congestion to the situation. Each of these stations is struggling under the handicap of interference and lack of prestige. Their absorption by WOR would be most desirable from every standpoint, including that of the persons now paying the bills for their maintenance.

Stations WABC and WGBS now share the same channel and might profitably be combined in a single station. Broadcaster WEBJ, or one of the others in that frequency region, could readily assimilate WPCH, WQAO, WMSG, and WBNY, in the hope of making one strong station out of the present conglomeration of radio noise which they now thrust into the ether. Or still better, the whole group might better combine forces with WABC and WGBS so that only five major stations of ample resources would be serving the New York area.

Likewise the many other smaller stations in the New York area. By consolidation with one of the six they would reach a potential audience of undreamed of proportions compared with the paltry few who now, by virtue of the fact that they reside under the shadow of the individual stations' antennas, are forced to listen to so much—well, blather.

There would be no difficulty in securing adequate revenue from commercial broadcasting to make each of these consolidated groups a tip top station. Broadcasting in New York would be so attractive under these improved conditions that the radio audience would double in a year.

Punishment for the Defenseless Ether

BETWEEN July 1, 1926, and January 15, 1927, 181 new broadcasting stations have been placed in operation, 148 additional stations were under

© Harris & Ewing

TESTING AT THE BUREAU OF STANDARDS

The investigator shown in the illustration is making tests to determine the faults in radio battery jars, by means of polarized light. Part of the equipment employed is shown construction, 280 have announced plans for building stations, 150 increased power, 70 announced plans to increase power, and 104 old stations changed their wavelengths. Only those of the 150 who increased power without changing wavelengths have any real priority rights to their channels.

The Network System Grows

PRESIDENT COOLIDGE'S Washington Birthday speech was well broadcast by thirty-eight stations, including six in New England, eight in the north Atlantic states, one in the south Atlantic, twelve in the central west, three in the south central states, one in the west and seven on the Pacific coast. Three southern stations, WSM, Nashville, WSB, Atlanta, and WHAS, Louisville, have been added to the "blue network," bringing wire programs to a large area heretofore relying on local talent.

On the Pacific Coast, a chain, including KGA, Spokane, KJR, and KEX, Seattle, KYA, San Francisco, and a new station in Los Angeles, is to be placed in operation in the near future. This chain hopes to establish relations with the National Broadcasting chain, although it is unlikely that commercial broadcasters will find it profitable to radiate their programs on a national scale because of the time difference.

Upon the heels of that announcement comes word of the formation of an N. B. C. chain on the coast, including KPO, San Francisco; KGO, Oakland; KFI, Los Angeles; KFOA and KOMO, Seattle; KGW, Portland; and KHQ, Spokane. Perhaps we shall see two rival chains fighting for program superiority. It is unfortunate that there is no such competition in the east, but so long as congestion remains in its present state, that situation is inevitable.

Well Administered Canadian Radio

OUR northern neighbors have succeeded in managing their radio affairs with a competence which is a marked contrast to our own methods. Unfortunately, American wavelength pirates have destroyed the interference-free reception conditions which prevailed in Canada prior to the loss of the WJAZ case in Chicago. The Radio Branch of the Department of Marine and Fisheries provides at cost, equipment to suppress radiation from electrical apparatus which interferes with broadcast reception. It aids interested persons to locate the sources of interference and advises how to remedy them. The interference suppression service of the Canadian Government is the only one like it in the world and is a remarkable evidence of helpful government coöperation. A total of 134,486 broadcasting receiving stations are licensed at an annual fee of one dollar, this providing the principal revenue for radio regulation. At the time of writing 22,831 bearings have been furnished by radio beacon stations and the average number per month is continually increasing and is now at about 1900 per month. One hundred and forty-five ships, plying from Canadian ports, are equipped with direction finders.

THE EXTERIOR OF A JAPANESE BROADCASTING STATION

Station JOCK at Nagoya, Japan. The apparatus is of English manufacture, and six kw. is the power input. The station operates on 832.8 kc. (360 meters)

The Lethargic Radio Industry

RADIO RETAILING states that 1,750,000 sets were sold during the last season, as compared with two million the year before, a decrease of twelve and a half per cent. The average price, however, has risen from $83 to $115 so that gross sales for the year will be larger than last year. Considering, however, that the radio market is only twenty-five per cent. sold and that this year's ether conditions were twice as good as last year's, two and a half million sets should have been distributed this season. The industry's apathy about the broadcasting situation has cost it a pretty penny.

Conflicting Radio Standards

THE Radio Manufacturers' Association announces that tentative or permanent standards have been adopted by it on fifteen items, including filament rheostats, sockets, panels, and other small parts. Both the set constructor and the manufacturer will profit by standardized mountings and wiring color codes. It is very unfortunate however, that two competing trade associations are establishing standards and indulging in a stupid war upon each other, thus defeating the usefulness of the work of each of them. This is another demonstration of the radio industry's deplorable lack of foresight.

The Weak Radio Listener "Organization"

WE ARE in receipt of data from the Iowa Radio Listeners' League and several petitions circulated by listeners in various cities of the central west, indicating several attempts at listener organization. The broadcasting situation could be immeasurably helped if listeners themselves raised their voices with a little vigor now and then. Although there have been a few petitions, some of them supporting dangerous proposals, there is not a single person who stands out, except in his own mind, as the representative of large bodies of listeners. One or two men are spokesmen for groups of two or three hundred listeners, but only an infinitesmal proportion of the 20,000,000 enthusiasts has ever given voice to their desires in matters of broadcasting regulation. We doubt very much if the radio listener can ever be organized. During the last season, he has been faced with the virtual destruction of broadcasting by wanton publicity seekers, with hardly a sound of protest.

Interesting Field-Intensity Measurements

A PAPER by Lloyd Espenschied, of the A. T. & T. Company, supplementing earlier papers on radio broadcast coverage of city areas, appearing in the January *A. I. E. E. Proceedings*, illustrates in a startling and conclusive way the effect of slight changes in location upon signal intensity in different directions. A half-kilowatt broadcast transmitter was installed on a motor truck and field strength measurements were made in all directions from a number of broadcasting station sites. The measurements prove beyond any doubt that to locate a broadcasting station in the

GERALD WENDT
State College

Dean, School of Chemistry and Physics, The Pennsylvania State College. Especially written for RADIO BROADCAST

"The most striking phenomenon in America to-day is the flood of returns which are pouring in on the electrical industries from their far-sighted investment in fundamental research, a policy adopted fifteen years ago when many people thought that electricity had already reached the peak of achievement. To-day, no one questions the policy, and other industries are learning the lesson. In August I ventured to predict in The Nation's Business *that events would be broadcast by combined radio-telephony and television by 1929. Within a month a man's mobile smile has been transmitted by radio. And now, within four months, Dr. E. F. W. Alexanderson announces that the broadcasting of moving pictures is imminent. It's a swift life nowadays, and the pace is set by the electrical world."*

middle of a city is certain to introduce transmission irregularities of a surprisingly large intensity. Some of the measurements indicate that moving a station ten miles further away from a receiving point within twenty miles of the transmitter may actually increase the signal strength. Commercial broadcasting stations, making claims of coverage to prospective users of the broadcasting medium, must soon be in a position to substantiate their claims by field strength measurement maps, prepared by a disinterested expert body. Recently, we saw a solicitation from a station in Buffalo which demonstrated quite clearly that it thoroughly covered the United States with its five hundred watts, while, as a matter of fact, field strength measurements might well show that there are even some sections of the city of Buffalo which do not hear it with adequate volume.

The Month In Radio

THERE are now 702 ships in the world equipped with radio direction finders, an increase from 291 in the last two years. Of these, 268 are American ships, 252 are British, and 63 Italian the rest being distributed among other countries in smaller numbers. We have 30 radio beacons in service, Canada seven, Spain five, Great Britain four and other countries smaller numbers.

Captain Fritz Kruse of the Hamburg American liner *Resolute*, took occasion recently to vent some well deserved wrath upon the indoor sea captains who send out SOS calls when they actually need a ship carpenter. He says that younger captains get hysterical upon the slightest provocation and that much of the self-reliance of seamen has been sacrificed by too much dependence on radio. There has been occasional criticism that broadcasting stations do not always stop for distress calls. The abuse of the SOS privilege for trivial matters is a sure way to encourage this practice.

EARL R. GLENN and L. A. Herr have prepared a pamphlet of interest to teachers of manual training in the schools, entitled *Curriculum Studies on the Place of Radio in School Science and Industrial Arts.* It gives a thorough study of the author's experience with various types of radio sets suited to schoolroom construction and gives the exact constructional details, including the cabinet work, for a number of practical outfits. The book should be helpful to all manual training teachers.

THE New York State Legislature is having a bill brought before it, introduced by Assemblyman Edwin J. Coughlin, who proposes a censorship of broadcasting programs and an annual fee of $100 to be paid by each station in the state to maintain this pernicious censorship. Upon a complaint in writing of five or more persons, a clause of his bill reads, that any of the regulations of the bill are being violated or that obscene or indecent programs or messages have been broadcast, a commission is to investigate and may revoke a station's license. Five soreheads with a little political pull could thus close down any station. There has been no complaint about the broadcasting of obscene matter and there is no excuse for this stifling and high handed bill. It is quite evidently a move of small minded politicians who would gather unto themselves power far in excess of their competence. If unnecessary censorship must be devised to hamper broadcasting, at least let its exercise be safeguarded so that it interferes only with real abuses. But why even consider a censorship until we have abuses?

A FORTY-PAGE document, comprising Secretary Hoover's reply in response to Senate resolution No. 149, seeking light on the relations between Major General Squier and the American Telephone & Telegraph Company in wired wireless matters, contains some evidence that the amiable friendship between the two is not being maintained at its fullest ardor. A casual reading of the document leads to the conclusion that the A. T. & T. is getting something for nothing, just as General Squier once seemed to intend when the patents were dedicated to the public. Now he wishes to collect royalties.

There seems to be no question about General Squier's priority in conceiving the transmission of radio-frequency currents over telephone wires which makes possible the utilization of a single wire channel for many services simultaneously, and also that the A. T. & T. has profited greatly from the utilization of the discovery. General Squire contends that he dedicated it to government use only, although he has been unable to convince the courts that the marking on the patent papers dedicating it to the public does not express his original desires in the matter.

MICHAEL I. PUPIN
Philadelphia

President, American Association for the Advancement of Science:

"The most important advance in the art of electrical communications concerns the transmission of magnetic action at a distance." The theory of this transmission was really worked out by the great Scotch scientist, Clerk-Maxwell, and published sixty years ago, but his great theory was not understood by the telegraph and telephone engineers for more than thirty years, and so the art of transmission of electro-magnetic action was not advanced.

"That which contributed most to the advancement during the last thirty years was undoubtedly the classical electrical wave experiment by Hertz in 1888 and Marconi's invention of the wireless in 1895.

"The Maxwellian theory of electrical transmission was the light that shineth in the darkness and the darkness comprehended it not; but the Hertzian experiment, and Marconi's wireless transmission, were nothing more or less than a simple inference from the Maxwellian experiment. These two achievements helped the telegraph and telephone engineer to comprehend Maxwell's light."

THE DeForest Radio Corporation successfully defended a suit brought by the General Electric Company which charged that its patents in the use of certain methods of preparing tungsten for use in filaments had been infringed. Federal Judge Morris's opinion held that the ductibility of tungsten was an inherent quality of that metal and therefore unpatentable.

In its original state, tungsten is highly fragile, and methods of making it ductile were disclosed by Doctor Coolidge, who described necessary highly intensive research work and considerable expenditure. The patent law clearly states that properties of materials, however remotely concealed, are not themselves patentable. The discovery of the ductility of tungsten has made the electric light bulb of tremendously increased utility and service.

WCFL in Chicago threatens to increase its power from 600 to 5000 watts. If it radiates that amount of power so that it interferes with WEAF, as it has done in the past, the program value of WEAF will be reduced very nearly to zero. It is unfortunate that about a million innocent listeners would be spattered with the mud of such an asinine ether onslaught.

Further Comments on the R. B. "Lab" Receiver

The Substitution of Dry Cell Tubes for the Storage-Battery Type—A. C. Heating of the Power Tube's Filament—Coil Data—The Advantages of Shielding—How to Use a Loop—Some Trouble-Shooting Hints

By THE LABORATORY STAFF

OF THE many minor changes that can be made to the "Lab" circuit as originally described in RADIO BROADCAST, there are few that are so simple as the substitution of dry cell tubes for the big fellows that require storage batteries. Pity the enthusiast, the farmer for example, far from a source of power by which he can charge batteries or run power tubes. Tubes of the 199 and 12 types are his only chance unless he undergoes the periodic task of hauling a battery to town.

Although there may seem to be something mysterious, something tricky, about this circuit to many readers, there really is no reason why

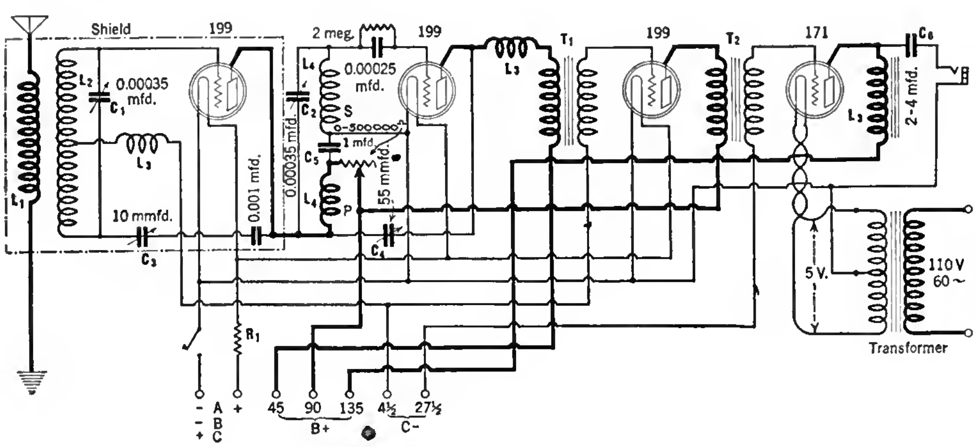


FIG. 1

small dry cell tubes may not be used satisfactorily. In the original article on this interesting circuit, published in June, 1926, the correct ratio of turns between the primary and secondary of the coil connecting the radio-frequency amplifier to the detector, for the different types of tubes used, was given, and for those who build their own the data given elsewhere on this page will be of value.

The mere substitution of a 199 for the 201-A tube in the detector and radio-frequency sockets without the bother of re-tapping the detector inductance, is all that is necessary for the average reader. It is only necessary to change the tap on the coil, which is designed for a 201-A, if the utmost is desired from the receiver. With present-day confusion in the ether, the gain in selectivity and slight loss in volume resulting from the substitution of a higher impedance radio-frequency amplifier tube—a 199 for example—will be worth while.

When it comes to the final stage in the audio amplifier, the 120 is the proper tube for dry cell operation, although a much better one is the 171. The latter requires one-half ampere at five volts, which may be obtained from a bank of dry cells arranged in series-parallel to prolong their life. The 120 draws only 0.125 amperes of filament current, while its filament voltage is the same as that of the 199 tubes. Where it would be impossible to power from one set of dry cells a four-tube set drawing one and a quarter amperes of filament current, it is not impractical to draw from a separate bank of batteries the current required for the single half-ampere tube, such as the 171, and use separate cells for the other tubes.

In substituting dry cell tubes of the 199 and 120 types requiring 3.0 to 3.3 volts on the filament, for those of the 201-A type, it is necessary to change the filament resistances, a simple matter indeed. It is true that these small tubes do not have the voltage amplifying ability of their larger brethren but it is also true that in a radio-frequency amplifier they are simpler to neutralize and to "hold down," and that, for a given amount of input filament power, they are about ten times as efficient as storage-battery operated tubes. Dry cell tubes also have the disadvantage that they are somewhat more microphonic, but there are simple remedies for this trouble.

An even better—almost ideal—arrangement, is the use of three dry cell tubes and a fourth power tube operated from a.c. This cannot be done by the farmer remote from power lines, but for the city dweller who does not care to face the storage battery problem with its charger and accessory apparatus, the inclusion of three dry cells to heat the filaments of the first three tubes in the console that houses his radio, need not bother him at all. If in addition to the business of running his 171 power tube from a.c., a device is used to supply high voltages for the plate circuits also from the house lighting system, the user has a receiver that requires almost no attention.

To light the filament of the last tube from a.c. requires only slight changes in the wiring of the set proper. It will be necessary to disconnect the filament wires of this tube from those of the three other tubes and to run a twisted pair of wires outside the set proper to the secondary of a small step-down transformer such as those sold as "bell-ringing" transformers. In Fig. 1 the connections of a receiver of this form are shown.

The method of lighting the filament of the last tube from a.c. has been described several times in RADIO BROADCAST and one should have no difficulty in following the diagram and in making the necessary changes.

There are several methods of returning the grid and plate circuits to the center of the filament transformer. This is usually done by making a center tap on the transformer secondary, but it is not difficult to use a potentiometer of any value for the same purpose. See Fig. 2, A.

If the filament transformer delivers more than the required five volts (which is probable), it will be necessary to reduce the voltage. The rheostat or fixed resistance for this purpose must be connected between the transformer and the potentiometer, as shown in Fig. 2, C. Fig. 2 also shows: A, the method of connecting the potentiometer across the toy transformer's secondary to return the grid and plate circuits to the center of the transformer, and, B, how this same

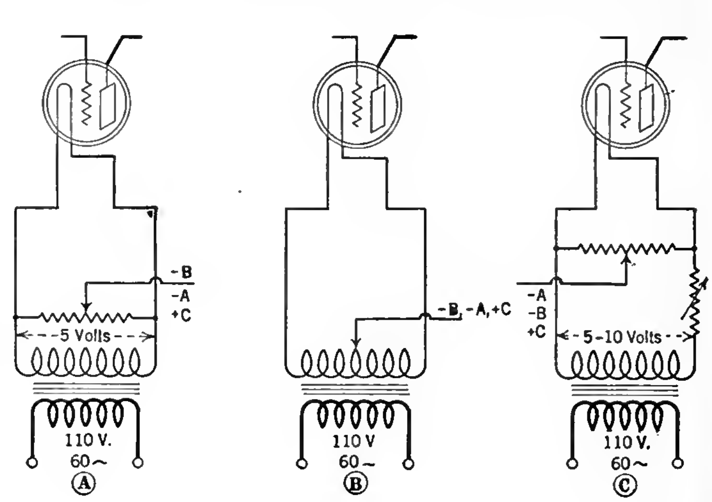


FIG. 2

thing is accomplished by using a mid tap on the secondary of the transformer.

It is worth noting that a power tube drawing one-half ampere in a four-tube storage battery-operated receiver represents forty per cent. of the total current drawn from the storage battery,

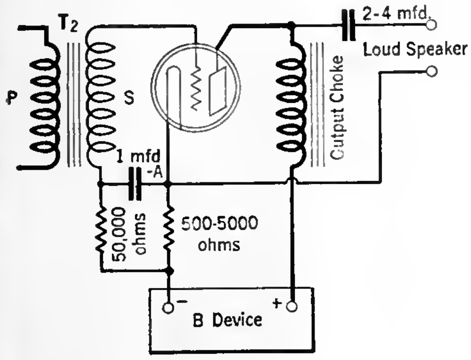


FIG. 3

so that relieving the battery from the final tube current is a distinct advantage from the standpoint of battery economy and care.

COIL DATA

THOSE who desire to use the correct number of plate turns for various tubes will find the following table useful. It is only necessary to divide the total number of turns in the detector coil by the factor given below to determine the place to insert the bypass condenser. Of course the larger part of the coil is the detector input, "S" in Fig 1.

TUBE	TURN RATIO	FACTOR
199	1.57	2.57
12	1.75	2.75
201-A	2.00	3.00
112	3.00	4.00

For example, if the coil has 75 turns and a 199 type tube is to be used, the plate turns, "P", are $75 \div 2.57 = 29$, which leaves 46 for the detector input coil, "S".

The matter of tapping the coil properly, however, is not extremely important, and those who desire to improve the sharpness of tuning in the detector circuit will do well to decrease the turns in coil P. This will, however, be at the expense of some voltage gain at the lower radio frequencies.

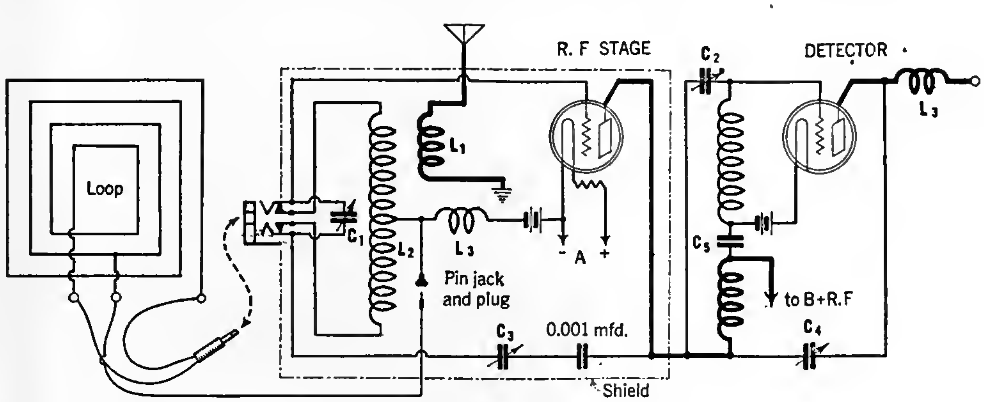


FIG. 5

GRID BIAS

MANY readers seem interested in securing C bias for the last tube from the device that supplies the plate voltage for the set when such is employed. It must be remembered that in this case the total voltage obtained by adding the C bias to the plate voltage must be delivered by the B power device. For example, the 171 type of tube requires a bias of 27 volts when 135 volts are used on the plate. This means that the total voltage must be 162, which must be maintained when the set is in operation and probably drawing a total plate current of about 20 milliamperes.

Inasmuch as there are many devices supplying plate voltages now on the market capable of delivering more than 160 volts at a drain of 20 milliamperes, it is easily possible for them to supply C bias as well. It is only necessary to force the plate current of the last tube to flow through a resistance on its way back to the negative filament lead—or center tap if a.c. is used on the last tube's filament—and to take the drop across this resistance as C bias. Fig. 3 shows in diagrammatic form the method employed and indicates that the resistance should be variable to get the proper bias. For example, if 135 volts are used on the plate of the 171 tube, the plate current will be about 12 milliamperes. The required voltage drop will then be $0.012 \times R = 27$, whence $R = 27 \div 0.012$, or 2250 ohms. It is well to include a bypass condenser as shown as well as a high resistance in the C lead to the transformer. This condenser-resistance filter will keep any hum out of the grid circuit. If there is no output choke or output transformer, a bypass condenser should be placed across the C bias resistance. Readers interested in this method of obtaining C bias should read Laboratory Information Sheet No. 73, in the March, 1927, RADIO BROADCAST.

DETECTORS

WHEN a C-battery detector is used, it may be found that the regeneration condenser, C_4, is not large enough to cause oscillation over the entire band. This is often the case with a plate voltage of 45 and a C bias of negative 4.5 volts, and the solution is to increase the plate voltage to about 67.5, or a little under this figure if possible. For freedom from microphonics, and for somewhat better quality, the oxide-coated 112 tubes can be recommended as detectors. They have considerably lower output impedance and, due to their heavier filament, are not so liable to be mechanically noisy.

For the best quality and greatest freedom from line noises when using a B power-supply device, a separate dry B battery for the detector is to be highly recommended. It is only necessary to connect its negative terminal to the negative of the power supply device and to connect the detector B wire from the lower side of the first audio transformer to the positive terminal of the B battery. This is shown in Fig. 4.

With the proper B and C adjustment, the detector should slide into oscillation quietly. With improper adjustments it will go into oscillation with a "whoop," and there will be considerable "hang-over" on the regeneration condenser.

HAND CAPACITY

THE greatest source of trouble with the four-tube receiver is from hand capacity on the antenna or radio-frequency amplifier dial. This is due to the fact that neither rotor nor stator is at ground potential. There are several solutions. In the first place, complete shielding of the radio-frequency amplifier will practically eliminate this difficulty, and at the same time make the receiver more stable, more easy to control, and eliminate much unwanted "pick-up" from local stations. Another method of decreasing hand capacity is to use a dial that has no metal connecting to the metal parts of the condenser. Yet

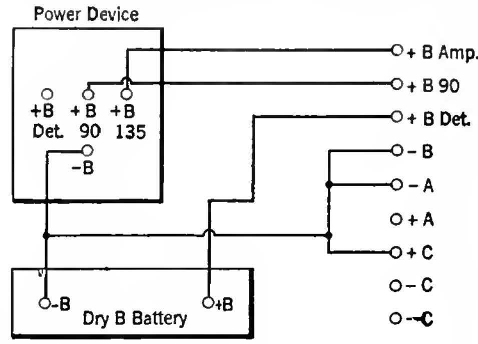


FIG. 4

another is to use a condenser with a shaft made of insulating material or to use an insulated coupling device between the condenser and the shaft that fits into the metallic dial.

USING A LOOP

IN OPERATING the four- or two-tube "Lab" receiver with a loop, several slight alterations must be made so as to allow easy change from antenna to loop connection.

The change is made with the aid of a jack and plug. The jack is of the double-circuit type into which a plug, connected to the loop terminals, is inserted.

The secondary coil of the antenna stage has its end leads connected to the inner terminals of the jack. The tube circuit, that is, the grid and neutralizing condenser points of the circuit, are connected to the upper and lower outside blades of the jack respectively. When the plug is not in the jack, the two inner blades make contact with the outer blades and connect the coil to the radio-frequency tube.

When the plug is inserted, the upper and lower outside blades are sprung away from the inner blades, disconnecting the secondary coil and in its stead connecting the loop to the tube circuit.

Since there is a third contact—the center of the loop—provision is made by means of a single pin jack located on the same insulation support in which is mounted the loop jack, so that a flexbile lead from the center point of the loop may make contact with the circuit via the pin jack, which is permanently connected to the center tap on the secondary coil.

Reference to Fig. 5 shows the revisions necessary in the circuit to include the loop, while Fig. 6 gives the dimensions of the insulation strip which supports the loop jack and pin jack.

The loop has pronounced directional characteristics, and it will be observed that signals are received loudest when the loop is turned with its plane in a line running between the center of the loop and the station received.

Where hand capacity effects are noticeable in the operation of the loop, this undesirable condition may be eliminated by turning the loop inside out. This is done by connecting together the two outside ends and using this connecting point as the center tap of the loop. At the original center tap the continuity of the turns of the loop is broken thus providing two leads which may be fastened to the terminals of the plug. Fig. 7 illustrates this point.

SHIELDING

A SET may gain a great deal by partially shielding it.

It is probable that even sticking a metal plate between the coils, or condensers, of a set does some good. At least the inclusion of the plate must distort the field between the apparatus on its two sides in such a manner that some inter-apparatus coupling is eliminated, and therefore it may be argued that the metal plate does some good. It is certain that surrounding the coil, condenser, and tube of the radio-frequency amplifier of the "Lab" circuit with a tightly fitted metal box isolates that circuit from the detector much better than any trick method of placing coils, and that the resultant freedom from unwanted coupling between amplifier and detector is worth every minute of the time involved.

In the Laboratory, such shielding nas been made of aluminum, copper, or brass. On one occasion a copper box was made from a single piece of metal and every crack was soldered, so that the amplifier was as totally shielded as possible. Wires came into it through very small holes, and there was provision for grounding the shield, or letting it hang "high and dry," assuming any desired potential with respect to earth.

In every case the shielded receiver had a marked freedom from hand capacity, a much greater freedom from unwanted pickup from strong local stations, and, when, equipped with plate voltage filters consisting of condensers and chokes as shown in Fig. 8, was remarkably stable and easy to operate. With a loop input, the detector unit should be shielded as well as the r. f. amplifier if the best possible results are desired. In this case there will be a minimum of feedback from the detector coil to the loop. A complete metal panel will be much better than a metal plate behind only the antenna tuning condenser.

TROUBLE SHOOTING

THE following paragraphs are not for those unfortunate members of the home constructors society who, like Voltaire's Doctor Pangloss, believe this to be the best of all possible worlds—all because they, personally, never make a mistake. Rather, these few words are for ordinary mortals like ourselves who are occasionally faced with a receiver that is surprisingly silent.

In the first place, one should take courage for, as Edgar Felix recently pointed out in RADIO BROADCAST, a receiver that seems dead may actually be in a state of coma only; like the Sleeping Princess, it may await the wakening hand.

Let us suppose the four-tube receiver has been connected up—properly, of course—and that we have gone over the connections several times, but that no sounds emanate from the loud speaker. The first thing to do is to test out the audio amplifier. It is a two-stage affair using Amertran De-Luxe transformers, and should have an overall voltage amplification of about 300. To test it,

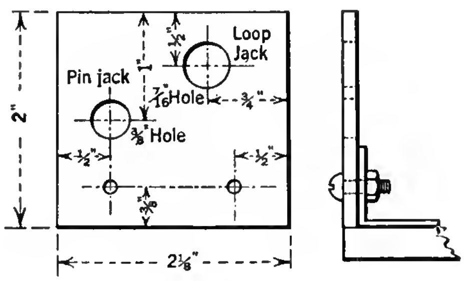


FIG. 6

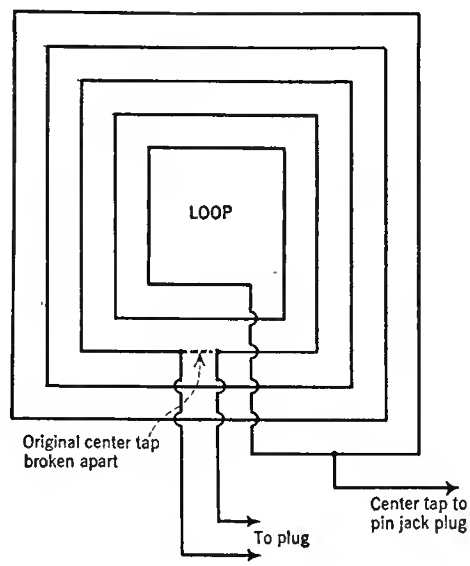


FIG. 7

gently tap the detector tube when a resounding "bong" should come from the loud speaker, or from a pair of phones across the output. If there is no "bong," start from the loud speaker end and make certain that each of the two tubes gets plate voltage.

A sharp click will be heard when the plate voltage is taken from either of the tubes. If the tubes get plate voltage, and if the connections are correct, shorting the input of the amplifier should also produce a click—which may require a pair of receivers to hear. Speaking into a pair of receivers connected across the input to the amplifier will make it possible to test the amplifier as a whole, the receivers acting as the pick-up device. If the loud speaker indicates that the amplifier reproduces the owner's voice, it proves that the amplifier is working properly. Then the receiver-pickup may be placed in series with the detector tube B-battery lead and again spoken into. This will indicate whether or not the detector gets plate voltage.

If the amplifier works, and the detector has plate current, the next step is to attach the antenna on the plate terminal of the radio-frequency amplifier with that tube out of its socket. The receiver will then be a single-circuit blooper and carrier waves at least should be picked up. If signals are heard it proves that the final three tubes in the set are working properly. The antenna should then be placed on the inductance side of the neutralizing condenser. Signals should now be weak—but if they have the same intensity as before it proves that the neutralizing condenser is shorted, a fact that may not be apparent unless tested in this way. Shorting takes place occasionally in a compression type of neutralizing condenser and causes considerable trouble.

The next step is to place the r.f. tube in its socket and to connect the antenna to the grid of that tube. If signals are now received the antenna may be connected to its proper terminal. With local stations it often happens that signals will be heard even though the r. f. tube is not getting plate voltage. Under these conditions, adjusting the neutralizing condenser will seem to have little effect and signals will be weak since there is no gain in the amplifier tube. It is even possible to receive signals if the detector gets no B battery voltage.

If there is difficulty in neutralizing the amplifier tube, plate voltage filtering will aid. The lower part of the plate inductance should be bypassed back to the amplifier negative filament lead and the B-battery voltage fed through another radio-frequency choke. It is also well to filter the detector plate voltage, thereby making the radio-frequency circuits short and direct, and keeping the r.f. currents where they belong. Fig. 8 shows where these bypass condensers are located. They may be anything from 0.01 to 1 mfd. in capacity, and probably 0.1 mfd, will do all that we can expect. The choke in the 90-volt lead may be a Samson or similar 85 mh. inductance.

If the audio amplifier "rasps" on medium or loud signals of rather high frequency, it is regenerating. This may be due to high-resistance B batteries or plate voltage supply, or to a direct feedback between the input plate lead and the output leads. If the audio amplifier is distinct from the two-tube tuner unit, the input to the amplifier should not be run in cable from the tuner unit.

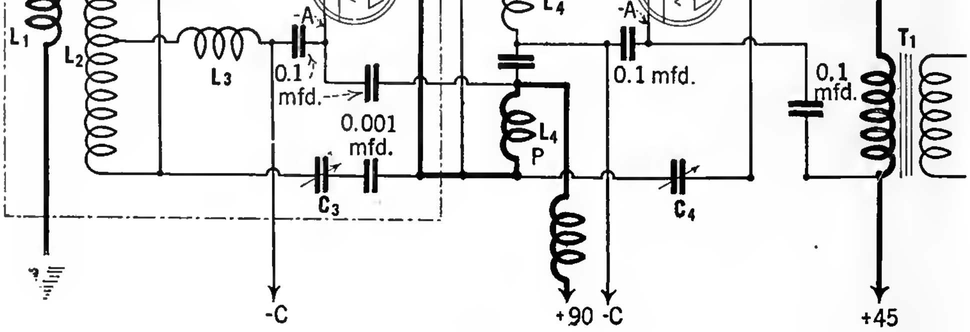


FIG. 8

Have You an Old-Type Freshman "Masterpiece?"

If Yours Is the Old Model A or B Receiver You Can Improve Its Quality by Resorting to Either of the Four Methods Outlined Here

By KINSGLEY WELLES

OWNERS of the old type model A or model B Freshman Masterpiece receivers, or similarly designed tuned radio-frequency sets, are addressed in this article, which explains in detail some simple alterations that can be made to give greatly improved quality. These particular Freshman receivers have now been in use for several years and, during this time, several new power tubes, detector tubes, loud speakers, complete audio-amplifier units, and power amplifiers have been placed on the market. With a few easily made changes many of these new accessories may be used in the Freshman "Masterpiece" and similar receivers.

To improve the quality:

1. We can connect a separate single-stage power amplifier such as the Pacent "Powerformer" or General Radio power amplifier to the output of the first stage and thereby not only improve the quality but also supply, from the amplifier, B potential for the rest of the receiver.
2. We can use a complete new audio amplifier such as the "Truphonic," in place of the amplifier in the receiver. A complete power amplifier, such as the National, may be connected to the detector output.
3. We can use a completely home-constructed power amplifier to replace the audio amplifier in the receiver and also use the power amplifier to supply plate potential for the r. f. and detector tubes; many home-constructed power amplifiers have been described in recent issues of RADIO BROADCAST.
4. We can use a power tube in the last stage with the necessary high C and B battery voltages.

Any of the suggested changes will give considerable improvement although, of course, just using a power tube in the last stage will not effect as marked an improvement as will be obtained if a complete new audio system and power tube are used. The four suggestions have not been arranged according to their desirability but more so according to the ease with which the changes can be made, and we will describe them in the same sequence.

The first suggestion is that a separate power amplifier be used. A single-stage power amplifier which usually also supplies B potential for the whole receiver may be employed to advantage, for not only is B power supplied to the entire set, but filament power and C voltage for the power tube are also obtained from the power mains. Amplifiers of this kind are of two general types — those employing the 210 power tube, such as the Pacent "Powerformer," and those employing the 171 power tube, such as the General Radio or National units.

To install a power amplifier of the single-stage type, it is merely necessary to plug the input cord of the power amplifier into the jack marked "Phones" on the front panel of the Freshman receiver. When thus connected, the last audio stage in the set is replaced by the power amplifier. The – B, + B Det., and + B Amp. posts on the back of the power unit are connected to the corresponding posts on the receiver sub-panel. The tube should be removed from the last audio socket (left-hand rear socket) in the set. Slightly better results may often be obtained if the set is first removed from the cabinet and the wire marked 4 in Figs. 1 and 2, cut. This is the flexible lead from the plate prong of the first audio socket to the primary of the second audio transformer. The ends of the cut wire should be covered with tape in order to prevent them from touching any other bare wire or metal part, and thus causing a short-circuit.

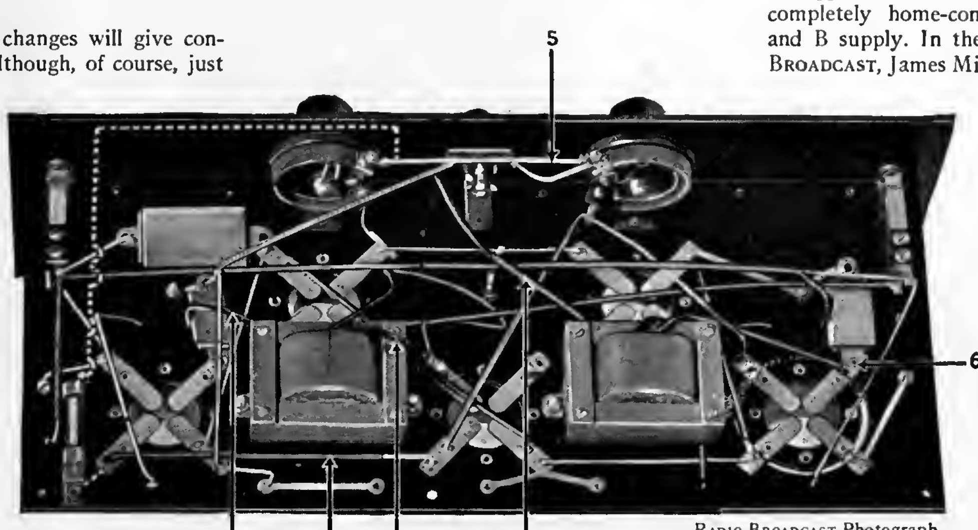
If the reader is willing to go to the expense and trouble, it is a good idea to replace the first-stage audio transformer in the receiver with one of the new high-inductance primary units, such as the Pacent "Audioformer." To do this, merely cut the four leads from the present first-stage transformer and run them to the four terminals of the new transformer, taking the necessary care to see that the various leads are not inter-changed, but connected to the proper transformer terminals. Rather than attempt to mount the new transformer in the space formerly occupied by the older Freshman transformer, it is suggested that it be placed on top of the sub-panel between the detector and first audio tube sockets.

WIRING IN A COMPLETE NEW AMPLIFIER

THE second suggestion is that we use a completely new audio amplifier with a power output tube in place of the amplifier already in the receiver. Of the many amplifiers that might be used, the "Truphonic" double-impedance or the Millen resistance-coupled amplifiers will be found eminently satisfactory. To use, for example the "Truphonic," proceed as follows: First remove the two audio tubes from the rear left and center sockets; second, remove the detector tube from the rear right socket, slip the special input lead on the "Truphonic" over the plate prong on the detector tube, and then replace the latter in its socket; third, connect the battery cable on the amplifier to the batteries; fourth, place two 201-A or high-mu tubes in the first two sockets of the "Truphonic" and a power tube in the last socket of the amplifier, making certain that the proper C and B battery voltages are used on the power tube; fifth, connect the loud speaker to the pin jacks. This completes the installation of the amplifier, and the improvement in tone obtained through its use will be very noticeable.

Suggestion number three was that we use a completely home-constructed power amplifier and B supply. In the last few issues of RADIO BROADCAST, James Millen has described the construction and operation of a number of such power units. The use of such a device with the Freshman receiver permits of well nigh perfect audio quality and necessitates only slight changes.

To make the changes it will be necessary to remove the receiver from the cabinet. There are five screws to be removed before the set can be taken from the cabinet. Three are along the back edge of the shelf and one is located at either end of the mahogany strip that runs along the top edge of the front panel. When the set has been



RADIO BROADCAST Photograph

FIG. 1

As much of the wiring in the Freshman receiver is located under the panel, it is necessary to remove the set from the cabinet before making the majority of changes suggested in this article. The arrows indicate places at which new wires are to be attached or old ones cut, as outlined in the text. The dotted lines indicate the connections for an automatic filament control resistance for the power audio tube

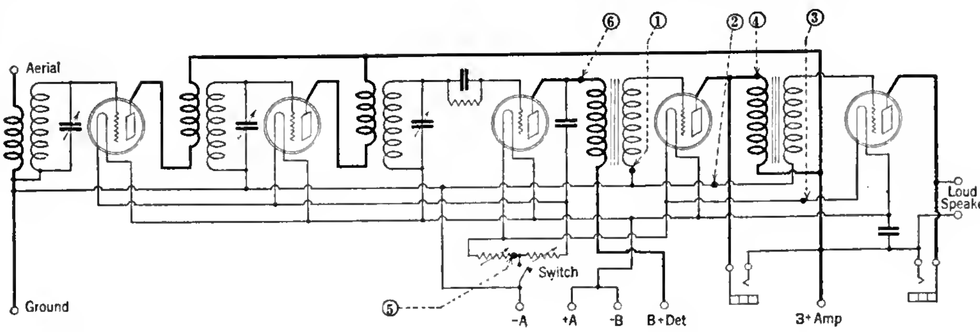


FIG. 2

The circuit diagram of the receiver before any changes are made. The arrows correspond to those in Fig. 1

removed from the cabinet, turn it upside down as shown in Fig. 1. The rear edge of the shelf should be supported so that the set will not rest on the coils.

The necessary changes are to add to the points numbered 5 and 6 in Figs. 1 and 2, leads of flexible rubber-covered wire. These two leads should be left several feet long since they must make connection to the power amplifier.

The complete diagram of connections showing the receiver connected to the power amplifier —B supply device is given in Fig. 3. This layout also includes an automatic relay and trickle charger. With such an arrangement the switch on the panel of the receiver controls the a. c. power, the A power for the amplifier, and the A power for the set. Full details on the operation and adjustment of a suitable amplifier are contained in an article in the January, 1927, issue of Radio Broadcast entitled, "A Combined Amplifier and A. C. Operated Power-Supply Unit."

WIRING IN A POWER TUBE

THE fourth suggestion is that a power tube be used in the output in conjunction with the regular audio amplifier in the receiver. This suggestion, which sounds the easiest, really necessitates more changes in the receiver than any of the foregoing suggestions.

Some people have the idea that one of the new power tubes may be substituted for a 201-A type tube in the last audio amplifier socket of any radio set without making any changes whatsoever to the wiring of the set. Such a substitution of tubes is only possible in those cases when the plate potential for the last tube is brought out to a separate binding post and when there is also provision for high value of C battery on the last tube. Power tubes should never be used without proper C batteries or the tube will be ruined and the quality will be little better than that obtained from a 201-A type tube.

In order to use a power tube most advantageously in one of the old "A" or "B" Freshman receivers, the following changes are necessary:

1. The B batteries and loud speaker must be connected in a slightly different manner in order to have a high plate voltage (135 to 180 volts) on the last power tube and only normal voltage on the plates of the other tubes. In the old Freshman "Masterpiece" receiver the r. f. tubes and both audio stages have the same plate potential.

2. The proper C batteries for the new tube must be used. The old Freshman receiver, as manufactured, is equipped with neither C batteries nor C battery terminals.

3. In those cases where a 171 type tube is to be used with more than 135 volts, it will be necessary to use an output device to protect the loud speaker from damage.

4. The audio amplifier rheostat in the old type Freshman receiver is only designed to take care of the current drawn by three 201-A tubes. If a power tube is substituted for one of the 201-A's, the present rheostat will be overloaded and will soon burn out. The power tube filament must be controlled by a separate rheostat, or a half-ampere filament ballast resistor.

These changes should be made as described below. Do not cut any wires until you are sure that you are cutting the right lead. Also, the leads connecting the transformers into the circuit should be handled carefully since they may easily be broken:

1. The grid return lead from the secondary of the first audio transformer should be cut at the point indicated by arrow No. 1 in Figs. 1 and 2 and a flexible lead soldered to this terminal of the transformer. This lead will supply C battery to the first stage and it is indicated as $-C_1$ in Figs. 4 and 5.

2. The grid return lead from the secondary of the second audio transformer should be cut at the point indicated by the arrow No. 2, and a flexible lead also soldered to this transformer terminal. This lead supplies C battery to the power tube. It is marked $-C_2$ in Figs. 4 and 5.

3. Completely remove the lead marked No. 3 in Figs. 1 and 2 by cutting it free at the socket prongs to which it connects.

4. Mount a filament ballast resistor (for a 0.5-ampere tube) and connect as indicated by the dash lines in Fig. 1, to the wire joining the two rheostats.

Replace the set in the cabinet and connect the batteries and loud speaker as shown in Fig. 5. At the right of this drawing is shown an output device which had best be incorporated if a 171 tube is used in the last stage with more than 90 volts (90 volts is sufficient for the 171 tube for average purposes), in which case no output device need be included. Output devices are of two general types. One consists of a choke coil and condenser, while the other is a special transformer resembling in external appearance one of the new large size audio transformers. Either type is satisfactory for use here. Output transformers are made by Silver-Marshall, General Radio, and several other manufacturers. National, Mayolian, General Radio, and others make satisfactory choke-condenser combinations. Space within the set is limited so it will be best to mount the output device on the outside of the cabinet.

The B and C batteries shown in Fig. 4, are of correct value when the last, or power tube is of the 112 type and the other tubes are of the 201-A type. While the 112 is not capable of delivering to the loud speaker anything like the same amount of undistorted energy as the 171 power tube, it is to be recommended in preference to the 171 where B batteries are employed as the source of plate potential. The 171 requires a heavier plate current than the 112 and as a result is not so economical when operated from dry B batteries.

Where a B power-supply unit is to be employed, however, then the 171 is the output tube to use rather than the 112. The correct grid battery voltage for either the 112 or the 171 for different values of plate voltage are as follows:

Tube	Plate Voltage		
	135	150	180
UX-112 . . .	9	9	—
UX-171 . . .	27	33	40

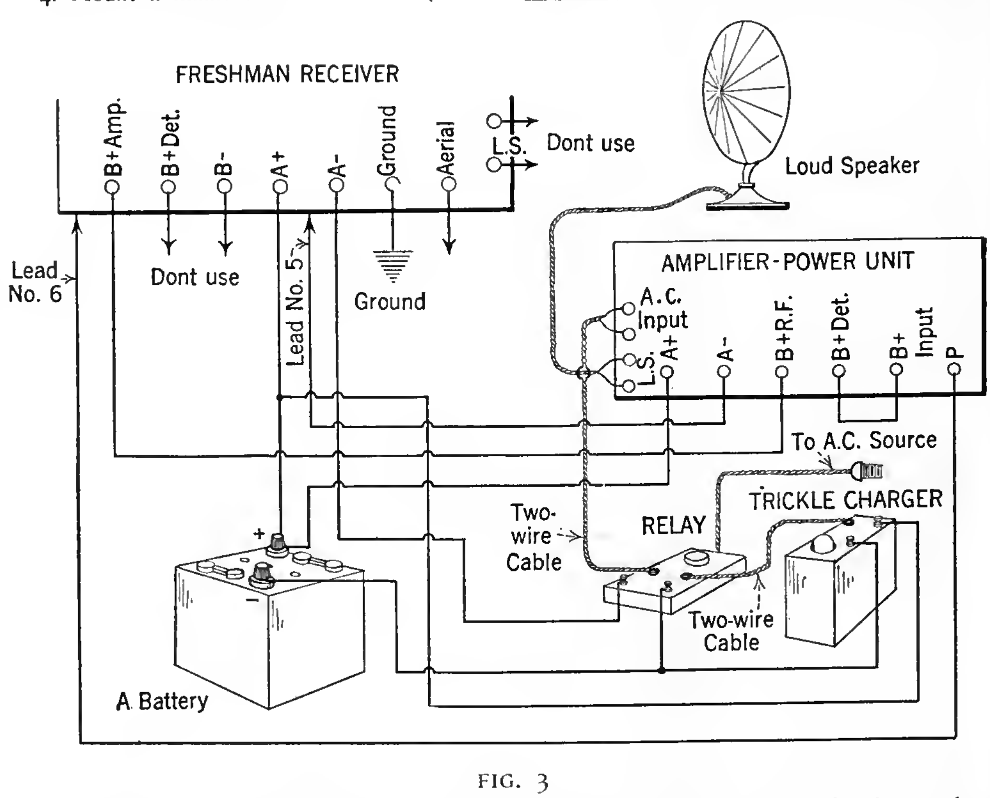


FIG. 3

The Freshman receiver will give very excellent results when used in connection with the complete power amplifier and B supply device described in the January issue of Radio Broadcast. In this diagram complete connections for the receiver and amplifier, with an automatic power control relay, are given

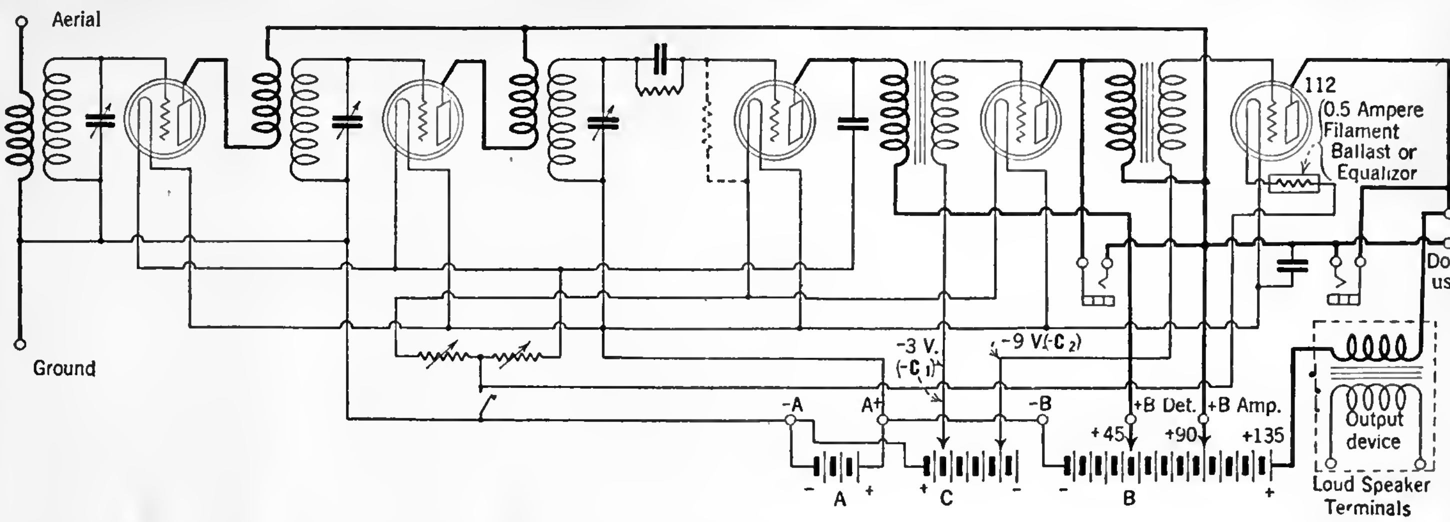


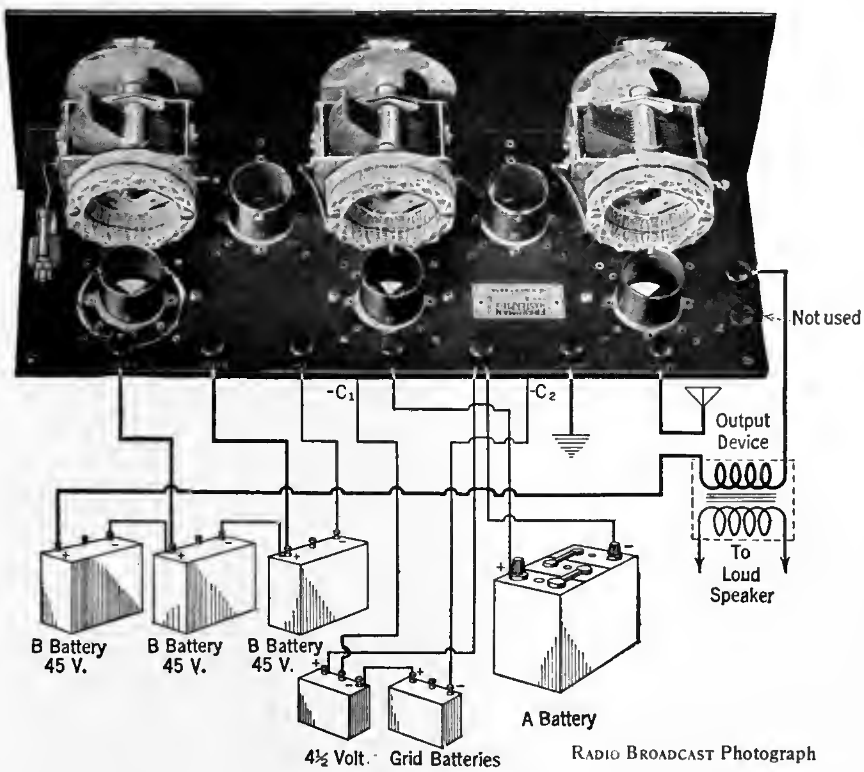
FIG. 4

The circuit diagram of the receiver after the wiring for a power tube has been made. At the right is shown an output transformer which is essential if a 171 tube is used in the output with more than 90 volts but need not necessarily be used in conjunction with a 112 tube. The plate and grid voltages shown are satisfactory for a 112. A table printed on page 564 gives the correct B and C voltages for other tubes. The two C-battery leads, minus C_1 and minus C_2, should be connected as described in the article. If a 201-A tube is used as a detector, no changes in the detector circuit are necessary, but for a new type detector tube the grid leak should be connected to the negative filament, as shown in dotted lines, instead of to the positive filament

The new detector tubes, such as the 200-A type, the CeCo H, etc., will be found very advantageous in a number of cases. On signals of normal strength no difference is noticeable in volume when using one type or the other, but these new detector tubes are more sensitive to weak signals than the 201-A tubes and, as a result, will permit the reception of signals too weak to be understandable with the 201-A. The only change necessary in order to use one of the special detector tubes in the old model Freshman receiver is to increase the detector plate voltage and change the grid leak connection. By referring to Fig 4 the grid leak can be seen in its usual place, while the location of the leak when using a new detector is indicated in dotted lines. The easiest method of making this change is to purchase a grid leak and mount and fasten it to the sub-panel near the detector socket. One end connects to the grid and the other end connects to the negative filament terminal of the detector socket. The optimum plate voltage for a special detector tube must be found by trial during the reception of signals from a distant station and is frequently higher than that required for the 201-A tube. In the case of the CeCo H detector tube, as much as ninety volts may be necessary for the best results.

When a cone or disc type loud speaker is placed quite close to a set, trouble will frequently be had, especially with the 201-A tubes, due to what is known as mechanical feed-back between the detector tube and the loud speaker, causing an audio-frequency howl to build up until it becomes a roar that completely drowns out the signal. By carefully selecting a detector tube that is not microphonic, by placing the loud speaker some distance from the set, or by using a spring-suspended detector tube socket, the difficulty is readily overcome.

To install a spring suspended detector socket, cut the four brass strips that support the present socket and mount the new socket on a small strip of bakelite just large enough to cover the hole in the base in which the regular socket was located. Connections are made to the four eyelets that held the old socket. Before changing sockets, note which side the slot for the tube pin is on so that the spring socket may be turned the proper way without the necessity of tracing out the wiring.



Radio Broadcast Photograph

FIG. 5

The batteries and loud speaker are connected to the re-vamped receiver in the manner indicated in this illustration for power tube use. Note that the loud speaker binding posts are not used. The C battery leads are connected to the points indicated in the other diagrams

FIG. 6

The jack on the front panel of the Freshman receiver marked "Phones" is used when a Pacent power amplifier of the single-stage variety is used in place of the second stage amplifier in the set. The second audio tube in the receiver should, of course, be removed

Radio Broadcast Photograph

THE LISTENERS' POINT OF VIEW

Conducted by John Wallace

What Many Listeners Think About Broadcasting

HEREWITH some of your own opinions, listeners, as culled from supplementary notes accompanying the questionnaire replies, together with diverse comments by ourself:

LINCOLN, NEBRASKA.

SIR:

Ah! Another questionnaire! I hasten to answer. [Here some bouquets which we blushingly delete. *Ed.*]. Now as to the questions. You need not apologize for that first one. I am a traveling man and I have been entertained in at least 200 private homes this year. I can not remember a single place in the bunch where the broadcasts were listened to as one would in a show. Even the prayers in the church services were interrupted with bright remarks, and other irresponsible and extraneous material. If I were sure Carl Dreher would get a peek at it I should call it "static", but it wasn't. I'll bet a quart of "snake juice" that there would not be so many church services broadcast if the parsons could sit around the garage stove with some of their audience.

You will have to get some more work in on that "kiddies" nuisance. Note the enclosed clipping from the *Literary Digest.*

The clipping was from a department concerning the correct use of words, entitled "The Lexicographer's Easy Chair" and stated:

kid.—"J. H. C.," Chicago, Ill.—As a common vulgarism for "child," the use of this term can not be too severely condemned, but "kiddy" or "kiddies" are permissible as terms of affection.

What! Must we do battle with the lexicographers as well as with the Uncle Charlies and Aunty Janes?

YONKERS, NEW YORK.

SIR:

With a large and varied field of entertainment to choose from, I have no quarrel to pick with any of the broadcasters. Each is endeavoring to the best of his ability to attract customers, much in the same manner as the stage purveyors do. To me the element of chance is part of the fun. One night everything off color, the next an oriental dream. It's good and soul satisfying philosophy to take the good with the bad and mediocre in alternate doses.

Again I have no quarrel with direct or indirect advertising; at least I am satisfied to know, in a decent way, to whom I am indebted for the privilege of being entertained. I protest the present method adopted by the [New York] *Herald Tribune's* daily program, wherein it prints "Orchestra and Artists" 9:00 P. M. Worthless stuff. If it is the Eveready Hour, I am entitled to know it. I like them and when I see that name, and all others for that matter, I can make my own choice without prejudice, just as I choose rubber tires, perfumes, radio sets or batteries. If this new method on the part of the *Herald Tribune's* is ethics, I call it cheap junk. I commend your magazine which I have read for one year and will continue to read. I find it the best, judged by all standards.

IN THE January and February RADIO BROADCAST, *we printed a questionnaire designed to find out what a representative body of listeners really thought about radio stations, radio receiving, and radio programs. The many replies—which are still coming in, by the way—have been extremely informative. Answers have been returned from every section of the United States and Canada, and they have contained a wealth of suggestion which we wish we could hand to every program manager. That is not possible, nor can even a fraction of the results be shared with you. However, this month, Mr. Wallace has chosen excerpts from some answers to the questionnaire which are not only interesting, but represent very well the trend of all the replies. In the May number, we hope to present a final installment of this information which may almost be considered a cross section of radio opinion.*

—THE EDITOR.

For further remarks on this subject, see the article by Pro Molto Gigolo a few columns on. We quote the following two letters as typical of a great number received:

HARTFORD, CONNECTICUT.

SIR:

Our radio usually runs most of the time each evening when we are home and reception conditions are good. Dinner music during our evening meal. The local newspaper is scanned for programs of merit and we tune-in on those appealing to us as being most interesting and of best quality.

When any particular event of outstanding interest is advertised we generally plan to invite a few friends and make an evening of it.

THE BALTIMORE SYMPHONY ORCHESTRA

The Baltimore Symphony Orchestra will go on the air from WBAL on April 24th, presenting as soloist the winner of a municipal violin contest to be held in Baltimore in March. The cantata "Columbus" by David S. Melamet, which won the Saengerfest prize in New York several years ago will be sung by a chorus of 400 male singers assisted by the orchestra.

Our local station is used only when their programs are of a greater merit than we can get from a distance. DX in itself is not sought except when experimenting on a new hook-up or new parts. There is still a thrill in DX and occasionally when coming in late from a party I sit at the dials for 15 to 50 minutes listening to the west. Waiting up for the furnace to draw properly is a good excuse for sitting up late when one knows he ought to go to bed.

POUGHKEEPSIE, NEW YORK.

SIR:

We usually start the radio at 6 P. M. and keep it going while we carry on our other activities. Of course we follow the programs and pick out the numbers which we like best, changing from station to station. It usually takes a concert like the Victor Concert last evening to make us stop our bridge game and give our whole attention to the music. However we seem to hear everything that's going on even while we're concentrating on something else. A jazz concert, however, always means that we tune-in on another station or turn off the radio entirely. Some dance music is all right but most of it sounds like—well, I could make better music by dumping the kitchen utensils on the floor. We enjoy popular music as long as it is music. You may think we are inconsistent but we do enjoy banjo and Hawaiian music. Now as to popular music, it's all right but I wouldn't give up the others for it; and as for radio plays, there are still theaters where we can see the actors act and anything else which is supposed to be seen. So radio plays will have to wait until television is a success. I believe just as you do about speeches. However we do enjoy hearing Vice-President Dawes trying to shatter the filaments in the tubes. As for education, we have had considerable. Besides a lot of static comes along at the wrong time and ruins the most important points of the talk. The miscellaneous novelties aren't worth bothering about.

The Rising Tide of Radio Stations is the subject of a large group of letters. F'rinstance:

BISBEE, ARIZONA

SIR:

Now that you have given your readers an opportunity to tell what they do with their radio receivers, through the medium of your questionnaire, I would like to suggest that you give us another questionnaire to find out what the sentiment is about elimination or muzzling about ninety per cent. of the broadcast stations of the country. I refer particularly to the broadcasters who are dishing out direct advertising and grinding out the most mediocre of programs. Radio is doomed as a source of entertainment unless something is done quickly to remedy the heterodyning nuisance. It is impossible to listen fifteen minutes to a satisfactory program without having the program ruined by some interfering station. With the many thousands of "better, cost less" bloopers, and the heterodyning of interfering stations, radio reception is nothing more than a horrible experience just now. As a partial remedy to the heterodyning trouble why not put all the broadcasters who do direct advertising on one wavelength, reducing their power, and then let them advertise and heterodyne each other to their hearts' content. It would try the patience of Job to try to tune-in a program these nights that did not have its infernal jazz background, or some advertiser dishing out the "dope" on the wares he has to sell. The radio advertiser is a worse offender of decency than the billboard advertiser, whose only offense is to spoil part of the scenery. It is high time for some drastic action to curb these nuisances, and cut out some of the "tank town" broadcasting stations whose only excuse for being on the air is to sell something, or radio is going to pass out as a family entertainer. RADIO BROADCAST, being the outstanding radio publication of the Western Hemisphere, should "take the bull by the horns" and build a good sized fire under him. Otherwise our radio receivers are only fit to look at. Personally, I am just about through with

MYRNA LOY

Who has utterly no connection with radio other than that she acted as guest announcer at KFWB recently. However we liked her picture so you'll have to humor us. It seems she acts in the movies

mine if this messy situation is going to be a regular diet.

Further bits about the superabundance of broadcasters:

ASHTABULA, OHIO.

SIR:

We want to see the total number of stations cut down to about 200 (for the U. S. proper,) these stations to be divided up according to population of territory and allowing, say, two or three apiece for the largest cities, and not over one apiece for states with smaller populations. These few stations to be maintained at the highest possible standards from both the point of entertainers and latest, most efficient equipment.

CAWKER CITY, KANSAS.

SIR:

A good way to remedy the radio business so the DX hound can get a look in, is to limit all the small stations to about one or two hours a week in the evenings between 6 and 10 P. M. And the large station run about two hours every other night. This chain station stuff is all right but it monoplizes too much air; it should all be on one wavelength. It looks as if they were trying to force the listeners to listen to them or go to bed. The little stations should be left to run as much as they want in the day time especially those located in the middle west in the agriculture country, as some of them are doing a service that is of great value. In the summer time they can all run as old man static will regulate all of them.

And more about the DX hounds:

DETROIT, MICHIGAN.

SIR:

Anent your query about DX—the writer has built quite a number of sets for friends, who wanted "only to listen to the local programs, which are plenty good enough," etc. You know it!

Probably you know the rest; every last one of them has been fishing for DX as soon as he learned how to push the switch. I have about twenty friends who have purchased various manufactured receivers recently. Without even one exception they have all come to me to find out how to get KFI, etc., and find out why they couldn't get every station in the United States every night in the week. Friends with receivers a year and more old are still trying to get DX—though usually more reasonable in expectations.

CATHLAMET, WASHINGTON.

SIR.

Every radio fan likes to fish for DX. If he does not do this for the sake of the program, he does it so he can log the station, and tell his friends about it.

On the Pacific Coast, there is yet another angle to the DX proposition. There are few broadcasting stations in this locality that broadcast good programs night after night. This is principally due to the lack of financial backing, I believe. There are many more stations in the East that are run by large corporations, etc., which can afford better musical talent, better speakers, and the like. Also, in the East, there are many more stations to choose from. For these reasons, the western fan often tries to get Eastern stations.

The following excerpts, having to do with any and all subjects are gleaned from marginal notes on the questionnaire replies:

Radio plays are never tolerated. It is some-

FORD AND GLENN

Formerly of WLS, now of WLW, seeking recreation between times. It's Ford's next move. Thank the powers that be, that no one has taken to broadcasting checker matches!

thing that requires undivided attention. If the phone rings or a neighbor drops in or the baby yells you are bound to lose the thread of the plot and it is thus marred. Likewise it must be tuned-in at the commencement of Act. I

I agree with your views in a recent number of RADIO BROADCAST that educational matter is no good over the radio. If I wish to obtain information on any subject I prefer to look it up at my leisure in some authoritative work and do not want to have it thrust at me through the loud speaker. My radio is for entertainment and entertainment only.

You answer this one, Doctor Wallace. What would the average receiving set be like to-day if there had never been any so called DX hounds?

I certainly agree with you regarding the reading of prepared speeches, especially by the man whose eye cannot travel in advance of his lips and see the periods, semi-colons, and commas. Even Mr. Work the other night in the bridge game, master of the subject though he is, would slide over a period, hesitate and then go back and pick it up.

I do not like radio plays because the performers all speak in a tone of voice that is not natural, which spoils the whole thing for me. I have listened to many plays and it seems that all the various players have assumed the same style of speech, which is a type that no one has heard in real life, and I find one that is very hard to understand by radio. To make a thing interesting make it true to life and then every one can understand it.

BURR MCINTOSH

KHJ's "Cheerful Philosopher" who reads poems and chats informally with his clientele on Sunday nights

Why do you not try and get information as to the listeners' attitude towards chain broadcasting, interference, and wave jumping? I myself do not believe in 15 or 20 stations broadcasting the same program simultaneously. I will not make comments on the other two evils other than to say that I am in favor of any radio act that will clear the air without giving the air over to the chain broadcasters, that they may get rich at the public expense.

The three punkest pieces ever written are Handel's "Largo" (he must have written this one Monday A. M. when he had an awful skull on him), "Deep River" by Burleigh, and "Mighty Lak a Rose." Come again.

In our house each number is awaited hopefully—and when one comes bearing that elusive quality that we call 'artistry,' it gets undivided attention. Let's stress this 'artistry' thing! Most anything *can* have it, be it even saxophone, banjo, uke solos, and the like.

Why not have more Gilbert and Sullivan Comic Opera, especially the Mikado. *Less* talk by the announcer and less explanation, which usually takes as long as the music.

Trusting that Congress stops gassing, and gets busy on radio legislation of the proper kind, and hoping that KDKA, WJZ, WEAF and all Radio Corporation stations broadcast *forever* without interference from Congress, bloopers, peanut whistles, static and fading and that *Chicago will not be permitted to have more than* $84\frac{1}{2}$ *per cent. of the radio stations in this country*

—Simply hate those so-called owls, nighthawks, etc., whose programs seem to mainly consist of a bunch getting together to laugh at their own supposedly funny sayings.

—A suggestion, let each program manager spend two full evenings a week listening-in. Let him note the miserably monotonous duplication of popular numbers. Let him get as sick of the popular stuff as some of the rest of us are. I can enjoy this type of music as well as the better class—but—to hear the same thing night after night, perhaps several times an evening, done by mediocre performers, spoils for me what would otherwise be a perfect type of home entertainment.

The broadcast of actual events is best, such as football, church services, conventions, banquets, etc. The greatest thing about radio is that it brings the world to our home. Our victrola still plays better music, orchestral, vocal, etc. But the radio is something *real, alive, actual,* bringing great minds, great voices, great personalities, great happenings, great thoughts, great news events, etc. to us all, wherever we are.

Compliments of the Season
from the Officers and Members of
Victoria Radio Club
to their twelve most popular stations:

			FEATURES REMARKED
CNRV	.	.	*General excellence*
KJR	.	.	*Henri Damski and His Orchestras*
KFOA	.	.	*Afternoon Programmes*
KOMO	.	.	*Power Plant Engineering Co. Programmes*
KOWW	.	.	*Organ Recitals from American Theatre*
KGW	.	.	*Hoot Owls*
KPO	.	.	*Rudy Seiger, Waldemar Lind and* Atwater-Kent *Programmes*
KFI	.	.	*Simultaneous Broadcast* Atwater-Kent *Programmes*
KGO	.	.	*Light Operas, Arion Trio and Richard Henry Jackson*
KTAB	.	.	*General excellence*
KOA	.	.	*General excellence*
KSL	.	.	*Male Choir*

COLLECTIVE THANKS

The Victoria Radio Club, an organization of some 300 listeners in Victoria, British Columbia, sent the above card to its favorite stations last Christmas. The stations were selected by the officers and directors of the club and only stations or features receiving a unanimous vote were selected. For over two years at each monthly meeting of the club a vote has been taken for the popular station for the preceding month, and the secretary instructed to write the station getting the most votes

All ailing and dying sopranos should be put out of their misery. I prescribe drowning.

I have a lot of other things on my chest. For instance, I do quite a bit of gardening during the summer, but after having been annoyed all winter by station KMA fuzzing up KFI and WJZ I never again expect to be in the mood to buy as much as a nickel's worth of canary bird seed from May or Field. I feel the same way about KOIL and KTNT and numerous others. As local stations they may serve a useful purpose in their community, but they are an irritation to all the rest of the country. Let them reduce power to 100 watts and get back out of the way.

I believe the multiplicity of stations and the general poorness of the programs is going to kill the goose that is now laying the Golden Egg. The bum saloons killed their own business.

Further:—I am persuaded that only the *very best* is worth broadcasting, and no good-will publicity is secured by anything short of the best. Indeed I regard certain parties as ill bred pests and purposely avoid them.

—I've been "curing" t.b. here in Saranac Lake for over six years and you can imagine what the radio means to me and the others like me up here. Probably my preference for sports is because I can't indulge in anything more strenuous than a little walking or fishing myself.

—As a subscriber let me ask you not to be too hard on the travelogues. Almost everyone is a potential traveller, and yet the opportunity comes to very few of us. One of the features that I wouldn't miss is the Thomas Cook travelogue from WJZ. Maybe the music doesn't fit the location being described but some of us who don't know any better get a kick out of it anyhow.

—Wish I could cast six thousand votes for good music, whether instrumental or vocal, to offset the more numerously expressed votes of the noise lovers.

There is too much striving for highbrow effect, while the average family about the fireside wants to be entertained, not forcibly educated. Even jazz and radio fun is a relief when one is tired.

—If the National Broadcasters give me the best possible programs, I am for them and all the stations they care to hook up. I do not worry in the least about the so called Radio Trust. America is bigger than the biggest trust.

PAUL STEINDORFF

Conductor of the KGO comic opera company

—What is the matter with the English language? The announcer introduces a noted singer—giving the title to a song you would care to hear—and all of a sudden out comes some foreign language and the song is about as interesting as a cat's midnight serenade.

—I do not believe that singers of great rep. get over even as well as some average voices that seem adapted to broadcasting.

—Don't like: Jazz, nor jungle music of any kind; Singers with lumps in their throats; "To a Wild Rose"; Victor Herberts Compositions; Political Talks (They're such liars); Sloppy, mushy songs; Foreign Travel Talks.

In conclusion, I believe that 75 per cent. of the stations now operating are serving no useful purpose, except perhaps to a very limited audience, if any, and the vast majority of listeners would no doubt prefer fewer and better stations.

I appreciate high-grade classical music but I must confess that I listen to it through more or less of a sense of duty when possibly I would rather be tuned-in on the better broadcasters of popular music. Jazz is good when it is not overdone. I am glad to see that there is a tendency to revive some of the older popular music like the Strauss waltzes, Gilbert and Sullivan, etc. The younger generation does not get much of a kick out of these however, as they do things different now. But anyone that has waltzed round the floor with the girl he adored to the strains of the Beautiful Blue Danube, The Sirens, Illusion, etc., sure will stick out his ears when he hears one of these on the air.

The Highly Condensed Newspaper Radio Program

"WHAT I crave," writes Pro Molto Gigolo, "is the job of the fellow whose daily task it is to make that list of agate lines telling us what to expect to-night from this, that and the other of twenty to fifty radio stations. Such ingenuity! Such a vocabulary! Such a wealth of synonyms, antonyms—all breeds of nyms!

"Look at these examples of the art that is his. Here, for instance, against 7 o'clock, what does his talent dictate should be announced?

7:00 P. M.—Musical program

"Then—look at 7:15! Do you see? Begin to appreciate his tremendous fecundity? Does he repeat himself? Ever? Is it 'musical program' again? No, sir! It is:

7:15 P. M.—Program of music

"But—go down the list. See for yourself. Appreciate for the first time, perhaps, the presence of unpretentious, unannounced genius in your midst—and realize how, at last, newspaper work calls with throbbing gulps to my latent, atrophied abilities—too late, perhaps! Alas, perhaps too late!

"Here! Read—and weep with me:

7:25 P. M.—Tea music
7:30 P. M.—Dinner music
8:45 P. M.—Orchestral
9:00 P. M.—Musical ensemble
9:15 P. M.—Vocal music
9:25 P. M.—Music by voices
9:30 P. M.—Male Quartet

"Then, marveling this far, look at this next touch! Genius, I call it!

9:40 P. M.—String

"Now, for suspense, can you better that? All accomplished by one word, too! Can't you picture every one of New York's 1,139,623 radio listeners chaffing at their dials—impatient for 9:40 to tick around—that they may know, at last, what that one word means—whether it refers to beans, Christmas bundle wrappings, or whether it is just the lister's little practical joke.

"Are you convinced? Run down the list—of each station—each with different programs, thereby multiplying the demand upon the ingenious lister to avoid repetition. And this every day! Can he hold up long under it?

9:50 P. M.—Concert orchestra
9:55 P. M.—Trio
10:00 P. M.—Concert
10:10 P. M.—Instrumental trio
10:20 P. M.—Choral
10:30 P. M.—Musical group
10:45 P. M.—Ensemble
10:55 P. M.—Duets
11:00 P. M.—Dance Orchestra
11:30 P. M.—Orchestra for dancing
12:00 M. —Orchestra program
12:30 A. M.—Test program—music
Early programs to-morrow
10:00 A. M.—Program for musical students
11:00 A. M.—Talk with music

"To this age's great men, add the first professional program lister! To our newspapers, the gratitude of this one humble aspirant, for devoting their white space at last to a fling in the realm of imaginative service."

FORD and Glenn, formerly of WLS, are now on the staff of WLW. They are on the air at noon, every week day, with a "dinner bell" feature intended especially for the farmers. Every night except Friday, Cincinnati's silent night, they stage their justly renowned "Lullaby Time," at 8:00 Eastern Standard Time. Their Sunday night programs are at 7:20 and 10:00 and they are scheduled further for two afternoon programs a week.

WGN is repeating its series of "Old Time Prize Fights." If you did not hear them last year they are well worth watching for. Various championship bouts of the last decade are re-created in the broadcasting studio and Mr. Ryan's announcing effectively puts across the illusion that the battles are actually taking place.

WOW is conducting a world's championship laughing contest. The contest is open to all men, women, and children who think they have world-beating laughs. Which strikes us as a swell idea, providing the laughs still sound like laughs after their journey through the ether—which is not always the case.

WEAF was on the air 3834 hours and 45 minutes during 1926, an average of 10½ hours every day during the year.

THUMB NAIL REVIEWS

WOC—The Moline Plowboys singing nice, sugary harmony—nothing subtle but good straightforward stuff.

WBZ—John Charles Thomas singing in a Maxwell Coffee Concert. An excellent baritone voice, and one well adapted to broadcasting.

WQJ—Jimmy Maloney and Harry Geise in yiddish dialect tomfoolery and nonsense songs. First rate comedians. The soulful ditty "By the Side of the Omelette Sea" being especially amusing and worth repeating.

WBBM—Lee Sims sitting at piano and rambling from one tune to another with nice modulations between, and fancy variations and improvisations. The station announcer guessing at the titles as the pianist proceeded.

WJZ—"Don Amaizo, the Wizard," a new series of broadcasts dealing with a character who is supposed to be mute, answering questions and telling his own story through a violin "gifted with the power of speech." Terrible. Too much talk and not very good violin playing.

KFQB—After telling us their telephone number and assuring us that out-of-town listeners could communicate with them by Western Union or Postal Telegraph, and further, after dedicating the next number to some lady in Waco, we were rewarded with a violin soloist playing at "Mother Machree"!

WEAF—(and everywhere else on the dial!) The Chicago Civic Opera broadcasting the "Garden Scene" from its performance of Faust on the stage of the Auditorium Theater. The most ambitious, and so far most successful attempt yet made to broadcast opera from an opera house. A thorough technical preparation was made, fifteen microphones were employed, and wires carried the broadcast to New York City from whence it was distributed as far west as Kansas City and south to WHAS, WSB, and WSM. The orchestra came through in excellent fashion, the singers better than ever before, but still with a trace of the mugginess incidental to all theater broadcasts. It is our pessimistic guess that broadcasts of large bodies of singers in large auditoriums will never be an unqualified success. The studio broadcasts of the same thing, even with a less redoubtable roster of stars, are generally pleasanter to listen to.

PHONE. RECTOR 88

Phoenix

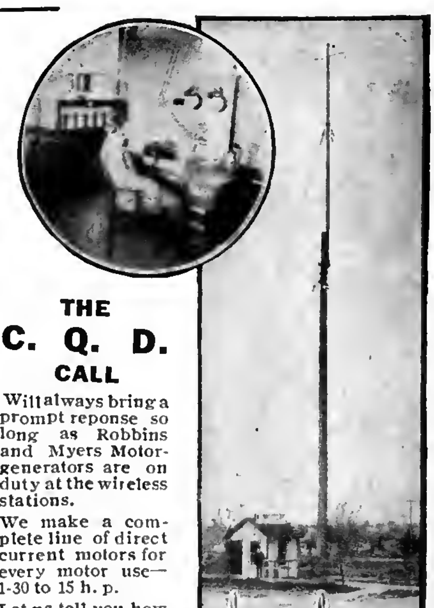
Non-Smut

Carbon Papers

The Kind the Copy's Always Clear

E. L. COTTELL, Inc.
35 Broadway,
New York

Used by the
United Wireless Telegraph Co.
ON BOARD THIS STEAMER

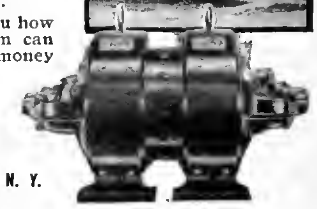


THE
C. Q. D.
CALL

Will always bring a prompt reponse so long as Robbins and Myers Motor-generators are on duty at the wireless stations.

We make a complete line of direct current motors for every motor use—1-30 to 15 h. p.

Let ns tell you how one of them can save you money



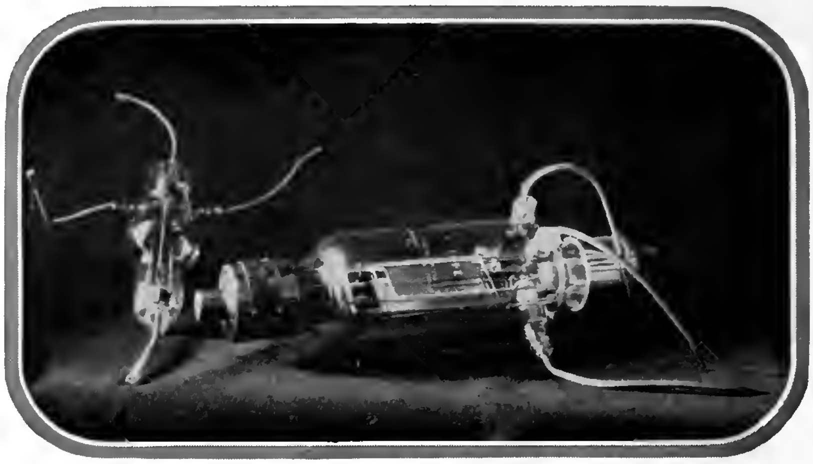
The Robbins
& Myers Co.
Springfield, Ohio.
145 Chambers St., N. Y.

ADVERTISEMENTS IN A SHIP WIRELESS NEWSPAPER OF 1906

The *Aerogram* was sold by the operators of the United Wireless Company aboard many of the ocean ships equipped with their system. It was a "wireless" newspaper, but a lot of the material was printed ashore before the vessel left port

A 20- 40- 80-Meter Transmitter

How to Make an A. C. Operated Hartley Transmitter for the 15,990, 7496, and 3748-kc. Bands—Two, Three, or Four Tubes May Be Used



TWO TRANSMITTING TUBES

Among other interesting tubes that DeForest makes are the two transmitting tubes shown above; one is high-powered with an in-put rating of 250 watts, and the other is the H tube with an in-put rating of 150 watts

By KEITH HENNEY

Director of the Laboratory

IN THE April, 1926, RADIO BROADCAST, there was described a simple short-wave transmitter designed from the standpoint of portability and powered from B batteries. It was with this outfit that 2 GY, the experimental station operated by the Laboratory, made a record of over 26,000 miles per watt power input to the plate, during the winter of 1925. The circuit employed was of the well-known Hartley form, perhaps the simplest of oscillating circuits, and it is shown in Fig. 1. Some additional notes on the operation of this circuit were given in a subsequent article in the November RADIO BROADCAST, and in this latter article the adjustments necessary for maximum output and maximum efficiency were outlined.

So many letters have come to the Laboratory requesting design data for this transmitter and a source of plate and filament power that would do away with the batteries that the following article has resulted.

The complete transmitter, oscillator and rectifier, is on a single baseboard, and no attempt has been made to make the thing a work of art. There is no panel—no unnecessary knobs—and short direct leads prevail throughout. The power enters the equipment at the right and is fed into the antenna at the left. As shown in the photographs, it is a complete transmitting equipment, capable of being set up quickly in any place where alternating current is available.

There is no reason why the tuned-plate tuned-grid circuit could not be used if the amateur desires, but the Hartley requires a minimum of apparatus and has enough variable factors so that the user may find the best adjustment to suit his particular tubes and antenna-counterpoise system.

With the present layout one can manage with only two tubes, one oscillator and one rectifier, thereby reducing the cost somewhat. The transmitter described, however, has four tubes, two paralleled oscillators and two rectifiers. If one wishes, he may start with the two tubes only and, at some future time, enlarge to three or four as described, this necessitating only a few simple readjustments.

This outfit, with the four tubes, will put about half an ampere into an antenna-counterpoise system consisting of a single wire more or less vertical and with an overall length of about 60 feet. This half-ampere will represent an input to the plates of the oscillator tubes of about 75 watts. With a half ampere on the forty-meter (7500-kc.) band, one should be able to work across the United States without any difficulty, and reports will show that a good "r. a. c. note" is being received.

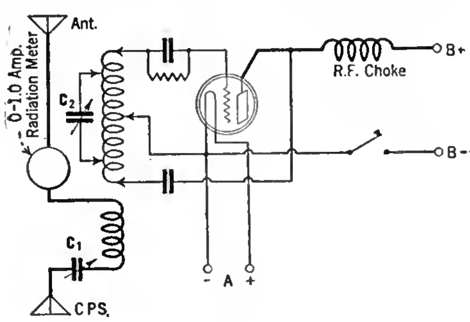


FIG. 1

This is the fundamental Hartley oscillator circuit and is adapted here for battery operation. Note that the antenna counterpoise system is coupled to the oscillator at the plate end of the inductance

TUBES

WHILE the transmitter illustrated has been used chiefly with tubes of the 210 type, amateurs desiring somewhat greater output may use the DeForest "H" tubes which are attracting considerable attention. These tubes, illustrated in a photograph on page 571, are rated at 150 watts, and will stand 1500 volts easily

The "H" tubes are designed to dissipate considerable heat at the plates and to have an extremely low capacity between elements; this latter feature is essential for very short wavelength work and for efficient circuits. In tubes of large grid-filament capacity, considerable current flows across this reactance so that the grid current (high-frequency) may be the factor limiting the power handling ability of the tube. Wide separation between elements means that high voltages may be used safely. Other tubes that have been successfully used in the Laboratory are of German make, known as Tobe MS-IV. A table giving some data on transmitting tubes is given on page 571.

THE CIRCUIT

THE Hartley circuit is shown in Fig. 1, and here is adapted for battery operation. When alternating current is used on the filament, a transformer with a center tap is necessary, and, instead of connecting the negative B to one side of the filament, it is connected to this center tap. This is also true of the grid return.

Keying may be accomplished by interrupting the negative B lead, or it is possible to key in the primary of the power transformer in case the

Facts About This Transmitter

Circuit, Hartley
Total Cost of Apparatus, About $100
Power Input to Plates, 75 Watts
Total Power from Mains, 125 Watts
Average Range on 40 Meters (7496 KC.), 1000 Miles

Number of tubes: Four: two UX-210 oscillators and two 216-B rectifiers. One only of each may be used if desired.

This transmitter carries its own filament and plate supply all on one baseboard. Wherever a. c. is available, this outfit may be placed in operation in about five minutes. All that is necessary is an antenna and counterpoise, and someone with a good "fist." A similar transmitter is now in operation at 2 EJ and 2 GY, stations operated by the RADIO BROADCAST Laboratory. It will operate on any of the amateur wave bands. Much of it can be made at home, as described.

filament voltage is derived from another source. In Fig. 2 another scheme of keying is used which on the whole is somewhat better than that shown in Fig. 1. It consists in opening the grid leak, resulting in the grid piling up a negative charge and decreasing the plate current. The key contacts in this case will have practically no power

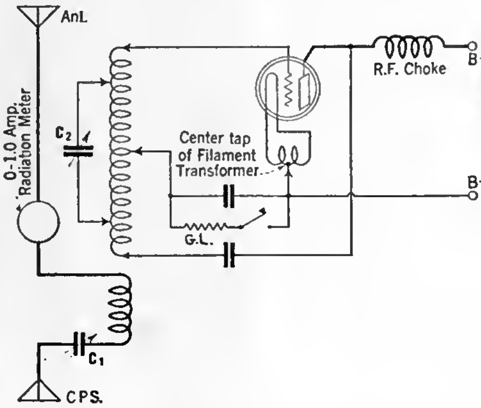
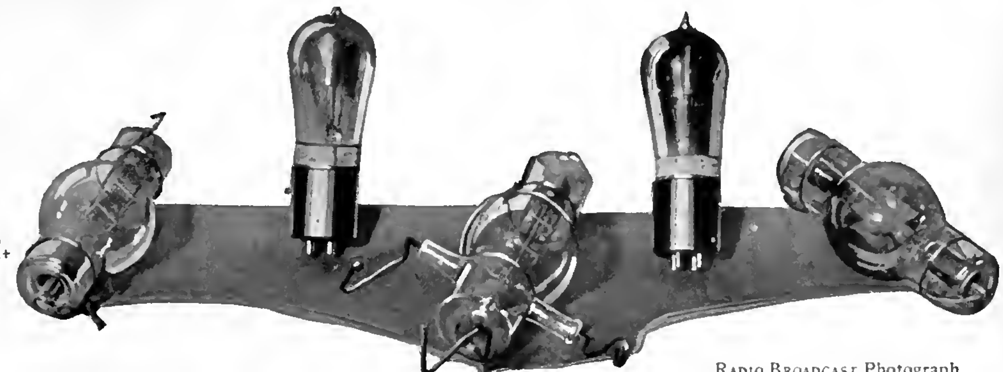


FIG. 2

There are various methods of keying a small transmitter. In Fig. 1 the negative B battery lead was broken. In this diagram the grid leak circuit is opened. This latter method has the advantage that the d.c. voltage across the key is small



Radio Broadcast Photograph

MORE TRANSMITTING TUBES

Among the tubes that have been used successfully as oscillators in the transmitter described are the DeForest H tubes, one of which is shown in the center of this group. The two rectifiers, at the extremes of this photograph, are also of DeForest make and may be used successfully here. The two other tubes shown are German, with an 8-watt rating

to break. Here the grid condenser is placed in the center tap to the inductance so that the key leads will be at comparatively low potentials. If the key is placed at some distance from the set, a choke coil may be inserted in its leads to prevent absorption of energy. Such a choke is included in Fig 5, and is indicated as L_4. It is not mentioned in the list of parts. It is better to use a simple relay situated near the set itself.

The power supply of this outfit consists of a high-voltage transformer, a rectifier tube (or tubes in this case), and a filter. The transformer can be of any standard make, such as Acme or Thordarson, and for full-wave rectification with two tubes, a center tap must be provided. The secondary voltage each side of the center tap should be about 550 volts for a 210, and up to 1500 volts for an "H" or a 50-watt tube.

Another transformer that can be used is the Amertran PF-52, designed for power amplifiers. This has two windings designed to heat the filaments of 210 and 216-B tubes without using rheostats, and a high-voltage secondary of 525 volts. This transformer cannot be used for full-wave rectification, however, since it has no high-voltage center tap. Other good transformers are the Acme 200 and 300 which have filament windings with terminal voltages of 10 so that resistances must be used to reduce the voltage for 216-B and 210 tubes. The following table gives data on several transformers:

Transformer	Plate Volts Each Side of Center Tap	Filament Volts	Price
Acme 200	750, 550	10	$20.00
Acme 300	1100, 750	10	$25.00
Acme 600	1500, 1000	12	$33.00
Amertran PF-52	525 (No center tap)	7.5	$18.00

As indicated in the diagrams, the center of the filament winding of the rectifier tubes forms the high-voltage lead, while the center of the plate winding is the negative lead. A capacity of about four microfarads should be placed across the inside of the filter, and of two microfarads across the output, to give a good note. These condensers must stand considerable voltage. Those used in the present transmitter are Sangamo Series B (designed to operate in 500-volt a-c. or 1000-volt d. c. circuits). Other good condensers are Tobe Deutschmann Type 1020 and 2020 for 1000 and 2000 volts respecively, and the American Electric Mansbridge type condensers, rated at 1250 volts. Dubilier and Faradon condensers are also well-known for this kind of work.

Tube	Filament Voltage	Filament Current	Plate Voltage (Maximum)	Plate Current Milliamperes	Price
210	7.5	1.25	750	65	$ 9.00
216-B	7.5	1.25	750	65	$ 7.50
MS-IV	6.0	2.2	800	40	$ 6.00
DeForest "D"	10	2.35	1000	50	$12.00
DeForest "H"	10	2.35	3000	50	$18.00
DeForest 15-Watt	7.5	1.25	750	50	$9.00
DeForest "HR"	10	2.35	3000	150	$16.00

If the Amertran transformer is used, or if the constructor uses only half of the Acme, only one rectifier tube is necessary. Such a circuit is shown in Fig. 3, B.

The single-tube (half-wave) rectifier will deliver about half the power of the full-wave one and will not have so good a note, but will be entirely satisfactory for a low-powered set. At the Laboratory, the Amertran PF-52 transformer circuit with one 216-B and one 210 oscillator has transmitted 1000 miles consistently. With two 216-B's and two 210 oscillators, operating from 750-volt taps on an Acme transformer, such as shown in Fig. 3, A, communication was maintained with a steamer off the Amazon River from station 2 EJ at the Laboratory. With two DeForest "HR" rectifier tubes and one "H" tube with 1100 volts, 2 EJ worked 1 AR at Rio de Janerio with a report of R5. The input was then 75 watts. With 85 watts input a report of "R6 d.c." was received from 6 RA, Johannesburg, South Africa, on February 14th. Johannesburg is more than 7000 miles away.

There is no particular difficulty with regard to the layout of the apparatus. The photographs give a good idea of where the various parts are placed, while Fig. 5 gives the complete circuit diagram of the transmitter-rectifier. As stated above, the rectifier part of this circuit may be substituted by the circuit in Fig 3, B, using only one rectifier tube.

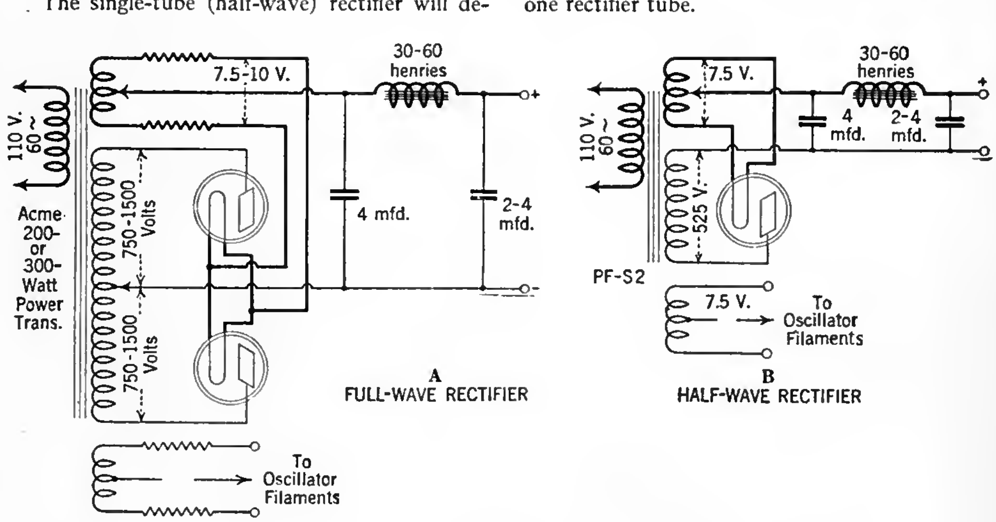


FIG. 3

A full-wave rectifier, as shown at "A," will deliver more power to the oscillator and result in a better note than will be possible from using a half-wave rectifier. The condensers should be as large as the amateur's pocket book will permit. The chokes naturally must have high inductance and low resistance

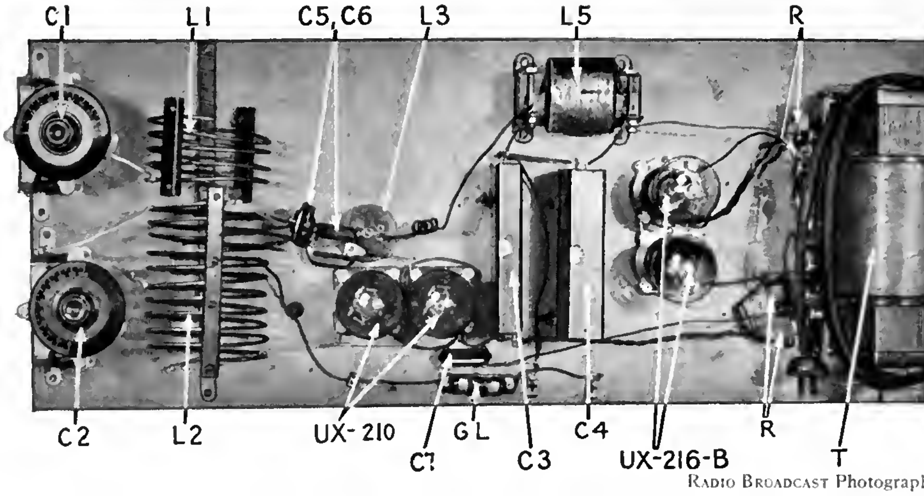
It must be remembered that the oscillating circuit may have large currents flowing in it. This means that the inductance and leads connecting it to the condenser should be well insulated and of heavy construction. Under the conditions of maximum output, with about 50 watts input, the oscillating current will be well over one ampere. The leads connecting this circuit to the tube are not so important. The tube may be considered as a device which merely places a voltage across the coil-condenser combination. Little current should flow to the tube.

It is a good idea to tune the plate part of the inductance rather than the grid end since the circuit will in general be more stable if this is done. This makes it possible for one side of the condenser to be grounded to the center tap and thereby simplify tuning. To tune to the 7496-kc. (40-meter) band, the maximum capacity will be about 0.00025 mfd. while a 0.00035 mfd. capacity is needed to tune to 3748 kc. (80 meters). In the latter case, the condenser must be placed across the entire coil.

Ordinary variable receiving condensers may be used although the use of double-spaced ones is advisable, especially when higher voltages are placed on the tubes—when using "H" tubes, for example. Double-spaced condensers are regularly made by National, Cardwell, General Radio, Hammarlund, and others.

No trouble has been experienced with small Sangamo fixed condensers when voltages up to 750 have been used, especially when two are connected in series. With higher voltages, condensers such as those made by the Wireless Specialty Apparatus Company and others, are desirable.

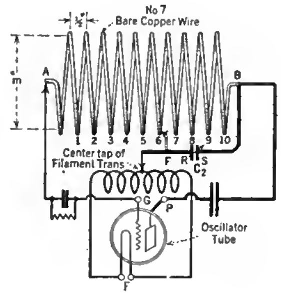
The grid leak for 210 tubes in this circuit should be between 5000 and 15,000 ohms, although greater efficiency and a better note seem to result with a high value of leak. The radio-frequency chokes may be of any type, provided they have natural wavelengths in excess of the longest wave to be generated in the oscillator tube, and provided that their distributed capacity is not large. Chokes of 100 to 200 turns of small wire, say No. 30, on a one-inch tube, have been used successfully at 2 GY for L_3 and L_4 in Fig. 5. Some very small and neat chokes are now being made by Cardwell.



RADIO BROADCAST Photograph

THE LAYOUT OF APPARATUS

This photograph gives a good idea of the layout of a complete transmitter and power supply. For operating on the 40-meter (7496-kc.) band, the present position of the leads to the inductance, L_2, will be entirely satisfactory. It was with this layout at 2 EJ that communication was had with a steamer off the Amazon River when the input to the two oscillator tubes was about 75 watts



Meters	C_2	G	F
20	0.00015 mfd.	5	7
40	0.00025 mfd.	A	6
80	0.00035 mfd. across entire coil	A	4

FIG. 4

By following this picture and the small table, amateurs building this transmitter can place it in operation on any desired band without owning a plate meter or an antenna meter, both of which, however, are desirable and necessary if maximum efficiency or power is desired. Note that to cover the 80-meter (3748-kc.) band the tuning condenser must be across the entire coil. If the capacity of C_2 is 0.00025 mfd., the settings as shown in the diagram will be correct for 40 meters (7496 kc.)

FILAMENT RESISTANCES

WHEN operating 7.5-volt filaments from a source supplying a terminal voltage of 10, such as is the case with the Acme transformers, some means of lowering the voltage must be provided. A separate filament lighting transformer has the advantage that a rheostat may be used in the primary as a logical solution. It is not possible, however, to use a rheostat in the primary of the transformers specified here unless the consequent lowering of the plate voltage supply as well as the filament voltage is not considered a handicap.

In the Laboratory, resistances (R in Fig. 5) were provided for each leg of the filament to drop the voltage to 7.5. A Pacent six-ohm rheostat was torn apart and the wire straightened. With two tubes drawing 1.25 amperes each, the proper length of wire was found to be about nine inches for each filament lead. Since 210 and 216-B tubes operate anywhere from 6 to 7.5 volts on the filament, the exact length of wire is not important as long as each leg has the same resistance. If 9 inches of a 6-ohm rheostat wire are in each filament lead, the voltage will be not over 7.5 nor less than 6. If only one oscillator or one rectifier is supplied from a 10-volt winding, the wire must be twice as long.

The table in Fig. 4 shows the proper places for the variable connections on the inductance for operation on the various bands, and in case the builder has no plate milliammeter or even an antenna meter, he may follow this illustration with the assurance that his transmitter will work satisfactorily on the bands listed in the table. The grid leak is, as previously mentioned, not critical although higher values increase the negative bias on the grid, lower the grid and plate currents, and increase the efficiency generally. With the connections to the inductance made in accordance with the diagram in Fig. 5, and the accompanying photographs, the transmitter will be set for 40-meter (7496-kc.) work.

The proper place to insert a plate milliammeter is in the negative B lead, as shown in Fig. 5, and with two tubes operating from 750 volts, this meter should be able to read about 150 milliamperes.

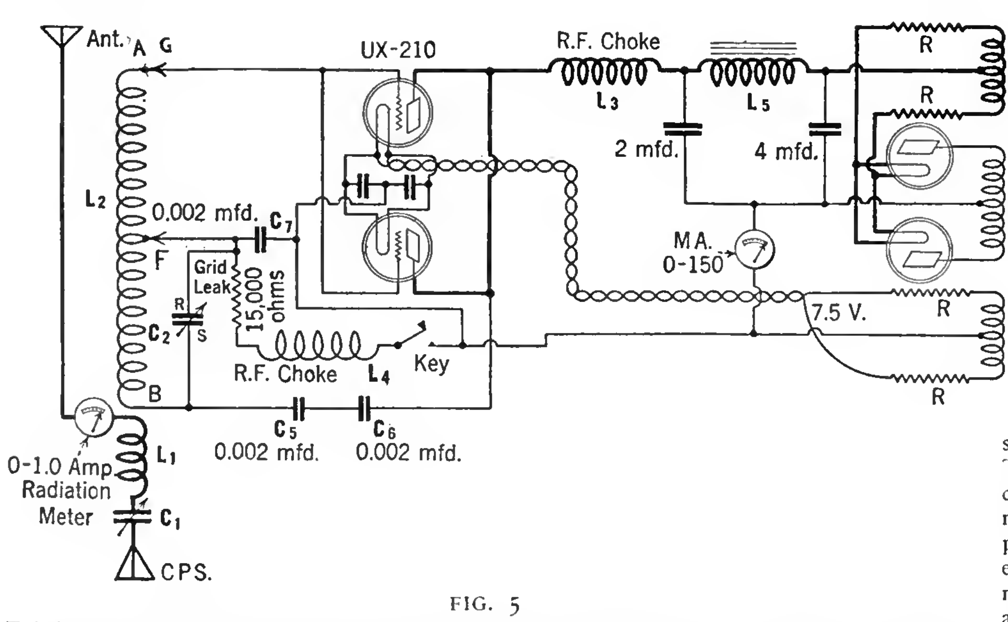
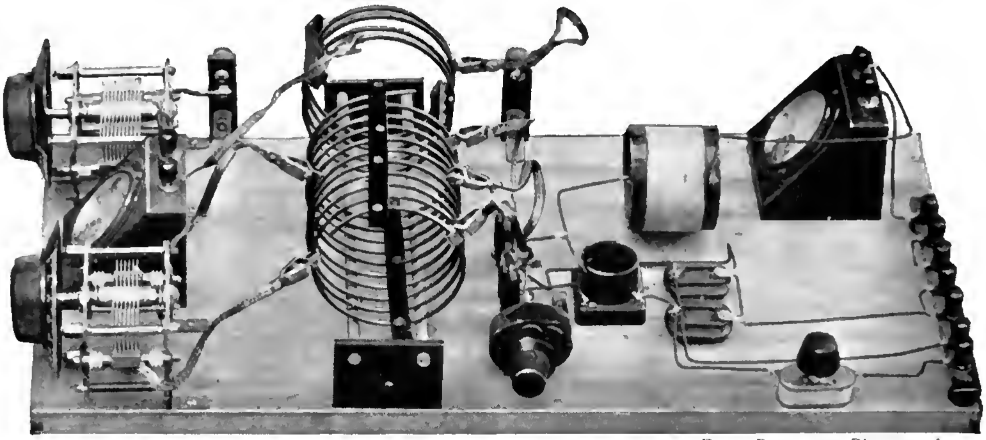


FIG. 5

This is the complete circuit diagram for a full-wave rectifier using 216-B or DeForest "HR" tubes and two oscillators, which may be 210's or DeForest "H" tubes. At 2 GY, with an antenna whose natural wavelength is 47.5 meters, or 6312 kc., communication has been maintained all over the United States and with several foreign countries. The antenna current with this set was as follows: At 42.5 meters (7054 kc.)......0.6 amperes; At 40.0 meters (7496 kc.)......0.50 amperes; At 37.5 meters (7995 kc.)......0.41 amperes; On 40 meters (7496 kc.), the total antenna resistance was approximately 60 ohms

Those who desire may use commercial inductances, such as those of the Radio Engineering Laboratories, with good success. These coils were included in both of the transmitters designed by the Laboratory for the Dyott-Brazil expedition. The coils used in this transmitter, however, were made by winding No. 7 bare copper wire on a three-inch form. The secondary coil in the original set had ten turns, and, with a 0.00035-mfd. condenser across it, it was possible to tune to as high as the 80-meter (3748-kc.) band, as Fig. 4 indicates. The primary coil has four turns of the same wire on a similar diameter. The following list of parts includes several pieces of apparatus that can be made at home, viz. inductances and chokes:

T_1—Acme Power Transformer, 300 Watts	$ 25.00
4—Sockets	4.00
2—UX-210 Tubes	18.00
2—UX-216-B Tubes	15.00
C_4—4-Mfd. Sangamo Series B Condenser	4.00
C_3—2-Mfd. Sangamo Series B Condenser	2.50
L_5—Amerchoke	6.00
C_5, C_6, C_7—Sangamo 0.002-Mfd. Condensers	1.50
C_1, C_2—Double-Spaced Cardwell Condensers	14.00
L_3—Radio-Frequency Choke	1.00
G. L.—15,000-Ohm Resistance	1.00
L_1, L_2—Inductances, Radio Engineering Laboratories	12.00
R—6-Ohm Rheostat (Dismantled)	1.00
Radiation Meter, 0–1.0 Amps.	7.75
Total	$112 75


Radio Broadcast Photograph

EMPLOYING THE SAME CIRCUIT

An experimental layout used at 2 EJ during the development of the transmitter described in this article

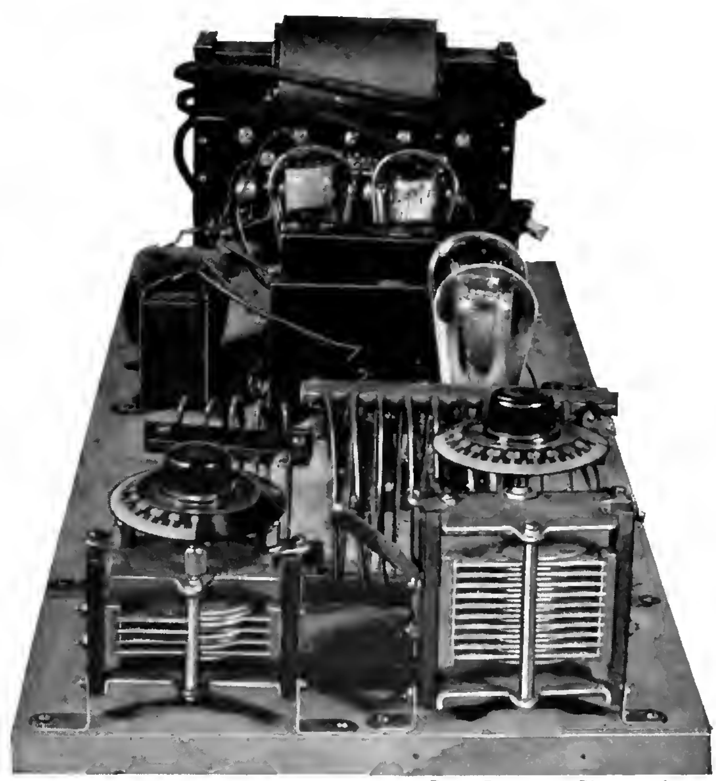
Coupling to the antenna should be loose enough that the tube does not stop oscillating when the antenna is in resonance. This non-oscillating condition may be evidenced by an audible "sing" in the tube circuit, with undue heating of the plates, and a decided and sudden drop in antenna current. The best adjustment of the coupling will be such that a single resonance peak is observed on the antenna meter—the current increasing slowly at first then rising rapidly to a maximum, and then falling with no sudden breaks. Some care must be exercised in finding this point for, if the coupling is too tight, there will be two resonance peaks more or less close together. It will usually be found that a distant station will report better signals with somewhat loose coupling, due to steadier oscillations. At 2 EJ the coupling is about 2½ inches.

With a plate milliammeter it is possible to estimate the antenna power by the following method: Let us suppose that, with the antenna disconnected, the plate current is 75 milliamperes at approximately 750 volts. This represents a power input of 750 x .075, or 56.25 watts. Now, with the antenna tuned, suppose the plate current is 100 milliamperes, or an input power of 75 watts. The difference—19 watts—is going into the antenna. This method of calculating the antenna power is not exact though the answer is accurate enough for average purposes. This antenna power, divided by the square of the antenna current, will give the approximate resistance of the radiating system.

This transmitter is flexible enough for any experimenter. At any time larger tubes may be substituted and greater power applied to them. Care must always be exercised, however, to see that the voltage rating of the filter condensers is not exceeded.

FROM THE RADIO ENGINEERING LABORATORIES

The circuit employed in this transmitter is basically the same as that used in the one described in the article. The R. E. L. equipment shown is eminently satisfactory for short-wave work


Radio Broadcast Photograph

A CLOSE-UP

This is an end view of the transmitter and shows particularly the oscillating and antenna circuits. Note the heavy connection from condenser to inductance

Judging the Tubes You Buy

SOME TYPICAL TUBE-TESTING EQUIPMENT

In this set-up a Jewell tube tester has been employed. Although the latter is seemingly considerably more elaborate than the simple one described in this article, it is really not so. The five meters are for reading the plate voltage, filament voltage, filament current, grid voltage, and plate current. In the home-made tester, the first four meters are eliminated, the manufacturers' figures for the batteries and tubes' filament current capacity being accepted as accurate

What You Should Know About Vacuum Tubes to Safeguard Yourself When Purchasing Them—Desirable and Undesirable Characteristics: How to Discriminate—A Simple Tube Tester for the Dealer or Fan

By EDGAR H. FELIX

A RADIO receiver is no better than its vacuum tubes, and they, in turn, function no more efficiently than their power supply permits. The extraordinary rejuvenation which usually follows the renewal of a receiver's tubes bears evidence of their vital influence on quality and volume. A tuner sufficiently sharp to eliminate undesired stations and an amplifier and loud speaker which handle the entire musical range with equal facility, may give unsatisfactory and distorted performance because of the use of the wrong type of tube, of second-rate tubes, or of incorrect grid, plate, or filament voltage supply to one or all of the tubes.

A technical analysis of tube functioning is helpful to the designer of receivers and amplifier units, but it is of little value to the average enthusiast as he goes to a radio store to buy his tubes. There he is dependent on the dealer who is, in part, dependent upon the tube manufacturer. No amount of inspection will reveal whether a tube has adequate emission or whether its plate impedance is precisely that for which a certain receiving set is designed. Only a precision instrument, a tube tester with half a dozen expensive meters, in the hands of a technically qualified person, tells the full truth about a tube. Quite a lot of valuable data as to a tube's condition and characteristics can, however, be obtained with simpler testing equipment.

The most prominent tube manufacturers do not recommend the use of a tube tester by the average dealer because, if improperly operated, or inaccurate, its use is misleading. Only dealers selling a large quantity of tubes are justified in employing the comprehensive measuring equipment necessary to make a conclusive tube test. Tube manufacturers therefore recommend a performance test, an actual trial of the tubes in the customer's presence, in an operating receiving set.

The buyer of a tube, then, has his choice of: (1) Taking a chance that the dealer will recognize his claim if a tube proves unsatisfactory; (2) of a performance test in a receiver at the radio store; or, (3) of confining his purchases to a dealer of such repute and handling capacity that he can afford to make a scientific tube test with the aid of an efficient instrument. Circumstances, in nine cases out of ten, compel reliance upon the first and most unsatisfactory of these three possibilities because there is no product harder to stand back of than a vacuum tube. When a customer comes to the dealer with a tube in his hand which he states was bought the day before, a suspicious glance is bound to creep into the salesmen's eyes. Buyers are not above bringing back a tube which has been paralyzed by an excessive voltage, which has been in use for a period of months, or which has been bought at a cut price because it is a "second," below standard, at another store.

The good way, then, to buy a tube, is to insist upon an informative test before it is accepted. The most conclusive test is made with the aid of a tube tester, which tells, with accurate high-grade measuring instruments, the exact plate, grid, and filament potentials applied to the tube and the resultant plate output current. A chart must be conspicuously in evidence near the tester, giving these essential test specifications for every kind of tube as evidence that the tube tester is being used correctly.

The performance test with a standard receiving set has the drawback that it requires broadcasting of good volume be available at all times of the day, a condition by no means universal. For this reason, the receiving set test is not always possible, however conscientious the dealer whom you select.

Under such circumstances, we are forced to rely upon a tube tester or no test at all. That being the case, an inexpensive tester is needed, which makes an informative test possible. It assures the customer that he is obtaining a tube of accepted characteristics, essential to the efficient and stable operation of most receivers.

STANDARD TUBE CHARACTERISTICS

THE difficulties encountered in the attainment of uniformity in tube production are simply inconceivable to the lay mind, and it is little wonder that cheap tubes of similar type vary exceedingly in their characteristics. The table on page 576 gives the characteristics of all the different types of tubes that are in general use. Tubes of these types should not vary to any marked degree from the figures given here, especially where their plate current is concerned.

When you, as a customer, hand your dealer the price of a 201-A tube, you should receive a device having a definite plate current output when supplied with its rated filament, grid, and plate voltages. If it fails to measure up to standard, or exceeds established standards, the general belief is that the set in which it is placed merely gives a little greater or less volume. But that is only an incidental result. Indeed, even more than volume, you sacrifice selectivity, stability, and tone quality to a degree dependent upon the deviation of the tube from its supposed characteristics.

Under the circumstances, a really informative tube test is a matter of considerable importance to the purchaser and to the dealer who believes in giving good service. The test made by most dealers for the purchaser is a filament conductivity test. If the tube lights, it is considered satisfactory. This test, however, gives no indication whatever of the way a tube will function in a circuit.

The most conspicuous guide to a tube's efficiency is its plate current output, when the

Data for the Home-Made Tube Tester

The following is a list of parts required for the home-made tube tester described in these pages:

1. UX Socket for Dry Cell Tubes
2. UX Socket for Storage Battery Tubes
3. 6-Volt Storage Battery
4. Milliammeter, 1 to 25 Mils.
5. Ballast Resistance, Reducing 6V. to 3V. at 0.06 Amp.
6. Ballast Resistance, Reducing 6V. to 3V. at 0.125 Amp.
7. Ballast Resistance, Reducing 6V. to 5V. at 0.25 Amp.
8. Ballast Resistance, Reducing 6V. to 5V. at 0.5 Amp.
9. Ballast Resistance, Reducing 6V. to 5V. at 1.0 Amp.
10. Grid Potential Switch
11. Filament Potential Switch
12. Filament "On-Off" Switch
13. Plate Potential Switch
14. C Battery, 4.5 volts (Note Special Connections to Obtain 22.5 Volts Bias).
15. B Battery (for C Bias), 22.5 Volts
16. C Battery, 4.5 Volts

17, 18, 19. B Batteries, 45-Volt

Tube	Switch Positions			Plate Current (in mils.)
	Filament switch	Grid switch	Plate switch	
				AV.
UX-199	F	D	O	2.5
UX-120	G	B	P	6.5
UV-200	J	E	M	1.0
UX-200-A	H	E	N	1.5
UX-201-A	H	D	O	2.0
UX-112	I	C	P	6.0
UX-171	I	A	P	16.0
High-Mu	H	E	O	1.5

tube is supplied with its rated filament, grid, and plate potentials, as indicated by an accurate milliammeter. These three supply voltages, however, must be adjusted carefully, if an accurate test is desired. Therefore a separate or combination precision meter, and means of adjustment for each voltage, is needed, in addition to the plate milliammeter. Commercial tube testers, capable of measuring all of these voltages accurately, are beyond the means of a dealer selling only a small quantity of tubes each month.

In the absence of accurate voltmeters to determine filament potential, grid bias, and plate voltage, these voltages may be secured, with some sacrifice of accuracy, from the usual storage A battery through ballast resistances and from dry cell B and C batteries. On this page is shown a circuit diagram of a tube tester equipped with two sockets, sufficient terminals, and switches so that any standard tube may be measured. It can be built by a dealer at a cost of only ten dollars or so. The only indicating instrument required is a milliammeter in the negative B-battery lead, which shows the plate current, no matter what kind of tube is being tested. The accompanying table gives the normal plate current reading for a good tube, the correct socket to use, and the switch setting for every type of standard tube.

An excessively high plate-current reading is as undesirable as a low reading. A tube should give its rated plate current. An excessively high plate current may indicate an exceedingly active filament liberating electrons profusely or, more likely, it indicates a low plate impedance which would cause even a most stable radio-frequency amplifier to oscillate; in an audio-frequency amplifier, it may cause exaggerated resonance points in transformers and loud speakers. A tube showing low emission may be improved by the ordinary reactivation process, but nothing can be done to make a tube giving excessive plate current entirely satisfactory.

Even with the simple tube tester shown, the dealer's salesman can make misleading tests. A UX-201-A for example, should be tested at five volts filament potential, four and a half volts grid bias, ninety volts plate potential, and should, under these conditions, give a two-milliampere reading. If, instead of a four and a half-volt negative bias, the grid return is made to the positive filament lead, the average tube will show a very high plate current. The plate current of power tubes goes up enormously if less than the rated negative bias is applied to the grid. Even in stores doing a large business in New York, the writer has been handed an UX-112 tube with the statement that it is exceptionally good, because it gave nearly twice its rated plate current!

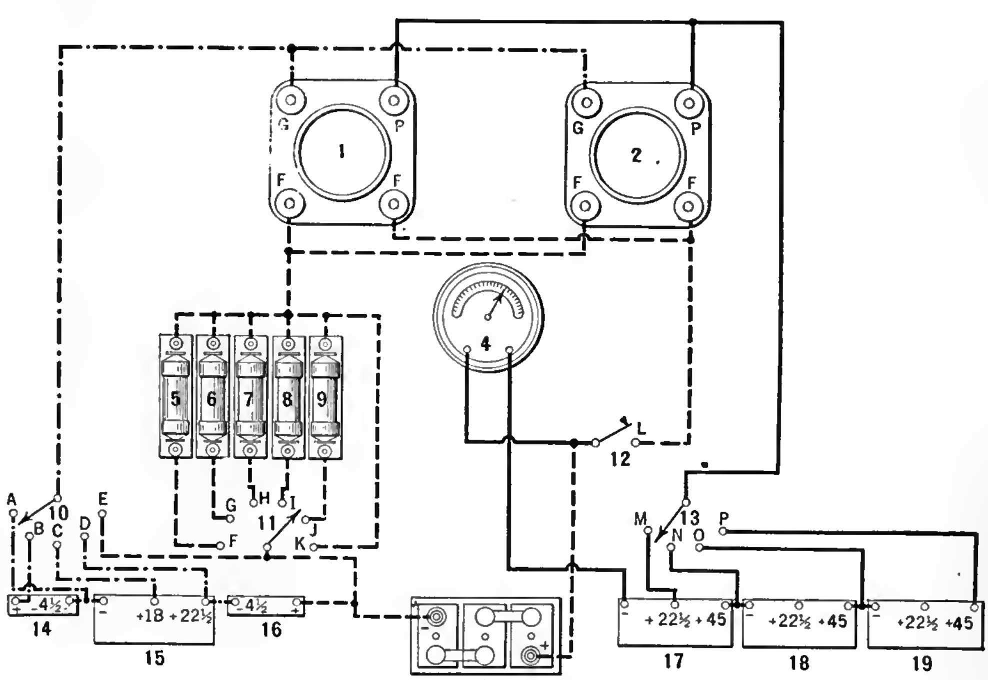
The commercial tube testers are of various types, some having more meters than others. A number of tube testers have a potentiometer for varying the grid bias over a scale of values. By means of a chart, the dealer is supposed to ascertain the change in plate current which should result from this variation in grid voltage. It is a more complicated test than direct plate-current measurement under fixed conditions and, placing more technical responsibility on the salesman, is less likely to be properly made.

A prominent radio servicing organization in New York, which has more than four thousand regular customers, advised the writer that one of the most frequent causes of trouble is the supplying of incorrect tubes, by dealers, when sets are sold. A careless dealer sometimes gives a customer a power tube to be used with a receiver having no provision for connecting extra grid biasing voltage on the last stage; or he may simply fail to specify sufficiently high B and C battery voltage supply. Such feats of stupid salesmanship may be laid directly at the door of the dealer, but, when a customer purchases a specific tube, he takes full responsibility for its correct utilization. Consequently it is of advantage to know the operating characteristics and the use to which existing tubes are employed to the best advantage. The table on page 576 shows the potential supply which each type requires if it is to function with satisfaction. These should be religiously adhered to.

GENERAL HINTS FOR BUYING TUBES

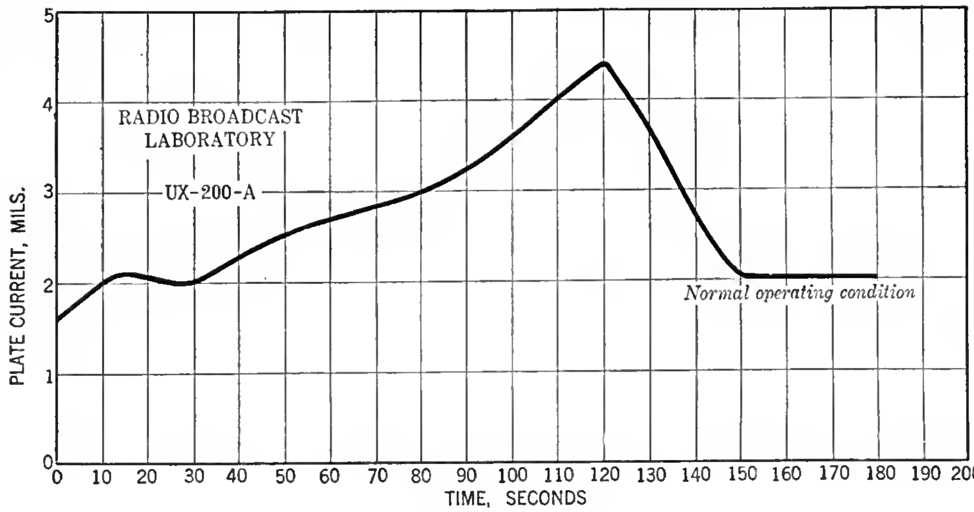
THE purchaser of vacuum tubes should first satisfy himself that he is using the tubes best adapted to his receiving set; secondly, that he has available a suitable power supply for use with the most desirable tube; third, that he buys the tube from a reputable dealer who will stand back of it.

The expression "matching the tube impedance



A ONE-METER TUBE TESTER

The 1-25 mil. meter is the only one required for this simple tube tester. The data in the box on this page will help in the construction and operation of this handy tester. The switch positions for the various voltages are as follows: Switch No. 10 (grid bias)—A, minus 27; B, minus 22.5; C, minus 9; D, minus 4.5; E, zero. Switch No. 11 (filament)—F, 3v., 0.06 amp.; G, 3v., 0.125 amp.; H, 5v., 0.25 amp.; I, 5v., 0.5 amp.; J, 5v., 1.0 amp.; K, no resistor in circuit. Switch No. 13 (B battery)—M, 22.5 volts; N, 45.0 volts; O, 90.0 volts; P, 135 volts. It is important that the tube to be tested is not inserted into its socket until all the battery switches have been set correctly, and that the filament switch is left open while changes are made. If this precaution is not followed, blown out tubes, ballast, or meter may result



A CURVE FOR A UX-200-A TUBE

Showing how it takes a few seconds after the correct battery potentials have been applied before the tube settles down to normal operating conditions. For two minutes after the set is turned on the plate current gradually increases, after which it drops to its normal value of 2 mils. and stays there

to its output load impedance" is frequently offered as a guide in selecting the correct tube. The fundamental principle behind matching impedance is that any source of power output works best when the load to which it is harnessed is its normal working load. This principle works both ways. A locomotive towing a baby carriage is just as inefficient as a rabbit pulling a freight car. A seesaw works best when the weight on both sides is nicely balanced. When we have unbalance, there is reaction of the load on the power source.

Most radio-frequency amplifiers employ some form of balance for neutralizing the voltages set up through the grid-plate capacity. Whatever method is used to stabilize the receiver, it is dependent for its operation upon the use of tubes of definite and specific plate impedance, amplification factor, and internal capacity. Consequently, the use of a tube which departs from these standards—even a better tube with higher power output—upsets the balance for which the set is engineered. Fortunately, tubes which give normal plate current readings with correct applied voltages are generally normal in their other characteristics. Consequently, the tube purchaser should insist on a tube test which assures him that his tube is a normal one of standard characteristics.

When excessive plate voltages or incorrect grid voltages are used, the tube impedance changes and conditions for which the set was designed are upset. For example, if a B power-supply device is used which delivers twice the rated plate voltage, the tube impedance is materially reduced, causing the set to howl and squeal. Insufficient grid bias causes a tube to overload easily; excessive bias chokes it and may completely block its output. There is no compromise in the matter of potential supply; it is either correct or else optimum results cannot be obtained.

Tubes which vary greatly from standard, therefore, should not be used, lest there be serious loss in amplification or undue oscillation at the high frequencies. The dealer who hands you a tube and says it is good because it gives an extra large plate current does not know what he is talking about.

One or two other tube characteristics are not identified by measurement tests within the scope of ordinary tube testers. The internal capacity of a tube is determined by the physical proportions and spacing of the tube elements. Unusual variations from standard, as we have seen, by the use of special types of tubes, upsets any form of neutralization.

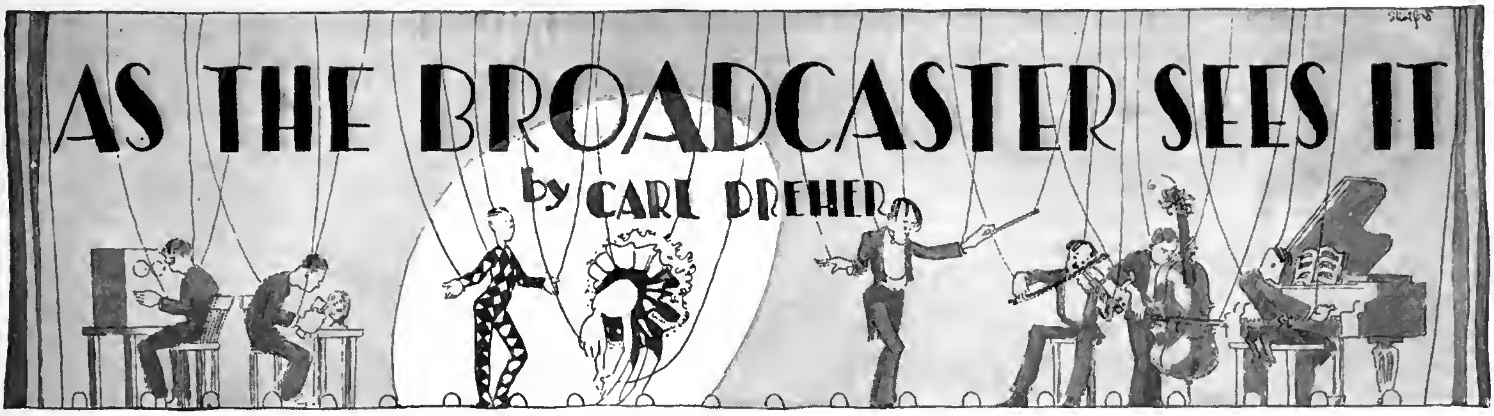
One difficulty with tubes is microphonic noises, resulting from physical vibration of the elements. Some control over the frequency at which microphonic noises are experienced is secured by adjustment of filament rheostats. A UX-112 tube used as a detector may sometimes overcome microphonic noise, due to its more rigid filament.

Howling results from a microphonic tube being within close range of the loud speaker. The most effective way to overcome howling due to microphonic tubes is to place the loud speaker at least ten to twenty-five feet from the receiving set, depending on the maximum volume used. The use of sound dampening devices, such as the placing of rubber covers or wooden boxes over the tubes, have been found fairly effective. Set cabinets not tightly assembled are sometimes the real cause of a microphonic tube because they vibrate freely at a certain frequency. The resulting vibration is then passed to the tube elements through the cabinet and socket. Sometimes merely opening the lid of the cabinet stops the trouble.

Another trouble often attributed to the tubes or to defective B batteries is crackling noises similar to static. It is surprising how often that trouble can be remedied by polishing up the A battery leads and carefully tightening all B and C battery connections. A large proportion of the trouble attributed to noisy B batteries and noisy tubes is due to careless set connections made by the set user. When spring clips are fastened on A battery leads, sometimes just squeezing them with the fingers will eliminate set noise. Tube socket prongs and springs should likewise be shined up and inspected occasionally, to make certain of a good connection.

Intelligent tube purchase is therefore a matter of: (1) Selecting the right tube for each purpose; (2) powering the tube with correct grid, filament, and plate voltages; and, (3), purchasing a tested tube which gives normal results as indicated by normal plate current output at its specific operating voltages. The careful purchaser will patronize a dealer who will stand back of the tube after he has purchased it. He will insist upon a tube test of some kind employing, at least, the equivalent of a tester of the type described, or, if possible, a more elaborate and accurate device.

Type	A Battery Volts Supply	Filament Terminal Volts	A Battery Current (Amperes)	B Battery Volts Detector	B Battery Volts, Amplifier	Negative C Battery	Plate Current (Milli-amperes)	Output Resist-tance (Ohms)	Voltage Amplifi-cation Factor	Undistort-ed Output (Milli-watts)
UX-199	4.5	3.0	.06	45	90	4.5	2.5	16,500	6.25	7
UX-200	6	5	1.0	15 to 25	—	—	—	—	—	—
UX-201-A	6	5	.25	45	90 135	4.5 9.0	2 2.5	12,000 11,000	8 8	15 55
WX-12	1.5	1.1	.25	22½	90	4.5	2.8	15,000	6	7
UX-112	6	5	0.5	45	157 135 112 90	10.5 9.0 7.5 6.0	8 6 3 2.5	4800 5500 8400 8800	8.0 7.9 7.9 7.9	195 120 85 40
UX-120	4.5	3.0	.125	—	135	22.5	6.5	6600	3.3	110
UX-210	8 6	7.5 6.0	1.25 1.1	— —	425 350 250 157	35 27 18 10.5	22 18 12 6.0	5000 5100 5600 7400	7.75 7.65 7.5 7.5	1540 925 340 90
UX-171	6	5	0.5	—	180 135 90	40.5 27 16.5	20 16 10	2000 2200 2500	3.0 3.0 3.0	700 330 130
UX-200-A	6	5	0.25	45	—	—	1.5	—	—	—



Drawings by Franklyn F. Stratford

Some Notes on Morale Among Broadcasters

THE quality of morale has been much talked of in business and industry since the war. Stanley Hall, the eminent psychologist, wrote a book about it before he died. It may be defined as a state of zest and confidence permeating a body of men engaged in some enterprise. The presence of such a feeling is most essential in war, and its absence is then most serious; but of course all existence is a sort of war, against competitors and obstacles animate and inanimate. In a settled industry morale is important, but where unusual conditions obtain it becomes indispensable. Broadcasting is a case in point.

Broadly speaking, the people engaged in any business may have two attitudes toward the enterprise. They may consider the business simply as a source of income. It consumes their labor and pays for it. A certain proficiency on the part of the employee is required, if he is to hold his job. Beyond that, he does not have to worry. The second attitude involves pride rather than fear. The man who has it is concerned about the whole enterprise, even though he may play only a minor part in its operations. He identifies himself with the institution, and desires its success as he desires his own. This feeling among the body of soldiers in an army, or the mass of employees in a business organization, is what we call good morale. Either attitude is normal, although one is desirable and the other undesirable from the standpoint of efficiency. The men at the top are more apt to feel the urge to work spontaneously than those below. Being in charge, they have more at stake and their responsibility is direct. Their interest may be taken for granted. What is required is the transmission of this attitude downwards to the levels where the details of relatively small jobs receive attention or neglect. These small jobs, added up, ultimately determine the success or failure of the business.

There are a number of prerequisites which must not be neglected if a state of psychological health is desired in a factory, or a broadcasting station, or what you please. One is equitable treatment of employees. The men who do the best work must receive the largest rewards. If other factors, such as favoritism on the part of someone in authority, enter into the case, a devil-may-care attitude is quickly generated among the men who feel unjustly treated. Adequate tools must be provided. If the men at one broadcasting station have an adequate supply of good microphones, whereas those at a neighboring studio get only enough transmitters to stay on the air, the second group naturally throws up its hands. They are licked from the start, and they know it. Sound organization is another factor. Everybody must know what he is responsible for, and duties must be clearly defined. Finally, some men will do the work they have agreed to do without being checked up continually, whereas other men *want* supervision, and become slack if the whip is not cracked at them occasionally. The will to get things done is not in them; someone else must supply it for them. It must be supplied, furthermore, not only at the top, but at closer range. It is rarely possible for executives to supervise the details of operation. Each executive requires a group of lieutenants for that specific purpose.

A broadcasting station may be considered as a factory producing entertainment by radio. Morale is important even in a factory. But, as a matter of fact, the broadcaster's work, whether on the technical or program end, contains unique elements. For one thing, the broadcaster does his work in the glare of publicity. In an ordinary factory or business office errors may be made and corrected without other loss than that of time; the end-product and the prestige of the business may remain unaffected. In broadcasting, a slight error, leading to a mix-up on the air, may have grave consequences. Hence, in broadcasting, the tension is greater, and the importance of a healthy psychology among the workers increases in proportion.

"THEY TALK TO THE CIGARETTE SIREN AT THE RESTAURANT"

For a time it was my belief that on the technical side this element of pitiless publicity would in itself generate a spirit of resolution among the men doing the work. I argued that when a field operator, for example, realized that any difficulties he might have on the job would be heard all over town, he would automatically take care of his connections and his apparatus. The theory is plausible, but wrong. After some years of practice I am convinced that at least half the broadcast technicians now practicing their art in the United States do not take life so seriously. Starting out on a job they will blithely drop a microphone, pick it up, and, seeing no obvious dents in the diaphragm, put it on the air for a concert. When noise develops they are astonished and feel that fate has given them a raw deal. They make connections which a bell-hanger would be ashamed of, forget half the equipment altogether, get to the job ten minutes ahead of the time set for the air, and talk to the cigarette siren at the restaurant while working the gain control. Some of these fellows are hopeless, and the sooner the accident which got them into broadcasting is rectified, the better for all of us. But a majority of them can be utilized quite efficiently, so that they will broadcast with credit to themselves and their stations if some hard-boiled but just and competent technician is placed in authority over them. There must not be so many that he cannot watch them, because watching, at least for a time, is what they need. After they have been trained for a period to protect their microphones from the screw-drivers and pliers thrown into the satchels with the transmitters helter-skelter, and to see to it that the amplifiers do not drop into the gutter while the taxicab is rounding a corner, and to take a few other such precautions, they may get into the habit of being careful, and the station will function as well as can be expected.

These, however, are essentially negative measures. What is desired is a spirit of courage, enterprise, and solidarity among the personnel. This develops spontaneously after a time when the prerequisites are taken care of. The station then turns out a good job. Its reputation mounts accordingly, and likewise its income, whether derived directly or indirectly from its activities on the air. Under these conditions the men feel reasonably happy and confident; they still have their troubles, of course, but they are imbued with the psychology of victory. This holds as much for the program people as for the technicians. It is easy for either group to slip into a rut. When the program force puts on the same stale "features" week after week, without even looking at the newspaper headlines for something new, the station goes downhill as fast as when the operators overload the amplifiers until the plate current could be read on a microammeter. When the announcers start talking before throwing the microphone switch to the "on" position, and get mixed up on their change-overs, the reaction on the operators is bad. The whole station hangs together as a unit. I have never seen a station with a poor program department and an excellent technical division, or vice versa. They are always approximately on a level. The mental or emotional condition of the workers always plays a great part in determining what that level shall be. The action, furthermore, is a regenerative one; a healthy emotional tone in a business leads to good results, with a resulting increase in personal confidence. The effect of this is again shown in the production of the plant, and so on up to a certain limit. And the same amplification operates downward, so that we find broadcasting stations, as well as other enterprises, afflicted with a general inferiority complex, and turning out a corresponding performance on the air.

As much as anyone, I have jibed at the promotors of specious optimism in business. None has ever found a place on any pay roll with which I had anything to do. But it is important to note that the result they are after is of much consequence, in all truth. The only trouble with the professional boosters is that they deal in hot air, instead of analysis; they cry loudly for good will and courage in business, without taking the essential steps. We have our share of them in broadcasting. They belong on the streets, selling imitation pearl necklaces at fifty cents apiece by the power of eloquence. But the quality of morale, about which these spellbinders talk so much, is really vital in broadcasting, and it will do no harm for station directors to ponder, when the carrier has ceased to bubble and the grid leads are at rest, on ways and means of getting it, and keeping it after it is got.

Abstract of Technical Article. V

THE NATURE OF LANGUAGE—A RÉSUMÉ OF RECENT WORK ON THE PHYSICS OF SPEECH AND HEARING, by R. L. Jones, Engineering Dept., Western Electric Co., Inc. *Journal of the A. I. E. E.*, Vol. XLIII, No. 4. April, 1924.

[Continued from March RADIO BROADCAST]

AT SPEECH frequencies, the smallest discernible change in the intensity of a tone is one-tenth of its original value. Thus, for the human ear, the law connecting loudness apperception with sound energy is a logarithmic one. The smallest discernible change is about 1.0 TU, in telephone terminology. Generally 1.0 TU is taken as the smallest significant variation in a telephone system, for this reason. If, for example, the frequency characteristic of a broadcasting station has troughs or elevations of 1.0 TU or less at various points, they may be neglected as imperceptible to the normal human ear.

The law of pitch sensibility is approximately logarithmic also, a fractional change in frequency of about three-thousandths being perceptible over the ordinary musical range. On the above basis of frequency and intensity discrimination, within the normal limits of audition the human ear can separate about 300,000 *pure* tones. The number of complex tones is of course even vaster. This gives one some idea of the complexity of the job of reproducing speech and music naturally.

In studying sound, for practical results, we must take into account the peculiarities of the ear as much as the physical characteristics of the sound energy itself. Some of these peculiarities arise from the non-linear response of the ear. An intense simple tone impressed on the ear drum gives rise within the ear mechanism to harmonics. A second simple tone will have the same effect, and the harmonics thus generated are capable of giving rise to combination tones and beats within the ear. These effects, while complicating the study of acoustics through the introduction of subjective factors, are sometimes a practical aid. For example, very low pure tones emitted by an instrument, reaching the ear with considerable intensity are heard as complex notes, the harmonics being contributed by the ear mechanism with its non-linear response. Hence, when a radio set and loud speaker deliver a low note, originally pure, in the form largely of harmonics, the ear does not perceive the difference as radically as it would if it were not in the habit of mixing harmonics even with notes that do reach it in their pristine form. This is not an argument for permitting distortion; it simply shows that in some cases this distortion is partially masked through the subjective distortion tendencies of the ear, and these effects are most noticeable at high intensities.

Low tones of great intensity are observed to mask or interfere with relatively weak high notes, but intense high tones do not appear to mask low notes to any degree. This may be due to the action of a loud low note, with its subjective harmonics, in setting up vibrations along a considerable portion of the basilar membrane, interfering with other incoming vibrations of frequencies in the neighborhood of some of the harmonics. But in the case of high-pitched tones only a restricted sector of the membrane responds, and the other nerve terminals are left free to vibrate when a low note is added externally.

In normal speech, frequencies between about 100 and 6000 cycles are used, with the most essential tones between 200 and 2000 cycles at a pressure amplitude of between 1 and 10 dynes R.M.S. In the case of defective hearing there may be a general raising of the threshold of sensation shown in Fig. 2 (March RADIO BROADCAST). Thus certain sounds readily perceived by a person of normal hearing are missed by a listener whose hearing is subnormal, the intensity being below the latter's individual threshold curve at the frequency in question. Evidently by means of amplification some cases may be partially remedied. But amplification is limited by the tendency toward subjective distortion at high intensities. Again, defective hearing may be due to an unusual degree of non-linearity in the response of the ear. The study and relief of deafness is a special field in which research acoustics has been of great help when carefully applied.

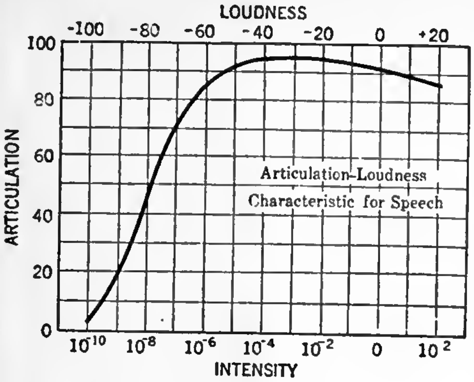


FIG. 1

Electro-acoustic apparatus of the type described in the Abstract of the Crandall-MacKenzie paper on *Analysis of the Energy Distribution in Speech*, given in the January RADIO BROADCAST, may be used in studying the interpretability of speech. This is accomplished by pronouncing detached speech syllables into the transmitter of the experimental system, controlling the volume and distortion at will, and observing the errors in reception at the receiver. The articulation of a telephone system is defined as the per cent. of the total sounds spoken which are correctly received.

With a distortionless experimental system the effect of intensity on interpretability of speech may be studied. The result of such an experiment is shown in Fig. 1, reproduced from Fig. 6 of Jones' paper. The abscissas of the curve represent loudness, expressed as a ratio of the intensity received to the intensity at exit from the mouth. At about one-thousandth of this intensity articulation is at a maximum, although there is no great variation over the range from about 10 down to about 10^{-5}, a ratio of 10^6. With speech of the order of 10 down to 10^{-2}, the loudness is too great for comfortable listening, the ear mechanism being more or less overloaded, with consequent exaggeration of subjective distortion. Below 10^{-6} the curve drops rapidly, the sounds becoming too faint to be interpreted readily; at 10^{-10} inaudibility is reached. These are the results for a quiet room. In a noisy place the peak of articulation would of course occur at a loudness greater than the optimum of 10^{-3} obtained for a quiet room.

The fundamental sounds differ in their articulation over a telephone system at various intensities. In general, diphthongs and vowels are easier to interpret than consonants, and among the consonants the stop class has the advantage in this respect over the fricatives. As speech becomes weak, the consonants drop out first. This is a general rule with some exceptions. The easiest sounds to interpret are the diphthongs *i* (long sound) and *ou*, and the long vowels ó, ō, and ā, which have an average articulation of over 95 and maintain a figure of 84 even when very weak. At the other extreme are the sounds *th*, *f*, *s*, and *v*, whose energy is weak; these sounds are responsible for about half the errors of interpretation.

By means of high-pass and low-pass filters the effect of frequency distortion on articulation may be studied. Fig. 2, reproduced from Fig. 8 of Jones' paper, shows some results. The ordinates show articulation in percentage of syllables correctly received; the abscissas represent the cut-off frequency of the filter. When a low-pass filter (one passing all the frequencies *below* a certain marginal value) is used, we note by the curve marked *Articulation L* that when the system transmits only frequencies below 1000 cycles an articulation of 40 per cent. is obtainable. Now looking at the corresponding point for the high-pass filter, on the curve marked *Articulation H*, we observe an articulation of 86 per cent. for a system transmitting only frequencies *above* 1000 cycles. The dotted curves in Fig. 2 show the per cent. of the total energy of speech transmitted through filters having the cut-off settings indicated by the abscissas. There we note that, by elimination of all frequencies below 500, 60 per cent. of all the energy is lost, but only 2 per cent. in articulation. On the other hand, by suppressing all the frequencies above 1500, although we lose only 10 per cent. energy, articulation is reduced 35 per cent. But of course, from the standpoint of naturalness of reproduction, which is essential in broadcasting, the low frequencies are as important as the high. "Tinny" speech is more readily interpreted than "drummy" transmission, but neither is natural.

"In conclusion," writes Jones, "we have seen that the ordinary ear is an exquisitely developed organ for sensing minute and rapidly repeated variations in air pressure. It can perceive sound waves ranging in pressure amplitude from less than 0.001 dyne to over 1000 dynes, and in frequency of vibration from about 20 cycles per second to about 20,000—a range of about ten octaves. Human speech employs frequencies from a little below 100 cycles per second to above 6000 cycles, a range of about six octaves. The intensities and frequencies used most in conversation are those located in the central part of the area of audition. The energy of speech is carried largely by frequencies below 1000, but the characteristics which make it intelligible, largely by frequencies above 1000. Under quiet conditions, good understanding is possible with undistorted speech having an intensity anywhere from one hundred times greater, to a million times less than that at exit from the mouth. On the whole, the sounds *th*, *f*, *s*, and *v* are hardest to hear correctly and they account for over half the mistakes made in interpretation. Failure to perceive them correctly is principally due to their very weak energy although it is also to be noted that they have important components of very high frequency."

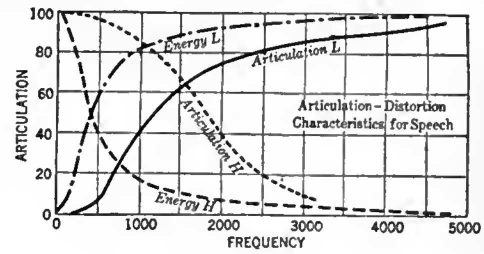
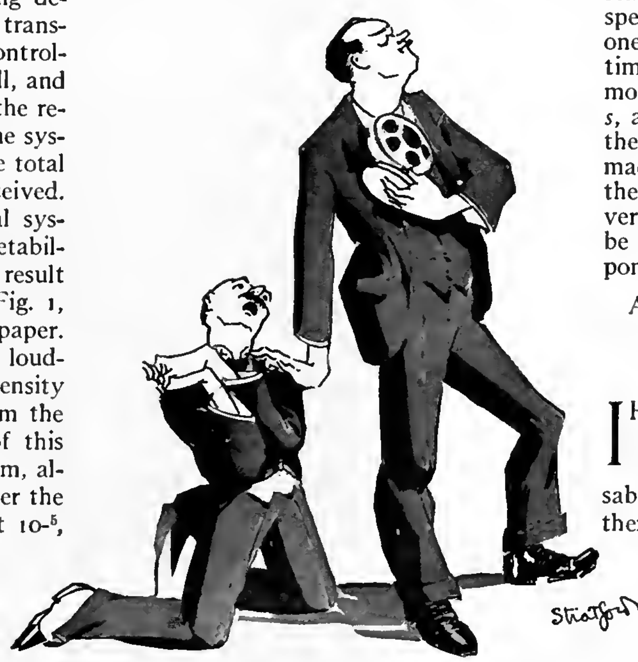


FIG. 2

A bibliography is appended to the paper.



". . . . BY REFUSING ALL SUCH PRAYERS HEREAFTER"

Dummy Microphones

I HAVE a suggestion to make to the theatrical outfitters who sell and rent rubber helmets, Roman togas, and tin sabres to the theatrical profession. Let them lay in a supply of microphone stands, stuffed with black paper inside the cage, and with twenty feet of flexible cord attached, so that the outfit looks real from the house side of the footlights. They will do more business with one such contraption than with ten masks of ape-men or complete suits of armor. The fact is that every broadcaster around New York, at any rate, receives numerous requests for the loan of microphones to be used by vaudeville comedians, banquet stage managers, fraternal organizations, and other ticklers of the public. They don't actually want to broadcast, but merely to kid somebody. This is well enough, but the broadcasters are frying their own bacon, and if they heeded all the requests they would not have enough mike stands left to hold up their own transmitters. I set a harsh example, therefore, by refusing all such prayers hereafter. If John Barrymore asks me to lend him a dummy microphone I may do so, but I shall hang up the telephone receiver on all lesser applicants. I have done my part by pointing out the need, at space rates. Now let the theatrical prop agencies get busy, thus terminating a nuisance for the harassed broadcasters, and enriching themselves.

Constructing a D. C. Amplifier-Power Supply Device

In Which Some Trouble-Shooting Hints Applying to A. C. Power Amplifiers Are Also Presented

By JAMES MILLEN

IN MANY of the older business and residential districts of some cities, the power supply is of the direct current rather than the more common alternating current variety. If the maximum voltages desirable for radio set operation were under 100 or so, then the person living in a district supplied with d. c. would indeed be fortunate, as he would not require an expensive transformer, rectifier, and large-capacity filter condenser in order to construct a plate-supply device. Instead, two small chokes and condensers would completely fill the bill. Unfortunately, however, such is not the case.

With a. c. any desired voltage may be obtained by means of suitable voltage step-up transformers and rectifiers. With d. c., however, the maximum voltage available cannot be stepped up in excess of the line voltage, usually between 110 and 120 volts.

With these facts in mind, the amplifier-power supply unit shown diagramatically at the foot of this page was designed for d. c. operation. Impedance-coupled amplification was employed in preference to resistance coupling due to the low voltage available. One hundred volts is ample for the first two tubes of an impedance-coupled amplifier, but very inadequate for a resistance-coupled amplifier.

A UX-171 tube is used in the last audio stage. With 100 volts on the plate, the proper C voltage is about 16.5 volts, which will permit of a fairly loud signal without introducing distortion due to tube overloading. Where greater volume without overloading is desired, the plate voltage may be raised by inserting a dry or storage B battery at the point marked X in the circuit diagram. To obtain C as well as B voltage from this device is possible but results in a reduction of the maximum available plate voltage, so C batteries are employed in this case rather than to reduce the B voltage further. Although the diagram indicates the use of an A battery or A power unit, the constructor who so desires may find field for interesting experiment by connecting the filaments of the two $\frac{1}{4}$-ampere tubes in parallel, and then placing that group in series with the filament of the 171 so as to obtain a series-parallel arrangement of the filaments, drawing a half ampere at 10 volts. A 50-watt lamp in series with this combination permits direct connection of the entire group to the 110-volt line. A small choke coil wound with heavy wire should be placed in series with the line for the purpose of hum reduction. Due to the fact that one side of the 110-volt line is grounded, this arrangement is rather a tricky one, and if care is not exercised, the tubes, and possibly one of the B-supply choke coils, may be burned out.

The layman is advised to use a storage battery in conjunction with the circuit shown.

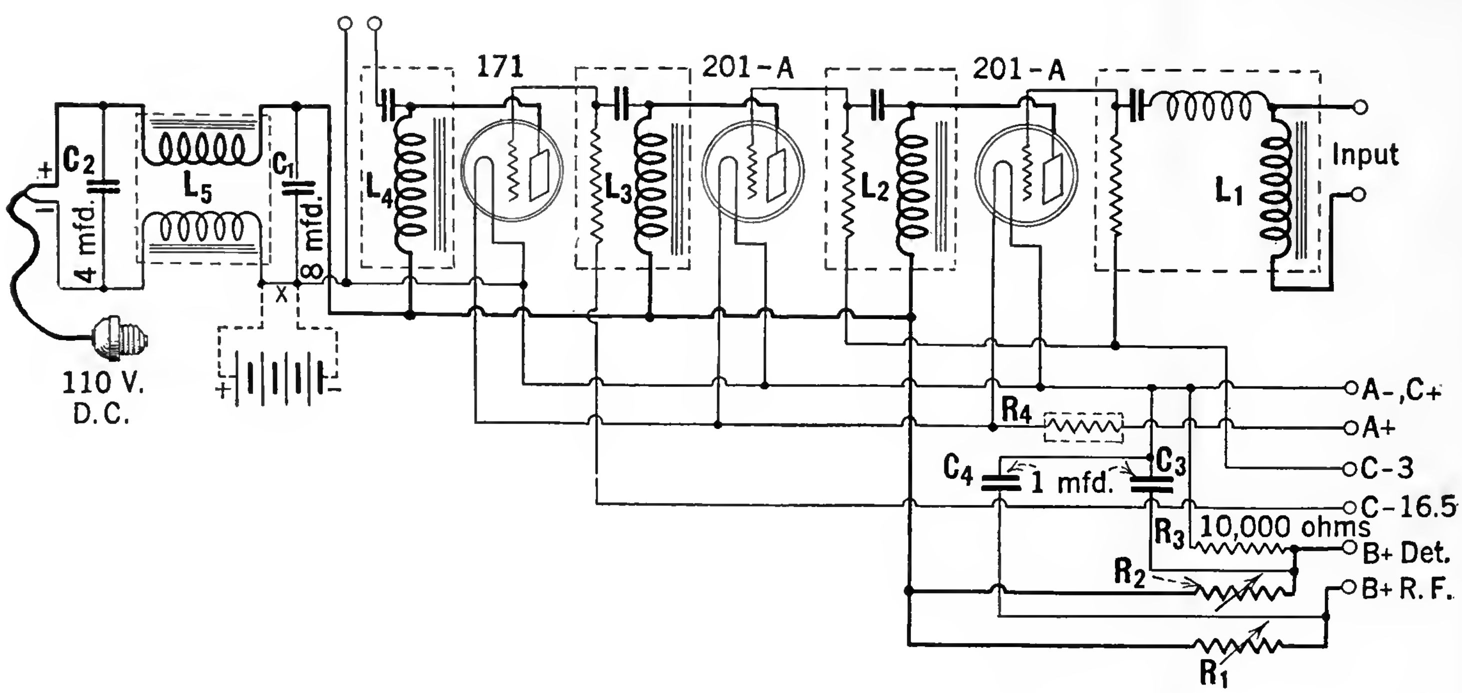
As one side of the line is always grounded, the ground connection must be removed from the set if it in any way grounds the filament circuit. If in doubt, play safe and disconnect the ground. If no signals are then heard, re-connect the ground through a 1-mfd. filter condenser.

In connecting to the d. c. lamp socket it will be necessary to insert the plug so that the positive and negative leads are connected as shown in the diagram. If in doubt as to which line is positive and which negative, forget about the matter and insert the plug in the socket first one way and then the other. One way will work and the other will not.

Perhaps some readers may wonder why a filter choke coil is placed in each line instead of the two in one line as in the case of the a. c. operated amplifiers. The reason for this special connection is to eliminate a high pitched "sing" that is heard from the loud speaker in some localities when all the inductance is placed in the one line. The double line arrangement also tends to reduce disturbances due to line noises.

Not so long ago the radio set was judged with the phonograph when a standard of comparison was desired. Since the introduction of high-quality amplifiers and combined power units, such as those designed and described by the author in this and the past few issues of RADIO BROADCAST, conditions have changed considerably, so that now the phonograph is compared with the radio rather than the radio with the phonograph.

In the very near future, the writer will describe in RADIO BROADCAST just how the amplifiers may be used to bring the phonograph up to date.



A D.C. OPERATED AMPLIFIER-POWER SUPPLY DEVICE

This is the circuit diagram of the d.c. unit described and illustrated in this article. The B voltage may be boosted by the insertion of a B battery at the point marked "X". No rectifier tube is, of course, necessary

A LIST OF PARTS

THE following list of parts names those products which were used by the author of the article in the construction of the d.c. amplifier power supply device described here:

L_1, L_2, L_3,—National Impedaformers, 1st, 2nd, and 3rd Stages	$16.50
L_4—National Tone Filter	8.00
L_5—National Type 35 Filter Choke	7.00
C_1—Electrad 8-Mfd. 200-Volt Filter Condenser	5.50
C_2—Electrad 4-Mfd. 200-Volt Filter Condenser	3.25
$C_{3,4}$—Two Electrad 1-Mfd. 200-Volt Filter Condensers	1.80
R_1—Electrad Royalty Resistor No. 2	1.50
R_2—Electrad Royalty Resistor No. 3	1.50
R_3—Lynch 10,000-Ohm Wire-wound Resistor	1.50
R_4—Lynch Equalizor No. 1 and Mount	1.00
Three Airgap Sockets	1.80
Eight Eby Binding Posts	1.20
Base-Board, Wire, Brass, Plug and Receptacle, Etc.	2.00
Two High-Mu Tubes (or 201-A type)	5.00
One UX-171 Type Tube	4.50
Total	$62.05

The National Impedaformer used in the first stage should be of the special input type.

supply devices (many of the instruments having several leads attached to each of their terminals) to omit one of the leads, or else run a lead to the wrong terminal. To completely wire and to check the work for accuracy, usually takes a neat worker, constructing his first combination amplifier-power unit, three hours or more.

When an amplifier, correctly wired, fails to operate, the trouble is almost without exception due to a defective piece of apparatus or a poor arrangement of the various parts. Some difficulties likely to be encountered are summarized in the following paragraphs.

PLATE OF RECTIFIER TUBE RED-HOT

A SHORT-circuit in the B-supply line, usually due to failure of the first (nearest the rectifier tube) filter condenser, will cause the elements in the rectifier tube to become red-hot. If a block type of filter condenser is employed, remove the connections from the first terminal of the suspected unit and substitute, externally, a new 2-mfd. condenser. If the first condenser proves to be all right, substitute for each condenser unit in turn. If the filter condensers are all satisfactory, then look for a short-circuit in the wiring. If a metal base is used in the construction of the amplifier, such as in the models shown on pages 383 and 385 of RADIO BROADCAST for February, the trouble will most likely be found where one of the high-voltage B leads, such as those from the rectifier tube, filter chokes, condenser block, or tone filter, pass through the metal base plate. Unless care is used to remove any burrs around the edges of the holes through which the wires are to pass, it is very likely that the insulation on the wires will fail at such points.

WEAK SIGNALS FROM LOCAL STATIONS

AN OPEN or burned-out plate coupling resistor would cause the signals from a strong local station to be barely audible in the loud speaker. Try another resistor in place of each coupling resistor until the defective one is located, or else, if facilities are available, remove the coupling resistors and test each one. Also check the wiring to the resistor mounts in order to be certain that a connection has not been missed.

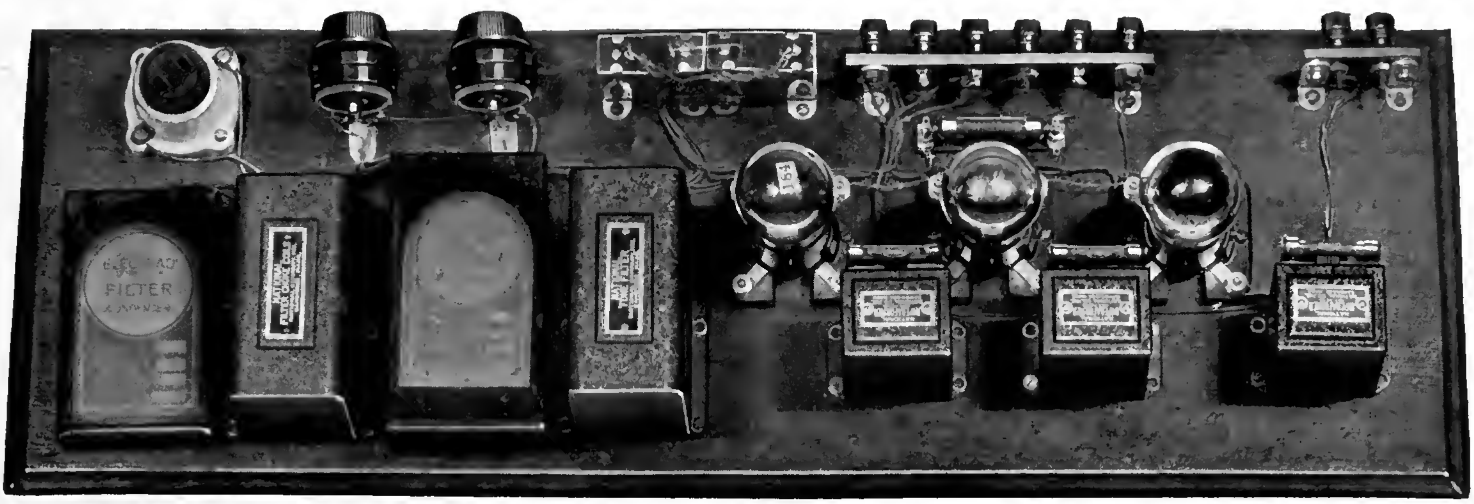
A short-circuited or an entirely open grid coupling condenser would also result in an extremely weak signal from a local station. Disconnect the coupling condensers and try others in their place. For this test any odd filter or bypass condensers that happen to be available may be used.

Another possible cause of a weak signal is an open grid bias resistor on the last tube. If a variable resistor, such as the Clarostat, is employed, see that it is not adjusted for too high a value of resistance. If a fixed resistor such as a 2000-ohm Tobe Veritas is used, either try another in its place, or else remove the resistor and test it.

DISTORTION ON MODERATE STRENGTH SIGNALS

IF THE variable grid bias control is improperly adjusted, blasting and distortion is bound to result. When this control has been adjusted for best results, however, and distortion due to blasting or tube overloading still continues, then the trouble may be due to improper C voltage on the first two tubes in the case of a resistance- or impedance-coupled amplifier, or on the first tube in the case of a transformer-coupled amplifier. If a change in C voltage does not improve matters, then try different tubes. If the trouble still persists, then an open grid leak is undoubtedly responsible for the difficulty.

If at any time a variation of the grid bias control for the power tube fails to make some marked change, either for better or worse, then it is likely that either the 0.25-megohm grid leak, the 0.1-megohm (0.05-megohm in some cases) grid-filter resistor, or both, are defective.



THE LAYOUT FOR THE D.C. AMPLIFIER

Using the units mentioned in the list of parts on this page. Other standard parts of similar electrical characteristics may be substituted. Satisfactory condensers are made by Dubilier, Aerovox, Tobe, Faradon, and others, and the impedance coupling-units may be made up of individual choke coils, 0.1-mfd. coupling condensers, and grid leaks, if the constructor does not desire to purchase Impedaformers

TROUBLE SHOOTING

ALTHOUGH trouble in any one of the amplfier power supply units designed by the writer, and described in the last few issues of RADIO BROADCAST, is not to be expected, no doubt some readers will run against some small snag, the remedy for which, while more or less obvious to the more experienced constructor, may mean all the difference between success and failure for the novice.

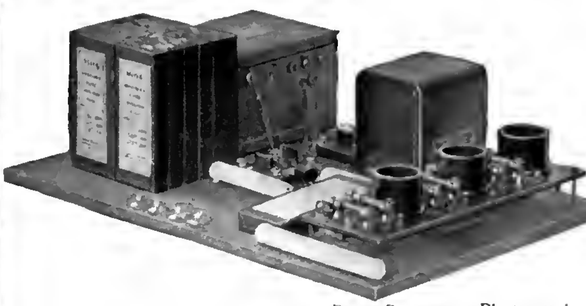
First, and most important, the constructor should guard against slovenly workmanship, poor wiring, loose connections, and lack of mechanical rigidity. It should always be kept in mind that the device being constructed is to be directly connected to the house lighting lines, and all connections should be made and all parts mounted so as to prevent any possibility of dangerous short-circuits.

When the unit has been completely wired, but before the wires are bundled together and cabled, all connections should be carefully checked in order that any errors due to carelessness may be located. It is easy for one not familiar with a circuit such as used in power-

WHEN TUBES DO NOT LIGHT

WHEN the tubes in the first stage, or stages, of the amplifier are known to be good, yet fail to light when in circuit, the trouble may be due to an open filament ballast, or to a poor socket contact. Where the socket is mounted on a metal base, the prongs of some UX type tube sockets, due to an excess of solder on the tube tips, will just touch and short on the metal base when the tube is pressed all the way down. The remedy is simply not to push the tube all of the way down, or else, to remove with a file the excess of solder from the tube prongs.

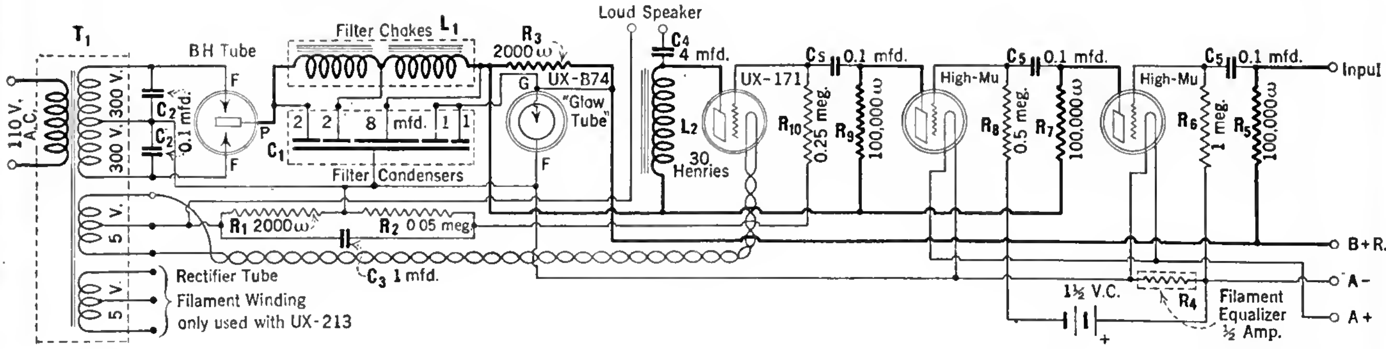
When an Amperite type of filament ballast is mounted on a metal base, care must be used to see that the heads of the two screws that fasten the mounting clips to the fibre base do not touch the metal. In case of trouble the best way is to take the mount apart and countersink for the heads of the screws. The Lynch Equalizor mount is so constructed as to permit direct mounting upon a metal base without trouble.



Radio Broadcast Photograph

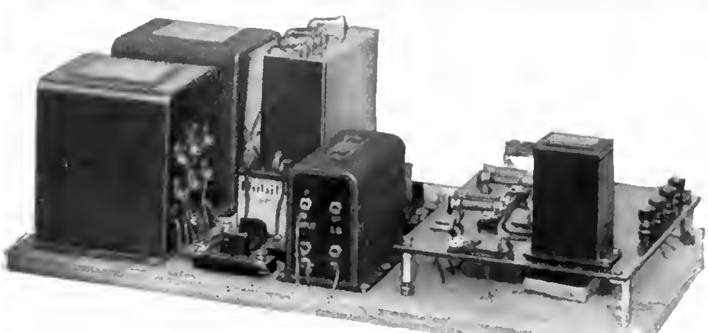
THE LIST OF PARTS

T_1, L_1—Dongan Power Compact, No. 3516	$13.00
C_1—Muter Condensers	
Two No. 568, 4-Mfd.	11.00
Two No. 566, 2-Mfd.	6.00
Two No. 565, 1-Mfd.	4.00
C_2—Muter Buffer Block No. 595	1.50
C_3—Muter Condenser No. 565, 1-Mfd.	2.00
C_4, L_2—General Radio Output Filter No. 387	6.00
Dejur Resistance-Coupled Amplifier (Includes C_5, Mountings, Sockets, etc.)	8.00
Two Airgap Sockets	1.20
R_1—Lynch Wire-Wound Resistor, 2000 Ohms	1.25
R_2—Metalized-Filament Resistor, 0.05 Megohm	.75
R_3—Lynch Wire-Wound Resistor, 2000 Ohms	1.25
R_4—Lynch Filament Equalizor, No. 2	1.00
R_5—Lynch Wire-Wound Resistor, 100,000 Ohms	4.00
R_6—Metalized-Filament Resistor, 1.0 Megohm	.50
R_7, R_9—Two Metalized-Filament Resistors, 100,000 Ohms	1.50
R_8—Metalized-Filament Resistor, 0.5 Megohm	.50
R_{10}—Metalized-Filament Resistor, 0.25 Megohm	.50
Lynch Single Mount	.35
Eveready 1½-Volt Flashlight Cell	.15
Raytheon BH Rectifier Tube	6.00
UX-874 Voltage Regulator Tube	5.50
Two High-Mu Tubes	5.00
UX-171 Type Tube	4.50
Baseboard, Fahnestock Clips, Wire, etc.	.75
TOTAL	$86.20



A RESISTANCE-COUPLED AMPLIFIER-POWER SUPPLY DEVICE

The transformer in the Dongan power compact has two five-volt filament windings which permit the use of the UX-213 Rectron in place of the BH Raytheon rectifier tube when so desired. The DeJur amplifier must be partially rewired in order to provide for use of a.c. on the power tube filament. It is recommended that metalized resistors be substituted for the impregnated paper type supplied with the amplifier. A 2000-ohm fixed resistor is used for obtaining the power tube grid bias



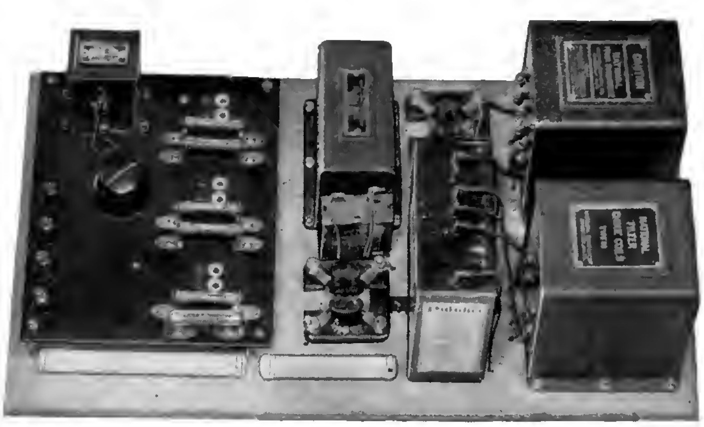
Radio Broadcast Photograph

ANOTHER AMPLIFIER-POWER DEVICE USING NATIONAL PARTS

The circuit for this amplifier unit is substantially the same as that for the amplifier at the top of this page, with the exception that a National type A impedance is used in the grid circuit of the last tube instead of the 0.25-meg. resistor. The UX-874 voltage regulation tube is used in these two units to maintain fairly constant r.f. and detector B voltages, regardless of load, thus eliminating controls which would otherwise be necessary. Wire-wound resistors are used in the input circuits of both amplifiers in order to carry safely the heavy plate current drawn by some of the new special detector tubes (6 mA.). C bias for the first high-mu tube is obtained by utilizing the voltage drop across the filament equalizor

THE LIST OF PARTS

T_1—National Power Transformer	$16.50
L_1—National Type 80 Filter Choke	10.00
L_2, C_4—National Tone Filter	8.00
C_1—Dubilier Filter Condenser Block No. PL-90-A	9.50
C_2—Dubilier Buffer Condenser Block No. PL-91	2.00
C_3—Dubilier 1.0-Mfd. Bypass Condenser No. 901	1.50
C_5—Three Dubilier 0.1-Mfd. Coupling Condensers	1.80
Two Airgap Sockets	1.20
R_1—Clarostat Variable Resistor	2.25
R_2—Metalized-Filament Resistor, 0.05 Megohm	.75
R_3—Lynch Wire-Wound Resistor, 2000 Ohms	1.25
R_4—Lynch Equalizor No. 2	1.00
R_5—Lynch Wire-Wound Resistor, 100,000 Ohms	4.00
R_6—Metalized-Filament Resistor, 1.0 Megohm	.50
R_7, R_9—Two Metalized-Filament Resistors, 100,000 Ohms	1.50
R_8—Metalized-Filament Resistors, 0.5 Megohm	.50
R_{10}—National Type A Impedance	4.00
Four Eby Binding Posts	.60
Bakelite Panel, 6 x 8 x 3/16 Inches with Resistor Clips and Three Sockets	4.00
Baseboard, 18 x 10 x ½ Inches	.50
Rubber Feet, Wire, Screws, etc.	.50
Eveready 1½-Volt Flashlight Cell	.15
UX-874 Voltage Regulator Tube	5.50
UX-171 Type Tube	4.50
Two High-Mu Tubes	5.00
Raytheon BH Tube	6.00
TOTAL	$93.00



Radio Broadcast Photograph

CRACKLING NOISE IN LOUD SPEAKER

A CRACKLING sound, much like static, frequently is heard when the buffer condensers (used with the Raytheon tube) are either omitted from the circuit or are defective (open-circuited). In either case the remedy is a pair of good buffer condensers. A defective Raytheon tube will also cause this same noise.

ARCING BETWEEN HIGH-VOLTAGE PRONGS OF RECTIFIER SOCKET

THE a.c. voltage between the two outside leads of the power transformer secondary is equal to twice the normal operating voltage of either half of the secondary which, in the case of the different transformers recommended by the writer in this series of articles, is between 500 and 600 volts. This high voltage is directly impressed across the two adjacent tube socket springs, and to prevent danger of a flash-over, followed by a steady arc, it is extremely important that nothing be done that will impair the quality of the insulation. For instance, just a little soldering flux or paste, between the filament springs of a rectifier tube socket—they are quite close together—is enough to start an arc, which, when once started, is capable of doing considerable damage. For this reason it is important to remove any traces of soldering flux around the terminals and contacts of the rectifier tube socket. Use a cloth dipped in alcohol for this procedure before connecting the complete unit to the electric light lines.

ARCING IN STEM OF RAYTHEON TUBE

IF A Raytheon tube flashes over and arcs between the two anode leads outside of the "cup," the useful life of the tube is over, as one of the lava insulating tubes has cracked. A new tube is the remedy.

DETECTOR AND R. F. RESISTOR GET HOT

AS EXPLAINED under another paragraph, care must be used when constructing an amplifier-power supply unit on a metal base to see that the metal does not at any point cut through the insulation on the wire and cause a short circuit. If the wiring is o.k., then look for a defective bypass condenser and replace it.

FIXED RESISTOR ACROSS THE PLUS-B DETECTOR

IF THE variable resistor controlling the detector plate voltage is turned to a very low value, or entirely short-circuited, the full amplifier B voltage is impressed across the 10,000-ohm resistor. An excessively high current will flow through the unit, and it will get hot. The variable resistor should never be so adjusted as to cause over-heating of the fixed resistor.

POWER TUBE DOES NOT LIGHT

WHEN the filament of the output power tube fails to light, and there is no doubt as to the tube being in good condition and making perfect contact with the socket prongs, make certain that the a.c. power is on before looking for further trouble. Possibly, the socket to which the amplifier-power unit is connected may be defective, or else the power may be temporarily off. If there is no doubt about the power and the condition of the tube, then check the wiring for an open or short-circuit. If the difficulty is still undiscovered, then temporarily disconnect one lead from each of the two buffer condensers. Should this latter step correct the trouble, then one or both of the condensers are defective and new ones should be secured. Should, however, the trouble still be present, the probability is that the power transformer is defective.

MECHANICAL HUM OR VIBRATION

A NOT altogether uncommon fault of some amplifier-power units, which are in other ways very excellent, is a mechanical vibration due to loose lamination in the core of the power transformer. If the transformer is assembled in some sort of frame, frequently all that is necessary to do is to tighten the frame bolts. In other cases, however, where the transformer is enclosed in a metal container sealed with wax, the trouble is more difficult to remedy. If the hum is very bad, then perhaps the best procedure is to return the transformer to the manufacturer. If it is only slight, but yet sufficiently annoying, then a simple remedy is to place the amplifier power unit in a closet, the cellar, or some other place sufficiently isolated to do away with the noise, and use cabled leads between it and the set.

RADIO BROADCAST Photograph

COMBINING COMMERCIAL UNITS

This illustration shows how a standard B supply unit, such as the Mayolian may be used with the audio amplifier designed by the author, to obtain a combination amplifier-power unit. The amplifier consists of an impedance-coupled stage and two stages of resistance-coupled amplification and includes an r.f. choke, a grid choke in the power stage to prevent motor-boating, and a tone-filter. Where the power supply is other than 60 cycles a.c., it is often difficult to obtain suitable transformers and chokes for the home construction of a power-supply unit. B supply units for 25- and 40-cycle a.c. are available, however, and when used as here shown, give the equivalent of a combination power amplifier and B supply

ELECTRICAL HUM IN THE LOUD SPEAKER

AN ELECTRICAL hum in the loud speaker may be due to any one of a dozen, or more, different causes. There is also considerable difference in the hum due to various causes, thus enabling the person experienced in the design and the construction of a.c. operated amplifiers to locate quickly the source or reason for hum. For instance, hum due to an unbalanced filament winding center tap is predominatingly a third harmonic of the fundamental power-line frequency, while that due to lack of electrostatic shielding in the transformer, a ninth harmonic, and that due to incomplete filtering of the B supply, a second harmonic. The novice, however, will probably have to go right through the list of possible causes and remedies until the difficulty is located and corrected.

First, and most important, the negative A terminal, either on the amplifier, set, or storage battery, must be grounded. If there are any other ground connections to the receiving set proper, remove them, or, in the case of sets with which the removal of the regular ground connection will interfere with the proper operation of the set, insert a 1-mfd. bypass condenser in series with the ground lead.

Secondly, remove any lamps or other electrical appliances from the vicinity of the set or amplifier. Merely turning off the light, in the case of a lamp, will not do. Either remove the lamp as a whole or else remove the lamp cord plug from the base outlet or socket.

Thirdly, see that the grid-bias voltage control, if variable, is not set at too low a value of resistance. Adjust for best quality, most stable operation, and minimum hum.

Fourth, do not run the a.c. cord from the amplifier near the antenna lead, the set proper, or the input lead from the set to the amplifier. Make the line cord as short and direct as possible without coming close to the set.

Fifth, ground the transformer, choke coils, and condenser cases, or frames.

Sixth, place the amplifier-power unit several feet from the set unless either the set or the power unit, or both, are completely shielded.

Seventh, so place the filter chokes with respect to the power transformer as to prevent any undesirable magnetic coupling.

Eighth, interstage coupling between either the radio or the audio stages, especially if the detector tube is involved, may result in a disagreeable hum. All of the amplifiers illustrated in connection with these articles have been so constructed as to minimize any possibility of such trouble.

If a hum still exists after all other attempts to stop it have failed, then, with the amplifier and the set in operation, pull out the first audio tube. If the hum then stops, it is probably being caused by interstage coupling, due to poor layout of parts, failure to cable all direct-current leads, failure to use bypass condensers and resistors, as shown in the various circuit diagrams, long grid and plate leads, or magnetic coupling between audio transformers.

Regeneration due to a regenerative detector circuit is confined to one stage and does not produce a hum. Interstage regeneration, due to any of the above causes, does produce a hum. Follow the different layouts described and trouble from this source will not be encountered.

"MOTOR-BOATING"

THE reason for and the methods of curing "motor-boating" were completely covered by the writer in the article in power amplifiers in the February RADIO BROADCAST. To recapitulate briefly, the two most important points to be watched are the proper adjustment of the grid bias control, and avoiding the use of excessive detector or r.f. voltages.

Some "Hi-Q" Improvements

Substituting Dry Cell Tubes—How a Loop May Be Used—A Loading Coil to Increase Sensitivity—How to Neutralize This Popular Hammarlund Receiver

By

JOHN B. BRENNAN

Technical Editor

Radio Broadcast Photograph

AFTER SOME CHANGES HAVE BEEN MADE

By incorporating the changes in the Hammarlund "Hi-Q" receiver as outlined in the accompanying article, it is possible to operate the receiver with a loop antenna

IT WAS Lincoln who said: "You can fool some of the people all of the time and all of the people some of the time, but you can't fool all the people all of the time."

Before asking oneself what this has to do with radio, and the Hammarlund "Hi-Q" receiver in particular, pause for a moment to hear all of the story.

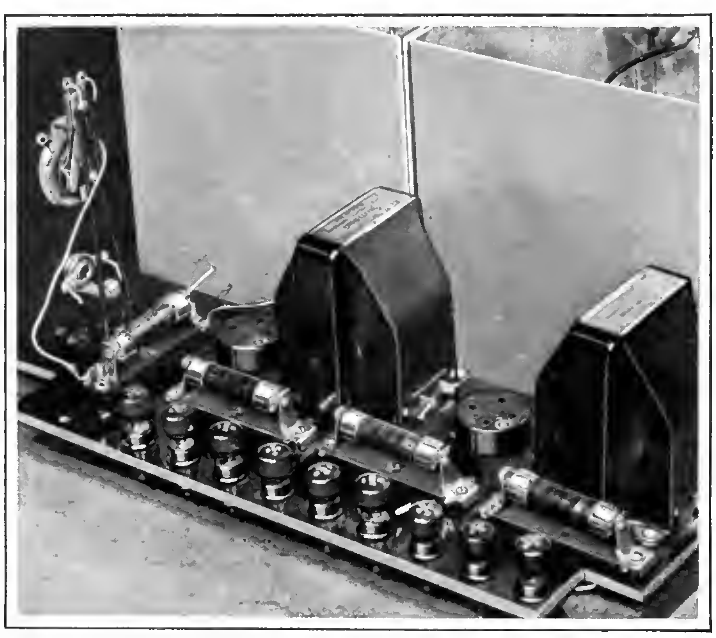
Of the many receivers which are offered to the home-constructor for home assembly, the Hammarlund Roberts "Hi-Q" enjoys the greatest popularity. Even the fellow who buys a commercial type of receiver has the urge to tinker with the set so that it will fit in with his particular ideas of what a set should be. How much more so this is true of the builder of a receiver such as the Hammarlund-Roberts "Hi-Q" is a question the answer to which is reflected in this article.

Applying the mania for improving, altering, changing, to the quotation above, it might be made to read: "You can satisfy some of the set builders all of the time, and you can satisfy all of the set builders some of the time, but you can't satisfy all of the set builders all of the time."

Pursuing this line of reasoning with respect to the "Hi-Q" receiver results in the bringing out of these salient points:

1. How may dry cell tubes of the 199 type be used with the "Hi-Q" receiver?
2. How may a loop be employed, particularly by the city dweller who requires unusually fine selectivity to tune-in to the locals without experiencing broadness of tuning?
3. How may the sensitivity of the receiver be increased?
4. How may neutralization be made simpler?

At Radio Broadcast Laboratory, an investigation into these various problems was instituted with results which are most gratifying.



Radio Broadcast Photograph

CHANGES IN THE FILAMENT CIRCUIT

A filament ballast replaces the four-ohm resistance strip which was formerly connected in the first r.f. filament circuit. In this illustration the additional filament ballast is that one at the extreme left of the sub-panel

Whether or not any of the changes as outlined above are seriously considered, it is recommended that at least the simple changes under classification No. 4 be made, thus making for better and more complete neutralization of the receiver.

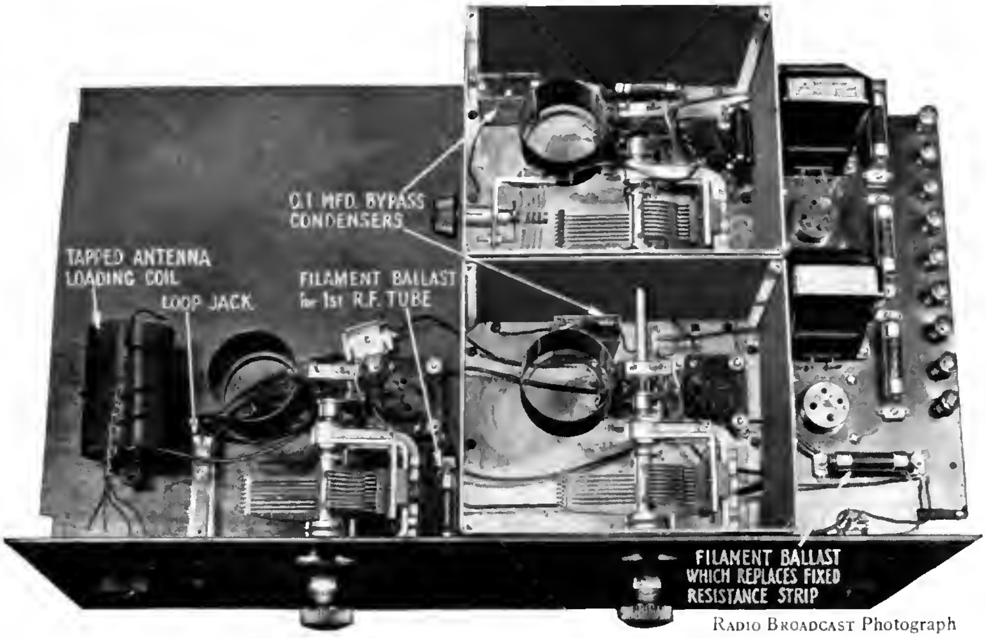
In the original circuit, no provision was made for a bypass to the negative filament for the r.f. currents. This sets up the possibility and probability of inter-coupling between adjacent tube circuits through the battery leads. When the bypaths are provided, the r.f. currents are kept out of the battery leads and the possibility of inter-coupling is greatly reduced, and in many cases completely eliminated. Two 0.1-mfd. fixed condensers are required to make this addition. The condensers are mounted, one in the second r.f. stage can. and the other in the detector stage can. To mount them, it is only necessary to unscrew one of the rear wood screws of each can which holds the can bottom to the wood base, and insert one of the feet of each condenser under the head of these screws. One contact of the condenser connects to the B-plus terminal of the primary coil in its respective can. The other contact connects to one of the wood screws holding down the can, and thus completes the bypass circuit direct to ground. The circuit diagram for this addition, step No. 4, is shown in Fig. 1.

USING DRY CELL TUBES

IN EXPERIMENTING with dry cell tubes, such as 199's, it has been found advisable to control the filament of each tube with its own Amperite because, when neutralization of the receiver is attempted, disconnecting the filament wire from the first socket applies an over-load to the filament of the second r.f. tube since both the filaments of the first and second r.f. tubes are connected in parallel. Controlling each tube with its own filament ballast will solve this problem. Incidentally, this change might even be applied to receivers employing the 5-volt type of tubes because it is much simpler to remove a ballast from its clips than it is to unsolder a wire from the socket when engaged in the process of neutralizing the receiver.

In the detector and audio-frequency circuits, filament ballasts are already provided, but for dry-cell operation, the value of the ballast differs from the value used for storage-battery tube operation. Type 4V Amperite is satisfactory for all but the last audio stage, wherein a 120 tube is recommended. This tube requires the type No. 120 Amperite.

To incorporate the additional filament ballasts in the circuit, first unsolder the fixed resistance strip



Radio Broadcast Photograph

SHOWING THE DISPOSITION OF THE NEW PARTS

All the changes which have been made are clearly depicted in this illustration. Bypass condensers have been included in the r.f. stages, a loading coil has been inserted in the antenna circuit, and each tube is controlled by its own filament ballast. The article also describes other novel features which have been applied to this receiver

and mount in its place the clip mount of the ballast. Then detach the wire fastened to the positive filament terminal of the first tube socket. In the right front corner of the space set apart by the wall of the can of the second r.f. stage, fasten another filament ballast to the wood base. Connect the wire just unfastened from the socket direct to the end of the ballast nearest the socket. Connect the other end of the ballast to the plus filament socket terminal. Follow through to the other can the wire formerly connected to

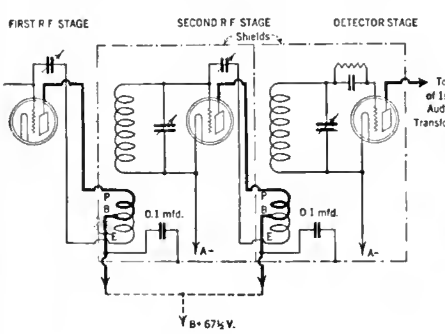


FIG. 1

the fixed resistance strip. Then re-solder it to the wire going to the rheostat which remains in the set. The altered circuit is shown in Fig. 2.

No change in sockets is necessary since the Benjamin sockets originally employed are satisfactory for use with UX-199 tubes.

USING A LOOP, AND SOME COIL CHANGES

OFTEN the owner of a receiver who desires to listen to a local program will experience interference from other local stations due to the

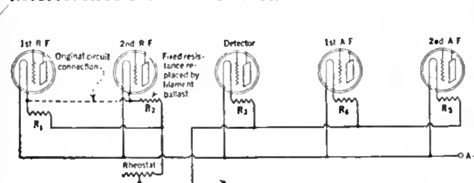


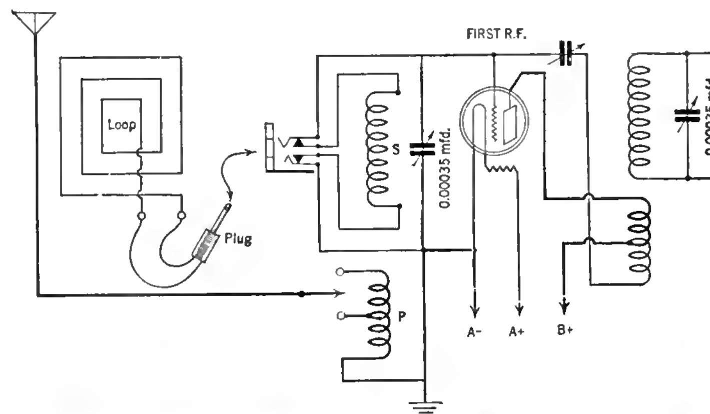
FIG. 2

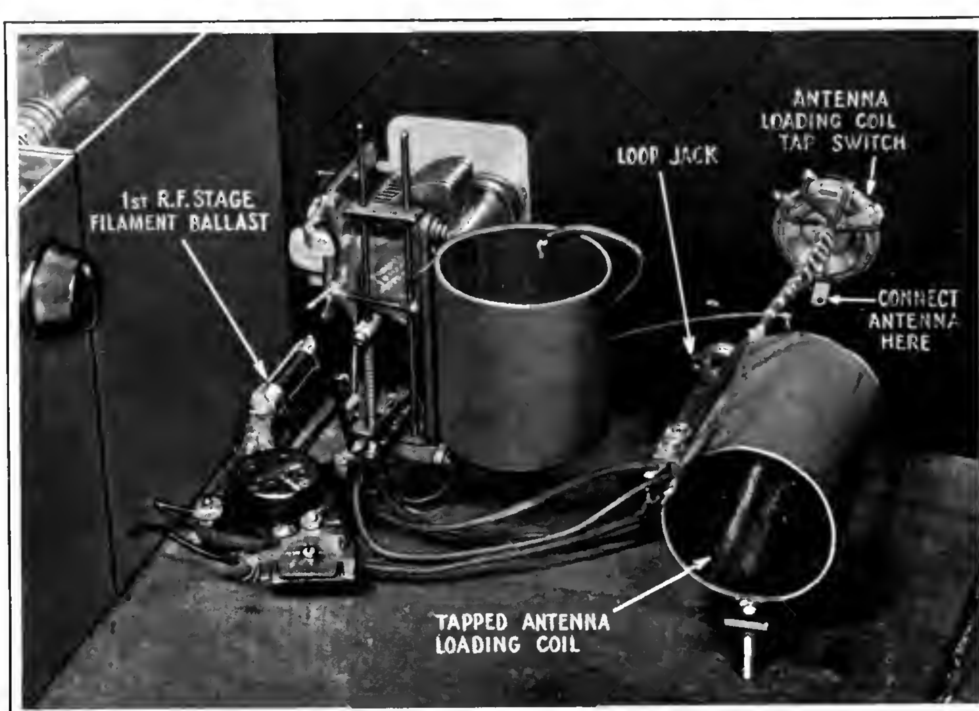
close proximity of the interfering station. Such a condition may often be remedied by the use of a loop for local reception. The loop may be substituted for the first secondary coil by means of a plug and jack arrangement as shown in Fig. 3. By means of the loop, sufficient selectivity is obtained so as to insure satisfactory operation without interference on local reception. A loop designed to tune with a 0.00035-mfd. condenser should be used.

Greater sensitivity of the receiver is possible providing several changes are made in the antenna circuit. Here a tapped loading coil may be inserted in series with half of the existing primary coil. Four taps are taken off this loading coil which resonate at approximately 1000 kc., 750 kc., 600 kc., and 545 kc. (300, 400, 500, and 550 meters). This loading coil enables the builder of a "Hi-Q" receiver to tune his antenna circuit roughly to a frequency which approximately equals that of the station he wishes to receive.

This change involves the discarding of the two-point switch mounted at the extreme left of the front panel of the original receiver, and in its place is mounted a Carter 4-point tap switch. The loading coil may be home-made or should consist of 95 turns of a piece of two-inch diameter Hammarlund space-wound coil. Taps are taken

FIG. 3





Radio Broadcast Photograph

THE ANTENNA COMPARTMENT

In this view of the antenna tuner circuit compartment the placement of the various new parts is easily seen. A four-point tap switch replaces the two-point switch formerly employed while a double-circuit jack is mounted on the panel for plugging in the loop

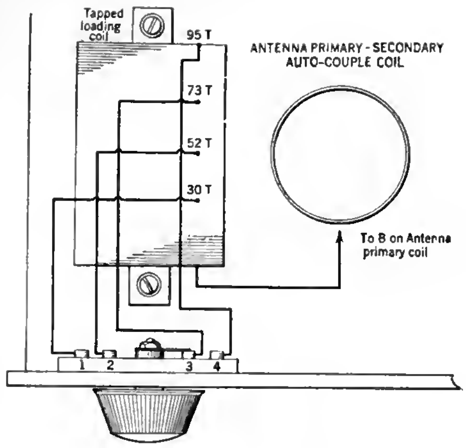


FIG. 4

off at the 30th, 52nd, and 73rd turns, corresponding with the first, second, and third position of the tap switch. The fourth tap switch point includes the entire 95 turns of the loading coil in the antenna circuit. Details of the layout, together with coil specifications, are given in Figs. 4 and 5 respectively.

HOW TO NEUTRALIZE THE RECEIVER

CIRCUITS that are represented to readers as of the non-blooper type due to some scheme of neutralization employed, do not always turn out that way. This is largely due to the indifference of the builder to his job when the time comes to neutralize his receiver. A receiver which is perfectly neutralized is better than one in which neutralization is not complete because, in the latter, oscillation is likely to occur at some point in the broadcast band and at that point reception is spoiled if not completely eliminated.

To neutralize a receiver does not require a great deal of technique and, in the end, the time spent on this important point is more than compensated by the superior results obtained.

Where each tube of the "Hi-Q" has been supplied with its own filament ballast, the job is made quite easy. Simply remove the ballast in the first r.f. tube circuit from its clips (after a station has been tuned-in), and, with a stick sharpened to a thin edge, adjust the neutralizing condenser until the signal is reduced to a minimum, or entirely eliminated. It is important to note that while the process goes on it is necessary to re-tune the condenser of the first stage as the neutralizing action usually de-tunes the first condenser circuit slightly.

If the stick of wood doesn't hold out long enough to complete the job, take an ordinary screw driver and wrap the shaft with insulating tape to within a half-inch of the blade. Then if the tape-covered part of this tool inadvertently touches the can walls, no blown-out tubes will result, which would be the case if the screw driver were not insulated.

After the first r.f. stage has been neutralized, the ballast may be replaced in its clips and the same process duplicated for the second r.f. stage.

A circuit diagram of the receiver incorporating all of the changes outlined in this article is shown in Fig. 6.

The following parts were used in making the changes described. Other makes can of course be employed, if the electrical characteristics of the unit concerned are similar.

1	4-Point Carter Tap Switch, No. 404	$1.00
1	Loading Coil (See Winding Specifications, Fig. 5)	1.00
2	Bypass Condensers, Sangamo, 0.1-Mfd.	1.60
1	Amperite and Mounting, Type No. 4V (For Use with 3-Volt Tubes)	1.10
3	Amperite Cartridges, Type No. 4V	3.30
1	Amperite, Type No. 120	1.10
1	Carter Double-Circuit Jack, No. 104	1.00
	TOTAL	$10.10

Previous articles on the building of the "Hi-Q" receiver have appeared in RADIO BROADCAST for January and March of this year.

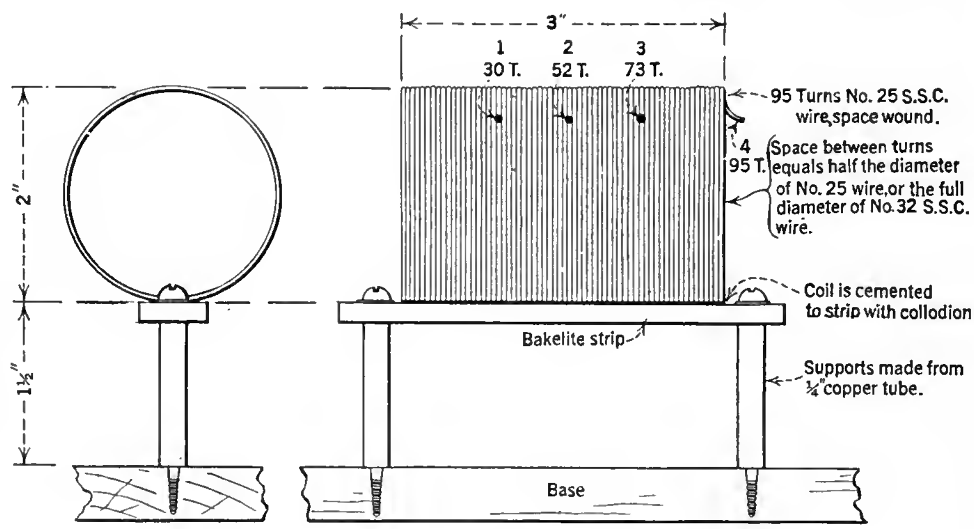


FIG. 5

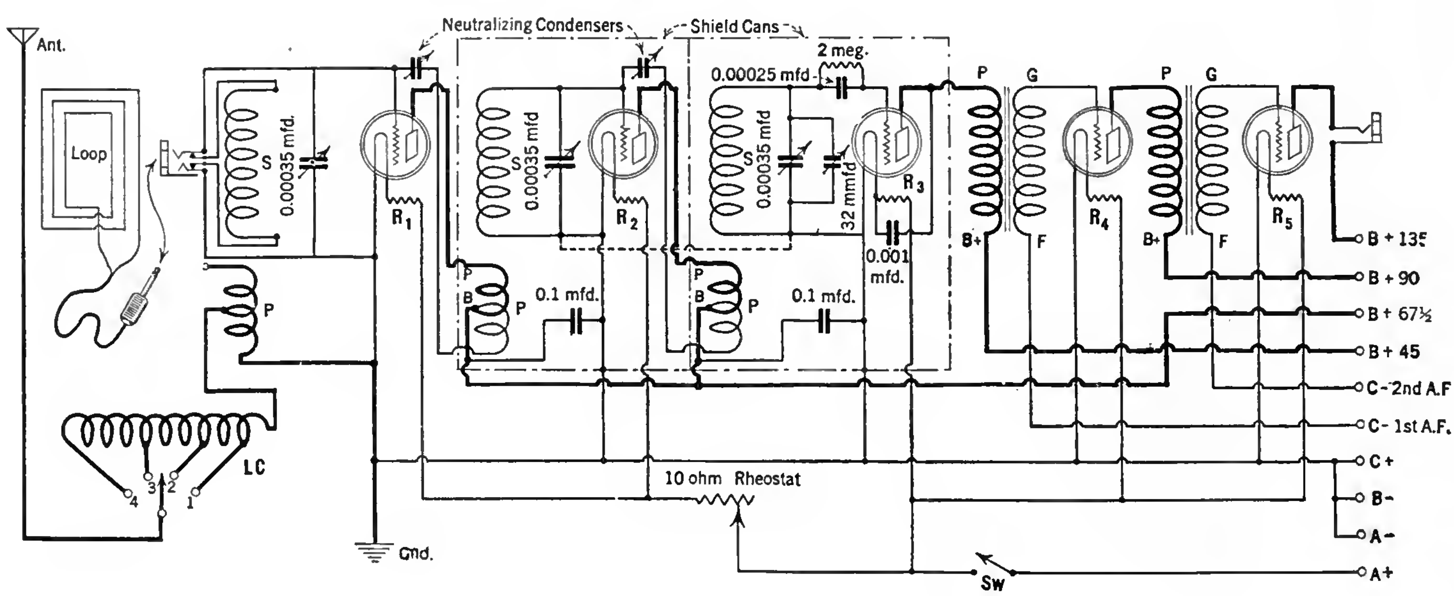


FIG. 6

A Fundamental Analysis of Loud Speakers

A Radio Club of America Paper Discussing the Signals a Loud Speaker Is Required to Reproduce—Factors Determining the Quality of Output from a Loud Speaker—Some Causes of Distortion in Reproducers

By JOHN F. NIELSEN

Engineering Dept., F. A. D. Andrea, Inc.

CENTURIES before we dreamed of modern loud speaking equipment, the natives of Africa had crude systems of communication in the form of cocoanut shells connected by a taut string, which acted as a medium for transmitting sound vibrations. Outgrowths of these crude systems of communication are our present telephone network and radio systems.

The primary function of any communication system is to transmit intelligence and entertainment. In considering the operation of any such system, the reproduced sounds may be referred

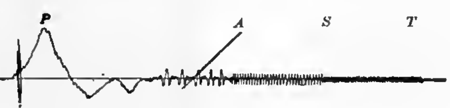


FIG. 1

to as having two properties, i.e., intelligibility and naturalness. In radio broadcasting, the communication system is supplemented by entertainment, and the property of naturalness, therefore, increases in importance in the reproduced speech. Moreover, the transmission of music imposes even more severe requirements upon a communication system because of the wide range of frequencies and intensities required for proper appreciation. It is the purpose of this paper to present in a popular fashion a few of the fundamentals of operation of one link of such a system, namely, the acoustic reproducer.

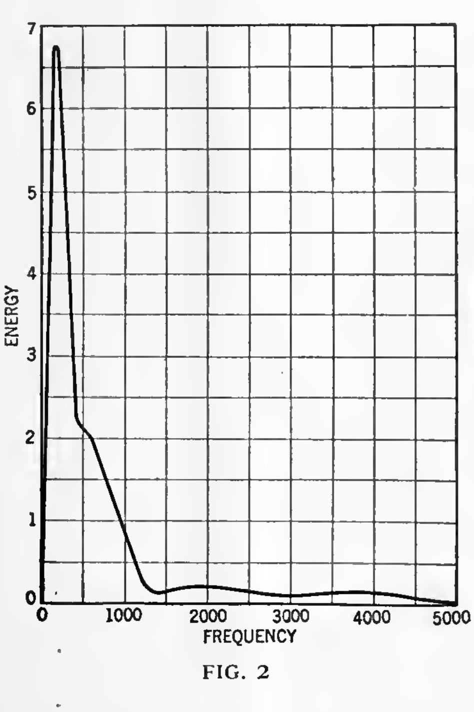


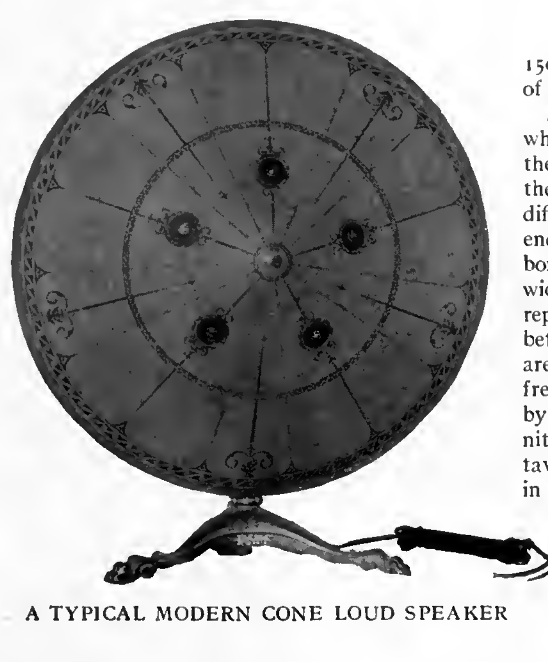
FIG. 2

The fact that there is ample opportunity for distortion in those parts of a radio system preceding the loud speaker is apparent from a consideration of the change the speech wave must undergo between studio and loud speaker. Although there is equal opportunity for distortion in the transmitter and receiver, transmitter distortion is generally negligible. The fact that a broadcasting station serves a large volume of receiving sets would point to this state of affairs, since the receiver must be far cheaper than the transmitter. Quality in the receiving set itself is affected by the sharpness of tuning of the radio-frequency stages, by the time constant of the grid leak-condenser combination of the detector circuit, by the characteristic and power capacity of the audio amplifier, and finally, by the loud speaker itself.

Before considering in detail the characteristics of loud speakers, let us digress for the moment and consider the nature of the signal it must reproduce. In general, the loud speaker should reproduce faithfully both speech and music, each of which presents its own peculiar problems.

Speech consists in general of two fundamental types of sound, namely, continuents and stops, and their combinations[1] (see bibliography on page 590). The former are those produced by a continuous flow of air, such as the letters F, S, etc., while the latter consists of those sounds produced by a sudden stoppage of air, such as letters, P, B, and M.

For instance, analyzing the word "Past," we notice, in Fig. 1, that "P" appears as a transient indicated by a high broad peak; "A," a nearly continuous frequency of approximately 800 cycles varying in amplitude; "S" and "T" are of a high frequency character, of low amplitude, and continuous.



A TYPICAL MODERN CONE LOUD SPEAKER

It is readily seen from the nature of the word that, in order to obtain perfect reproduction, the loud speaker must reproduce frequencies of an extreme nature with proper relative amplitude and without time lag. If a loud speaker is inefficient at the upper extreme of its frequency spectrum, it is generally noticed that "S," "T," and other high-frequency combinations, are either missing entirely or are of low relative intensity. In addition, a loud speaker may have resonant peaks at certain frequencies which may so exaggerate some sounds as to completely mask others. Speech energy is distributed over a frequency band of about 50 to 10,000 cycles per second and, in general, has a maximum between

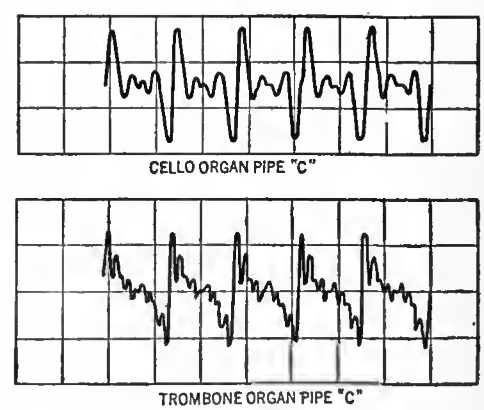


FIG. 3

150 and 250 cycles. The frequency distribution of speech energy is shown graphically in Fig. 2.

Music is characterized by various harmonics which may be of larger or smaller amplitude than the fundamental. These harmonics distinguish the same note in the same octave as played on different instruments. Fig. 3 shows the difference between a cello organ pipe "C" and a trombone organ pipe "C". It is readily seen that a wide frequency spectrum must be faithfully reproduced to enable the listener to distinguish between different instruments. Musical sounds are characterized by being sustained at definite frequencies for comparatively long periods and by having the change in pitch take place in definite musical intervals called, thirds, fifths, octaves, etc. Musical notes are usually very rich in harmonics; in some instances, as in the case of the cello, the harmonics may even exceed the fundamental frequency in intensity. Musical energy is distributed over a frequency band of from about 16 cycles to something over 10,000 cyles.

per second, and usually has its maximum below 1000 cycles. However, it has been found that a frequency range of about 50 to 5000 cycles is tolerable for natural reproduction of both speech and music.[2] (see bibliography on page 590).

Having considered the nature of speech and music, it is evident that the perfect reproducer should give constant response when actuated by constant audio signal impulses, and be free from resonant effects or hangovers of any sort. It is at once apparent that the action of the loud speaker may depend to some extent on the circuit elements used to couple it to the last amplifier tube, since the coupling devices may resonate the loud speaker at some audio frequency.

It has been variously suggested that the quality of reproduced speech and music depends both upon the average response of the sound reproducing element to steady tones, and to the irregularity of the response frequency characteristics. The former serves as a basis for a rough estimate of quality and relative loudness of fundamental notes, while the latter is an index from which it is possible to predetermine the clarity of the reproduced speech and music. That is to say, a response-frequency characteristic obtained by applying steady single frequencies to the loud speaker gives only a general indication of the action of the loud speaker when it is actuated by transient notes, sudden stops, etc. To predict the effect of hangovers which tend to confuse the listener by changing the relative phase displacement of independent notes, it is necessary to know something about the resonant peaks in the response characteristic. Obviously, quality also depends on the nature of the load characteristic of the motor element. Since, as previously pointed out, the energy of both speech and music is more or less concentrated below 1000 cycles per second, the loud speaker, in actual service, must necessarily operate with a wide variation in amplitude. For this reason it is desirable that the efficiency of the loud speaker be approximately constant for all armature excursions commonly met in practice, otherwise, the large amplitude frequency notes, or the smaller amplitude high-frequency notes, will be over-emphasized.

It has been shown elsewhere that musical tones between 200 and 2000 cycles have in general the same average intensity and that the human ear at the intensities generally used in reproduced music or speech has about the same sensitivity over this range.[3] (see bibliography on page 590). Further, it has been shown that departures from faithful reproduction above and below this range are far less noticeable than departures within this range. For example, changes in response at 70 or 6000 cycles are about one tenth as serious as the same changes between 200 and 2000 cycles. As the range of maximum sensitivity is approached, given departures from true reproduction become more serious; thus, at 90 or 4000 cycles, a given departure from the true signal is about half as serious as at 1000 cycles. Consequently, if it is taken for granted that equal departures from the original signal do equal damage at points of equal auditory sensitivity, it is possible to arrive at a basis for determining the maximum departure of response from perfect reproduction allowable for tolerable reproduction. Using this as a basis, a response-frequency characteristic can be drawn which represents approximately the limit beyond which it is unnecessary to go for acceptable reproduction. Such a curve is shown in Fig. 4. From the standpoint of relative loudness, the response-frequency characteristic of any loud speaker which falls within the shaded area is substantially as acceptable as a perfect

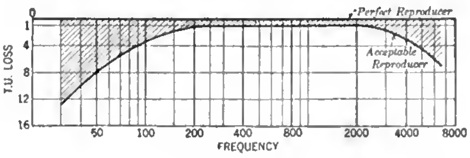


FIG. 4

unit. This, of course, holds only for relatively smooth characteristics, since resonance peaks of relatively large amplitude and sufficient sharpness always introduce sustained vibrations or hangovers, and these constitute an entirely different type of distortion. Representative response characteristics of two commercial cone loud speakers, are shown in Fig. 5.

A comprehensive method of measuring or

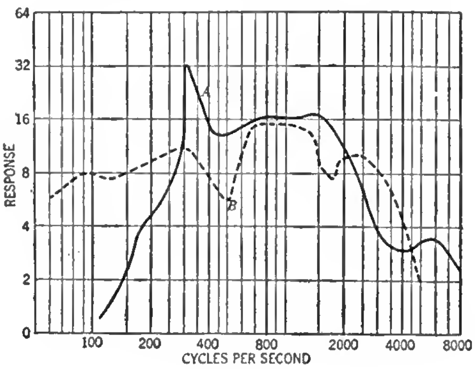


FIG. 5

rating a loud speaker in terms of its resonance peaks is probably as unnecessary as it is difficult. There are, however, a few conclusions that may readily be drawn from a first inspection of the response curve. A broad peak indicates high damping action, and a sharp peak, low damping. Therefore, if the broadness of any resonance peak is rated in terms of multiples or sub-multiples of the geometric mean frequency, the relative

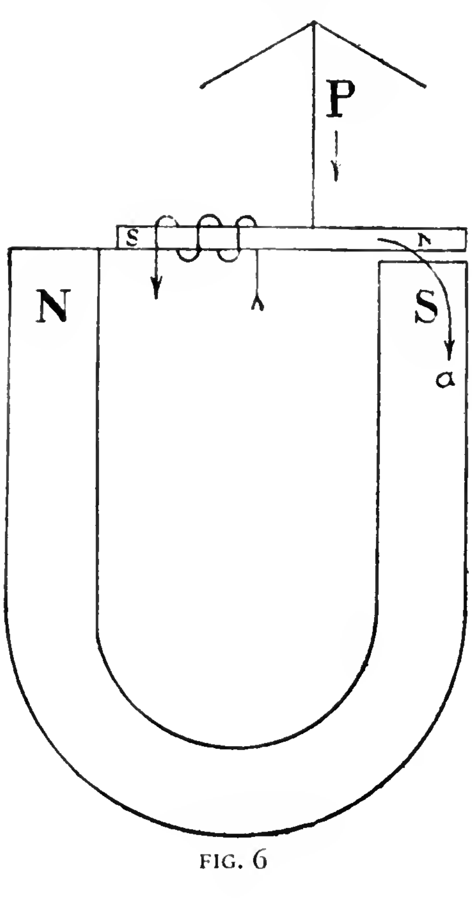


FIG. 6

length of the hangover can be approximately determined. Thus, a resonance peak of unit breadth at, say, seven tenths of its maximum height, will allow vibrations to persist roughly half as long as will one of the same amplitude and half its breadth, and in the former, these vibrations, for a given frequency, are about half as serious. It therefore appears worth while to examine closely the height and breadth of each resonance peak if its amplitude exceeds the average characteristic by 40 to 50 per cent. The absolute height of peaks that may be neglected is more or less a matter of opinion, and therefore, limits can only be fixed by measurement of the undesirable effects produced. Certainly, greatest harm will be produced by peaks falling within the frequency spectrum, most important from the standpoint of auditory sensitivity. Whence it would appear that the harmful effects of peaks can be weighted in accordance with the response curve of Fig. 4.

THE LOUD SPEAKER'S MECHANISM

HAVING considered, in general, the desirable characteristics of loud speakers, let us investigate the mechanism that is to produce these characteristics.

A loud speaker may be considered as made up of three systems:

1. The motor element, which converts the electrical impulses into corresponding mechanical vibrations.
2. The coupling system, which transmits the mechanical vibrations from motor to diaphragm.
3. The diaphragm or loading device, which radiates the mechanical vibrations into the air as waves of sound.

The simplest type of motor element in common use is the vibrating reed type. It consists, in general, of an armature pivoted or hinged at one end and actuated at the other, a magnet to supply a steady uni-directional magnetic flux, and a winding coupled to the magnetic circuit which is capable of superimposing an alternating or pulsating signal flux on the steady flux already present. A schematic diagram of such a unit is shown in Fig. 6. The free end of the armature is normally at rest in a steady uni-directional magnetic field supplied by the permanent magnet. When an alternating or pulsating current is passed through the coil coupled to the armature, the free end of the armature is alternately attracted and repulsed by the remaining pole. Thus, the electrical impulses in the coil are converted into mechanical vibrations which are, in turn, transmitted to a diaphragm through the medium of the driving rod.

A brief inspection of the figure will show that this type of motor is not free from distortion. Let Φ represent the steady flux across the air gap; $\alpha \sin \omega t$, the flux due to a signal current through the windings, and P the force acting on the armature.

Then:

$$\begin{aligned} P &= K(\phi + \alpha \sin \omega t)^2 \\ &= 2K\phi\alpha \sin \omega t + K\alpha^2 \sin^2 \omega t + K\phi^2 \\ &= 2K\phi\alpha \sin \omega t - \frac{K\alpha^2}{2}\cos 2\omega t + K\frac{(2\phi^2 + \alpha^2)}{2} \end{aligned}$$

Obviously, the first term represents a reproduction of the signal impulse, while the second term represents a second harmonic of the signal[4] (see bibliography on page 590). The remainder of the force adds a steady component to the steady pull exerted by the permanent magnet. It would seem, since that part of the coefficient of the second harmonic which is proportional to the signal, appears as a squared term, that the second harmonic could be made neg-

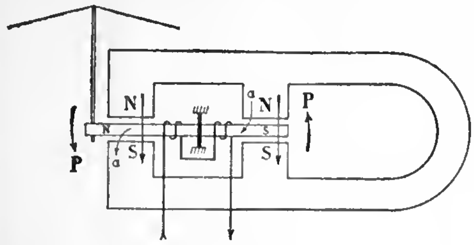


FIG. 7

ligibly small by the simple expedient of keeping the ratio $\frac{\Phi}{\alpha}$, large. Space will hardly permit a discussion of this point. Suffice it to say that good design dictates a limit to this ratio which must necessarily be determined by efficiency, and saturation of armature and pole pieces. Moreover, if a large permanent magnet is used, a stiff armature suspension will be required. Since the reed itself has a resonant period, great care must be exercised to properly fix this period in the frequency spectrum and to provide proper damping. Greatest apparent efficiency will, of course, be obtained by allowing the resonant period of the reed to fall between, say, 800 cycles and 2500 cycles. Best quality can generally be obtained if the resonant period falls near 100 cycles, and is highly damped. It is at once apparent that there are a number of factors which limit both the efficiency and the quality of this type of instrument.

Another type of motor of more recent design, which is very much in favor at present, is the balanced armature type shown in Fig. 7. Among other advantages, this type of structure will take larger loads without producing second harmonics of the signal. Using the same nomenclature as above, we have:

Force due to one set of poles
$= K(\phi + \alpha \sin \omega t)^2$

Force due to the remaining set of poles
$= K(\phi - \alpha \sin \omega t)^2$

The total force acting on the armature is obviously the difference of these two, or:

$$P = K(\phi + \alpha \sin \omega t)^2 - K(\phi - \alpha \sin \omega t)^2 = 4\,K\,\phi\,\alpha \sin \omega t$$

In this case, the overtone and the additional steady pull, due to the signal, which were present in the output of the reed type motor, vanish. This results, then, in an armature vibration, which is proportional to the signal and which contains no distorting components. It is also a fact that the balanced type of unit will in general reproduce much stronger signals without undue distortion than is the case with the reed type unit. Moreover, if the load contains sufficient damping, the response-frequency characteristic will obviously be more uniform than that of the reed type motor. This type of unit is, of course, not entirely free from resonance, although its fundamental resonant peak is generally not as serious as that of the reed type unit.

Fig. 8 shows the moving coil type of motor. Its operation is, in general, similar to that of the units described above, and lack of space forbids further comment here. This type of instrument may be made very free of mechanical resonant effects, since the mass and stiffness of the armature and its suspension system may be reduced.

CAUSES OF DISTORTION

THERE are numerous causes of distortion in loud speaker motors in addition to those already mentioned. Probably the worst offenders are:

1. Saturation of armature and pole faces.
2. Iron losses, including hysteresis and eddy currents. A detailed discussion of the effects of saturation is beyond the scope of this paper. A simple analysis will, however, serve to point out the general effects to be expected. Saturation occurs in practically all commercial loud speaker motors, at relatively large armature excursions. This particularly applies to reed type motors and balanced armature type motors. It seems reasonable to suspect that the saturation of armature and pole faces in these instruments may

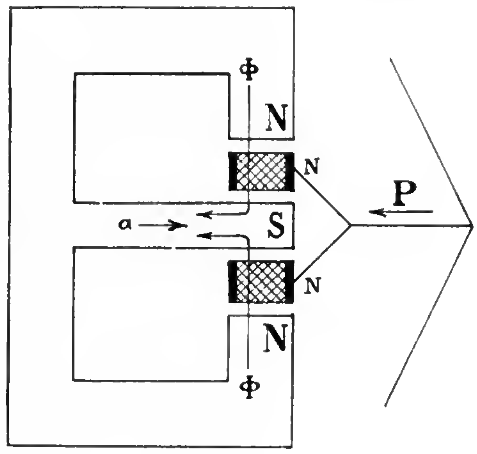


FIG. 8

be due, not to the alternating current in the windings directly, but rather to the permanent magneto-motive force producing large momentary fluxes through the pole faces and armature at large armature excursions. As is often the case, a direct current bias in the windings of a loud speaker, used directly in the plate circuit of an amplifier, may cause armature saturation at very small armature excursions. Be the cause what it may, the effects are the same in that they add odd harmonics of the signal output. Consider

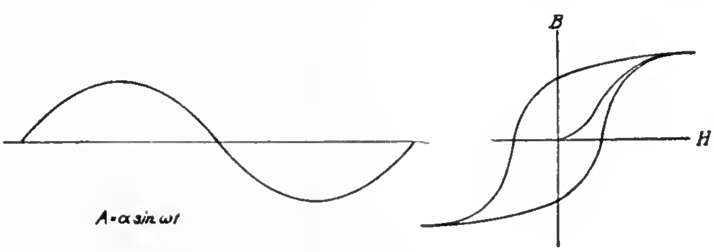


FIG. 9

a sinusoidal signal as shown in Fig. 9, and for simplicity, consider the magnetization curve of the iron involved to be shown in Fig. 10. This, of course, neglects hysteresis and the curvature of the B-H curve, but it is sufficient to illustrate the point. A sine wave signal of sufficient amplitude will produce an armature flux as shown. That is, the peaks of the sine wave will be flattened. Let the signal magneto-motive force be:

$$A = \alpha \sin \omega t.$$

The resulting flux may then be represented as[5] (see bibliography on page 590):

$B = \beta_1 \sin \omega t + \beta_3 \sin 3\,\omega t + \beta_5 \sin 5\,\omega t$ for the case in hand. In addition, there will also be a series of even harmonics for any practical case. Using the previous nomenclature, we have for the reed type instrument, operating at low flux density*:

$$\begin{aligned}
P &= K(\phi + \beta_1 \sin \omega t + \beta_3 \sin 3\,\omega t + \beta_5 \sin 5\,\omega t \ldots)^2 \\
&= K\phi^2 + K\beta_1^2 \sin^2 \omega t + K\beta_3^2 \sin^2 3\,\omega t + K\beta_5^2 \sin^2 5\,\omega t + \ldots \\
&+ 2K\phi\beta_1 \sin \omega t + 2K\phi\beta_3 \sin 3\,\omega t + 2K\phi\beta_5 \sin 5\,\omega t \\
&+ 2K\beta_1\beta_3 \sin \omega t \sin 3\,\omega t + 2K\beta_1\beta_5 \sin \omega t \sin 5\,\omega t \\
&+ 2K\beta_3\beta_5 \sin 3\,\omega t \sin 5\,\omega t + \ldots \\
&= \frac{K}{2}(2\phi^2 + \beta_1^2 + \beta_3^2 + \beta_5^2 + \ldots) \\
&+ 2K\phi(\beta_1 \sin \omega t + \beta_3 \sin 3\,\omega t + \beta_5 \sin 5\,\omega t + \ldots) \\
&- \frac{K}{2}(\beta_1^2 \cos 2\,\omega t + \beta_3^2 \cos 6\,\omega t + \beta_5^2 \cos 10\,\omega t + \ldots) \\
&+ K\beta_1\beta_3 \cos(\omega t - 3\,\omega t) - K\beta_1\beta_3 \cos(\omega t + 3\,\omega t) \\
&+ K\beta_1\beta_5 \cos(\omega t - 5\,\omega t) - K\beta_1\beta_5 \cos(\omega t + 5\,\omega t) \\
&+ K\beta_3\beta_5 \cos(3\,\omega t - 5\,\omega t) - K\beta_3\beta_5 \cos(3\,\omega t + 5\,\omega t) + \ldots \\
&= 2K\phi\beta_1 \sin \omega t + 2K\phi\beta_3 \sin 3\,\omega t + 2K\phi\beta_5 \sin 5\,\omega t + \\
&+ K\left(\beta_1\beta_3 + \beta_3\beta_5 - \frac{\beta_1^2}{2}\right) \cos 2\,\omega t \\
&+ K(\beta_1\beta_5 - \beta_1\beta_3) \cos 4\,\omega t - K\left(\beta_1\beta_5 + \frac{\beta_3^2}{2}\right) \cos 6\,\omega t \\
&- K\beta_3\beta_5 \cos 8\,\omega t - \frac{K\beta_5^2}{2} \cos 10\,\omega t + \ldots \\
&+ \frac{K}{2}(2\phi^2 + \beta_1^2 + \beta_3^2 + \beta_5^2 + \ldots)
\end{aligned}$$

Interpreted, this amounts to a force acting on the armature equivalent to the signal and a number of even and odd harmonics as shown above. It is apparent that the amplitude of the harmonics increases with the degree of saturation.

Similarly, for the balanced armature motor we have:

$$\begin{aligned}
P &= K(\phi + \beta_1 \sin \omega t + \beta_3 \sin 3\,\omega t + \beta_5 \sin 5\,\omega t + \ldots)^2 \\
&- K(\phi - \beta_1 \sin \omega t - \beta_3 \sin 3\,\omega t - \beta_5 \sin 5\,\omega t + \ldots)^2 \\
&= 4K\phi\beta_1 \sin \omega t + 4K\phi\beta_3 \sin 3\,\omega t + 4K\phi\beta_5 \sin 5\,\omega t + \ldots
\end{aligned}$$

Obviously, the odd harmonics are still present in their original relative amplitudes in the mechanical force acting on the armature. It will be noticed, however, that the conglomeration of added even harmonics present in the vibrating reed type motor, balances out in this case.

In addition to the introduction of harmonics due to saturation, there are present numerous other forms of distortion, even for very minute armature vibrations. Copper losses in general are negligible, but iron losses are responsible for a great deal of distortion at high frequencies.

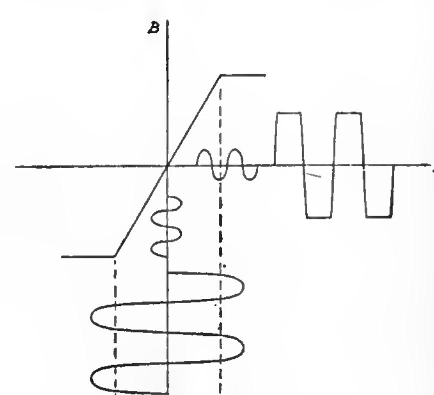


FIG. 10

*A rigorous treatment, would of course, involve even harmonics as well as odd ones since there is always a permanent uni-directional magnetic flux in the armature of the reed type instrument. For simplicity, the shift in axis due to the permanent flux has been neglected.

per second, and usually has its maximum below 1000 cycles. However, it has been found that a frequency range of about 50 to 5000 cycles is tolerable for natural reproduction of both speech and music.[2] (see bibliography on page 590).

Having considered the nature of speech and music, it is evident that the perfect reproducer should give constant response when actuated by constant audio signal impulses, and be free from resonant effects or hangovers of any sort. It is at once apparent that the action of the loud speaker may depend to some extent on the circuit elements used to couple it to the last amplifier tube, since the coupling devices may resonate the loud speaker at some audio frequency.

It has been variously suggested that the quality of reproduced speech and music depends both upon the average response of the sound reproducing element to steady tones, and to the irregularity of the response frequency characteristics. The former serves as a basis for a rough estimate of quality and relative loudness of fundamental notes, while the latter is an index from which it is possible to predetermine the clarity of the reproduced speech and music. That is to say, a response-frequency characteristic obtained by applying steady single frequencies to the loud speaker gives only a general indication of the action of the loud speaker when it is actuated by transient notes, sudden stops, etc. To predict the effect of hangovers which tend to confuse the listener by changing the relative phase displacement of independent notes, it is necessary to know something about the resonant peaks in the response characteristic. Obviously, quality also depends on the nature of the load characteristic of the motor element. Since, as previously pointed out, the energy of both speech and music is more or less concentrated below 1000 cycles per second, the loud speaker, in actual service, must necessarily operate with a wide variation in amplitude. For this reason it is desirable that the efficiency of the loud speaker be approximately constant for all armature excursions commonly met in practice, otherwise, the large amplitude frequency notes, or the smaller amplitude high-frequency notes, will be over-emphasized.

It has been shown elsewhere that musical tones between 200 and 2000 cycles have in general the same average intensity and that the human ear at the intensities generally used in reproduced music or speech has about the same sensitivity over this range.[3] (see bibliography on page 590). Further, it has been shown that departures from faithful reproduction above and below this range are far less noticeable than departures within this range. For example, changes in response at 70 or 6000 cycles are about one tenth as serious as the same changes between 200 and 2000 cycles. As the range of maximum sensitivity is approached, given departures from true reproduction become more serious; thus, at 90 or 4000 cycles, a given departure from the true signal is about half as serious as at 1000 cycles. Consequently, if it is taken for granted that equal departures from the original signal do equal damage at points of equal auditory sensitivity, it is possible to arrive at a basis for determining the maximum departure of response from perfect reproduction allowable for tolerable reproduction. Using this as a basis, a response-frequency characteristic can be drawn which represents approximately the limit beyond which it is unnecessary to go for acceptable reproduction. Such a curve is shown in Fig. 4. From the standpoint of relative loudness, the response-frequency characteristic of any loud speaker which falls within the shaded area is substantially as acceptable as a perfect

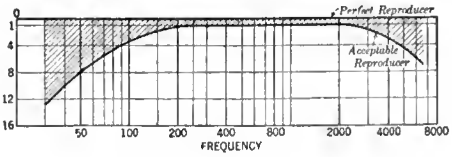


FIG. 4

unit. This, of course, holds only for relatively smooth characteristics, since resonance peaks of relatively large amplitude and sufficient sharpness always introduce sustained vibrations or hangovers, and these constitute an entirely different type of distortion. Representative response characteristics of two commercial cone loud speakers, are shown in Fig. 5.

A comprehensive method of measuring or

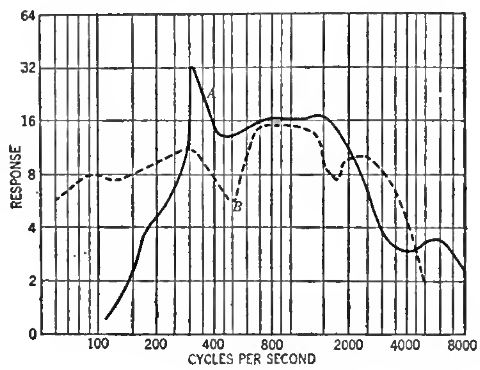


FIG. 5

rating a loud speaker in terms of its resonance peaks is probably as unnecessary as it is difficult. There are, however, a few conclusions that may readily be drawn from a first inspection of the response curve. A broad peak indicates high damping action, and a sharp peak, low damping. Therefore, if the broadness of any resonance peak is rated in terms of multiples or sub-multiples of the geometric mean frequency, the relative

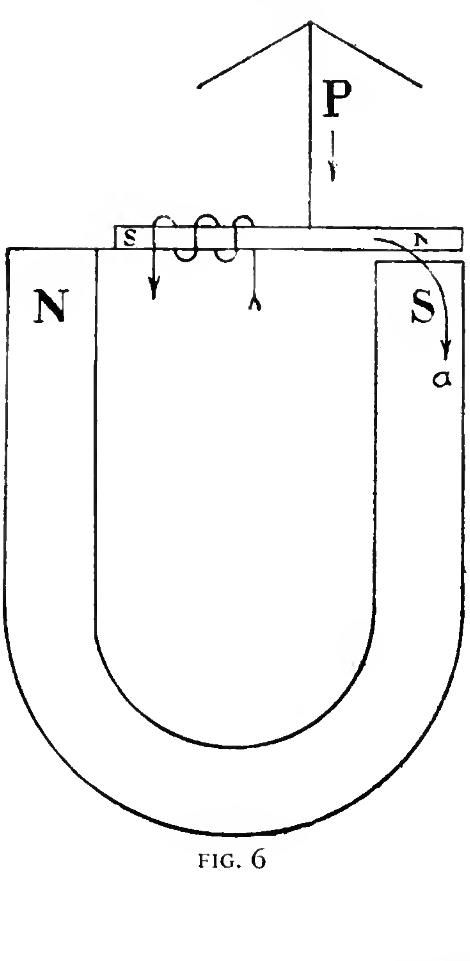


FIG. 6

length of the hangover can be approximately determined. Thus, a resonance peak of unit breadth at, say, seven tenths of its maximum height, will allow vibrations to persist roughly half as long as will one of the same amplitude and half its breadth, and in the former, these vibrations, for a given frequency, are about half as serious. It therefore appears worth while to examine closely the height and breadth of each resonance peak if its amplitude exceeds the average characteristic by 40 to 50 per cent. The absolute height of peaks that may be neglected is more or less a matter of opinion, and therefore, limits can only be fixed by measurement of the undesirable effects produced. Certainly, greatest harm will be produced by peaks falling within the frequency spectrum, most important from the standpoint of auditory sensitivity. Whence it would appear that the harmful effects of peaks can be weighted in accordance with the response curve of Fig. 4.

THE LOUD SPEAKER'S MECHANISM

HAVING considered, in general, the desirable characteristics of loud speakers, let us investigate the mechanism that is to produce these characteristics.

A loud speaker may be considered as made up of three systems:

1. The motor element, which converts the electrical impulses into corresponding mechanical vibrations.
2. The coupling system, which transmits the mechanical vibrations from motor to diaphragm.
3. The diaphragm or loading device, which radiates the mechanical vibrations into the air as waves of sound.

The simplest type of motor element in common use is the vibrating reed type. It consists, in general, of an armature pivoted or hinged at one end and actuated at the other, a magnet to supply a steady uni-directional magnetic flux, and a winding coupled to the magnetic circuit which is capable of superimposing an alternating or pulsating signal flux on the steady flux already present. A schematic diagram of such a unit is shown in Fig. 6. The free end of the armature is normally at rest in a steady uni-directional magnetic field supplied by the permanent magnet. When an alternating or pulsating current is passed through the coil coupled to the armature, the free end of the armature is alternately attracted and repulsed by the remaining pole. Thus, the electrical impulses in the coil are converted into mechanical vibrations which are, in turn, transmitted to a diaphragm through the medium of the driving rod.

A brief inspection of the figure will show that this type of motor is not free from distortion. Let Φ represent the steady flux across the air gap; $\alpha \sin \omega t$, the flux due to a signal current through the windings, and P the force acting on the armature.

Then:

$$
\begin{aligned}
P &= K(\phi + \alpha \sin \omega t)^2 \\
&= 2K\phi\alpha \sin \omega t + K\alpha^2 \sin^2 \omega t + K\phi^2 \\
&= 2K\phi\alpha \sin \omega t - \frac{K\alpha^2}{2}\cos 2\omega t + K\frac{(2\phi^2 + \alpha^2)}{2}
\end{aligned}
$$

Obviously, the first term represents a reproduction of the signal impulse, while the second term represents a second harmonic of the signal[4] (see bibliography on page 590). The remainder of the force adds a steady component to the steady pull exerted by the permanent magnet. It would seem, since that part of the coefficient of the second harmonic which is proportional to the signal, appears as a squared term, that the second harmonic could be made neg-

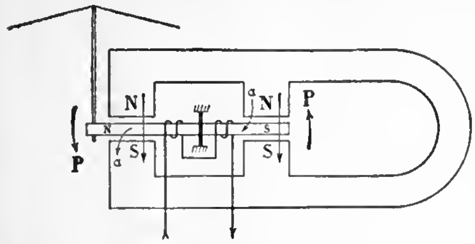


FIG. 7

ligibly small by the simple expedient of keeping the ratio $\frac{\Phi}{\alpha}$, large. Space will hardly permit a discussion of this point. Suffice it to say that good design dictates a limit to this ratio which must necessarily be determined by efficiency, and saturation of armature and pole pieces. Moreover, if a large permanent magnet is used, a stiff armature suspension will be required. Since the reed itself has a resonant period, great care must be exercised to properly fix this period in the frequency spectrum and to provide proper damping. Greatest apparent efficiency will, of course, be obtained by allowing the resonant period of the reed to fall between, say, 800 cycles and 2500 cycles. Best quality can generally be obtained if the resonant period falls near 100 cycles, and is highly damped. It is at once apparent that there are a number of factors which limit both the efficiency and the quality of this type of instrument.

Another type of motor of more recent design, which is very much in favor at present, is the balanced armature type shown in Fig. 7. Among other advantages, this type of structure will take larger loads without producing second harmonics of the signal. Using the same nomenclature as above, we have:

Force due to one set of poles
$= K(\phi + \alpha \sin \omega t)^2$
Force due to the remaining set of poles
$= K(\phi - \alpha \sin \omega t)^2$

The total force acting on the armature is obviously the difference of these two, or:

$$P = K(\phi + \alpha \sin \omega t)^2 - K(\phi - \alpha \sin \omega t)^2 = 4 K \phi \alpha \sin \omega t$$

In this case, the overtone and the additional steady pull, due to the signal, which were present in the output of the reed type motor, vanish. This results, then, in an armature vibration, which is proportional to the signal and which contains no distorting components. It is also a fact that the balanced type of unit will in general reproduce much stronger signals without undue distortion than is the case with the reed type unit. Moreover, if the load contains sufficient damping, the response-frequency characteristic will obviously be more uniform than that of the reed type motor. This type of unit is, of course, not entirely free from resonance, although its fundamental resonant peak is generally not as serious as that of the reed type unit.

Fig. 8 shows the moving coil type of motor. Its operation is, in general, similar to that of the units described above, and lack of space forbids further comment here. This type of instrument may be made very free of mechanical resonant effects, since the mass and stiffness of the armature and its suspension system may be reduced.

CAUSES OF DISTORTION

THERE are numerous causes of distortion in loud speaker motors in addition to those already mentioned. Probably the worst offenders are:

1. Saturation of armature and pole faces.
2. Iron losses, including hysteresis and eddy currents. A detailed discussion of the effects of saturation is beyond the scope of this paper. A simple analysis will, however, serve to point out the general effects to be expected. Saturation occurs in practically all commercial loud speaker motors, at relatively large armature excursions. This particularly applies to reed type motors and balanced armature type motors. It seems reasonable to suspect that the saturation of armature and pole faces in these instruments may

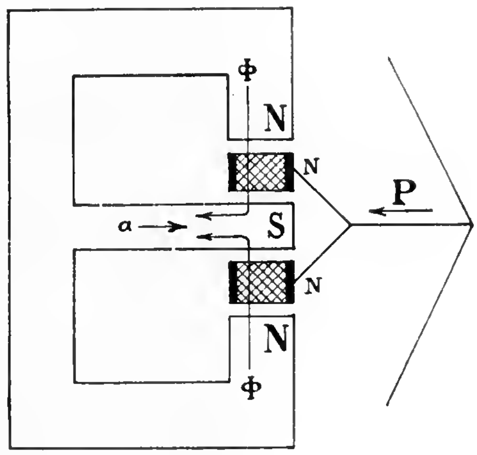


FIG. 8

be due, not to the alternating current in the windings directly, but rather to the permanent magneto-motive force producing large momentary fluxes through the pole faces and armature at large armature excursions. As is often the case, a direct current bias in the windings of a loud speaker, used directly in the plate circuit of an amplifier, may cause armature saturation at very small armature excursions. Be the cause what it may, the effects are the same in that they add odd harmonics of the signal output. Consider

FIG. 9

a sinusoidal signal as shown in Fig. 9, and for simplicity, consider the magnetization curve of the iron involved to be shown in Fig. 10. This, of course, neglects hysteresis and the curvature of the B-H curve, but it is sufficient to illustrate the point. A sine wave signal of sufficient amplitude will produce an armature flux as shown. That is, the peaks of the sine wave will be flattened. Let the signal magneto-motive force be:

$$A = \alpha \sin \omega t.$$

The resulting flux may then be represented as[6] (see bibliography on page 590):

$B = \beta_1 \sin \omega t + \beta_3 \sin 3\,\omega t + \beta_5 \sin 5\,\omega t$ for the case in hand. In addition, there will also be a series of even harmonics for any practical case. Using the previous nomenclature, we have for the reed type instrument, operating at low flux density*:

*A rigorous treatment, would of course, involve even harmonics as well as odd ones since there is always a permanent uni-directional magnetic flux in the armature of the reed type instrument. For simplicity, the shift in axis due to the permanent flux has been neglected.

$$\begin{aligned}
P &= K(\phi + \beta_1 \sin \omega t + \beta_3 \sin 3\,\omega t + \beta_5 \sin 5\,\omega t \ldots)^2 \\
&= K\phi^2 + K\beta_1^2 \sin^2 \omega t + K\beta_3^2 \sin^2 3\,\omega t + K\beta_5^2 \sin^2 5\,\omega t + \ldots \\
&\quad + 2K\phi\beta_1 \sin \omega t + 2K\phi\beta_3 \sin 3\,\omega t + 2K\phi\beta_5 \sin 5\,\omega t \\
&\quad + 2K\beta_1\beta_3 \sin \omega t \sin 3\,\omega t + 2K\beta_1\beta_5 \sin \omega t \sin 5\,\omega t \\
&\quad + 2K\beta_3\beta_5 \sin 3\,\omega t \sin 5\,\omega t + \ldots \\
&= \frac{K}{2}(2\phi^2 + \beta_1^2 + \beta_3^2 + \beta_5^2 + \ldots) \\
&\quad + 2K\phi(\beta_1 \sin \omega t + \beta_3 \sin 3\,\omega t + \beta_5 \sin 5\,\omega t + \ldots) \\
&\quad - \frac{K}{2}(\beta_1^2 \cos 2\,\omega t + \beta_3^2 \cos 6\,\omega t + \beta_5^2 \cos 10\,\omega t + \ldots) \\
&\quad + K\beta_1\beta_3 \cos(\omega t - 3\,\omega t) - K\beta_1\beta_3 \cos(\omega t + 3\,\omega t) \\
&\quad + K\beta_1\beta_5 \cos(\omega t - 5\,\omega t) - K\beta_1\beta_5 \cos(\omega t + 5\,\omega t) \\
&\quad + K\beta_3\beta_5 \cos(3\,\omega t - 5\,\omega t) - K\beta_3\beta_5 \cos(3\,\omega t + 5\,\omega t) + \ldots \\
&= 2K\phi\beta_1 \sin \omega t + 2K\phi\beta_3 \sin 3\,\omega t + 2K\phi\beta_5 \sin 5\,\omega t + \\
&\quad + K\left(\beta_1\beta_3 + \beta_3\beta_5 - \frac{\beta_1^2}{2}\right) \cos 2\,\omega t \\
&\quad + K(\beta_1\beta_5 - \beta_1\beta_3) \cos 4\,\omega t - K\left(\beta_1\beta_5 + \frac{\beta_3^2}{2}\right) \cos 6\,\omega t \\
&\quad - K\beta_3\beta_5 \cos 8\,\omega t - \frac{K\beta_5^2}{2} \cos 10\,\omega t + \ldots \\
&\quad + \frac{K}{2}(2\phi^2 + \beta_1^2 + \beta_3^2 + \beta_5^2 + \ldots)
\end{aligned}$$

Interpreted, this amounts to a force acting on the armature equivalent to the signal and a number of even and odd harmonics as shown above. It is apparent that the amplitude of the harmonics increases with the degree of saturation.

Similarly, for the balanced armature motor we have:

$$\begin{aligned}
P &= K(\phi + \beta_1 \sin \omega t + \beta_3 \sin 3\,\omega t + \beta_5 \sin 5\,\omega t + \ldots)^2 \\
&\quad - K(\phi - \beta_1 \sin \omega t - \beta_3 \sin 3\,\omega t - \beta_5 \sin 5\,\omega t + \ldots)^2 \\
&= 4K\phi\beta_1 \sin \omega t + 4K\phi\beta_3 \sin 3\,\omega t + 4K\phi\beta_5 \sin 5\,\omega t + \ldots
\end{aligned}$$

Obviously, the odd harmonics are still present in their original relative amplitudes in the mechanical force acting on the armature. It will be noticed, however, that the conglomeration of added even harmonics present in the vibrating reed type motor, balances out in this case.

In addition to the introduction of harmonics due to saturation, there are present numerous other forms of distortion, even for very minute armature vibrations. Copper losses in general are negligible, but iron losses are responsible for a great deal of distortion at high frequencies.

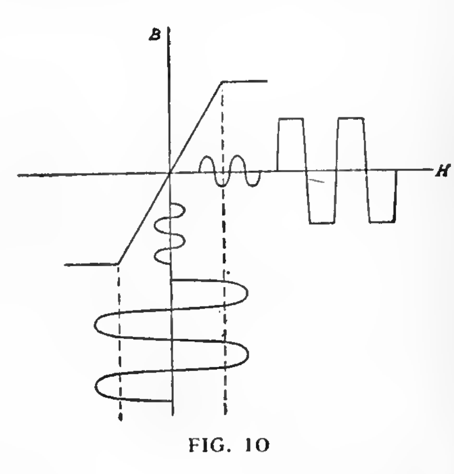


FIG. 10

Iron losses are due to hysteresis and to eddy currents. Hysteretic effect may in general be sufficiently minimized by the use of a good grade of iron, and lamination of that part of the magnetic circuit traversed by the alternating flux appreciably reduces eddy current losses. Eddy currents are due to induction and are induced in the metallic portions of the motor structure by virtue of the changing magnetic flux. Eddy current losses increase as the square of the frequency, and hence tend to reduce the high-frequency response of the motor. Eddy current losses are also dependent on the excursions of the armature and thus may cause amplitude distortion due to their variation over the signal cycle. The frequency distortion due to eddy currents is, however, generally far more serious than the amplitude distortion, and their effect is generally quite apparent in response characteristics.

In order that the armature vibrations be imparted to the air as sound waves, it is necessary to couple a loading device to the motor element. The loading device may consist of a horn together with a small diaphragm and air chamber, or of a large diaphragm which imparts the vibrations directly to the air. The function of either type of loading element is much the same although their action differs somewhat. Properly designed horns apply an almost constant load to a motor element and may thus be made to produce a much smoother response-frequency characteristic than the cone type (large diaphragm) device[6] (see bibliography on this page). The essential difference in the two lies mainly in the fact that the load presented by the horn is almost pure radiation resistance over the operating range, while that supplied by the cone is far from constant, resulting generally in an irregular response characteristic, and is very similar in its action toward the mechanical system to a complex impedance load in an electrical circuit.† Aside from the difference in relative smoothness of their response characteristics the frequency band covered in the two cases is quite different. See Fig. 11. The lowest frequency radiated by a horn is a function of its length. Many horns function in a manner similar to an open organ pipe, in that the lowest frequency transmitted is

$$F = \frac{\text{Vel. of Sound in Air}}{2\,(\text{Length of Horn})}$$

to a first approximation. This obviously depends on the shape of the horn and the shape of the opening. The lowest frequency efficiently radiated by the cone is, among other factors, determined by the size of the structure and the amplitude of motion. In addition, the highest transmitted frequency efficiently radiated by this type of loading device is partly determined by the effective high-frequency mass of the diaphragm. In some diaphragms, at high frequencies, only a small portion of the diaphragm near the driven point is effective as a radiator, the remainder of the device acting in general as a power absorbing network. That is to say, the high-frequency vibrations may travel from apex to edge of the cone as well as being directly radiated from the driven point. The effect of these impulses traveling across the face of the diaphragm is twofold: First, power lost in deformation of the diaphragm face, and, second, out-of-phase radiation. These may frequently occur to such an extent that the radiated sound is much reduced. In addition, the usual diaphragm has many resonant points of its own and thus may present a variable load to the motor.

†This applies to large flexible diaphragms such as paper cones. With a very stiff diaphragm of small size, plunger action and more uniform response may result.

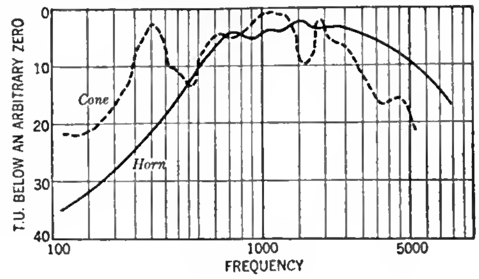


FIG. 11

The efficiency and response-frequency characteristics of a loud speaker depend to a large extent upon the device used to couple the motor to the loading element. In the case of the horn radiator, this device usually consists of a short light driving rod and is, in general, quite efficient and relatively free of distorting effects. In the case of the large diaphragm (cone) loading device, the coupling device must in general include a mechanical transformer, which amounts to a lever or system of levers for increasing the force. In the ideal case the mechanical transformer consists of a frictionless lever of zero mass. In practical cases it may consist of members having appreciable mass and considerable stiffness of suspension, amounting to a complex network, which further complicate the action of the loud speaker as a unit. This particular phase of the subject, however, has been treated in detail elsewhere[7] (see bibliography on this page).

The human ear which in the end is the final judge of quality, is far from a perfect instrument. Its response characteristic is far from linear either with frequency or amplitude[8] (see bibliography on this page). Moreover, the ear is in itself a modulator, due to the nonlinearity of its characteristics[9] (see bibliography on this page). Such being the case, it is often possible for an observer to apparently hear a fundamental note, when only harmonics of the note actually impinge on the ear drum[10] (see bibliography on this page). Therefore, it may often be permissible to allow a certain amount of distortion to actually take place, and still maintain tolerable quality. Thus, harmonics produced by a loud speaker may often cause a slight apparent increase in efficiency without materially affecting quality. The naturalness of reproduced speech and music depends to a large extent on the energy level at which it is reproduced. That is to say, the psychological reaction of the observer depends on whether or not the signal is delivered at normal intensity. Again, harmonics of the original signal are frequently not detected by the ear until the energy level is such that the harmonic output of the reproducer approaches that of the original signal. Moreover, relatively large irregularities in the response characteristic of an acoustic reproducer are frequently allowable at either end of the frequency spectrum, as previously pointed out. Consequently, a perfect reproducer, having a linear response characteristic, might not appear to have an appreciable advantage over a less perfect device with a reasonably acceptable characteristic.

BIBLIOGRAPHY

1—"Nature of Language," R. L. Jones. *Electrical Communication*—Vol. 2, No. 1. July, 1923.
2—"High Quality Reproduction of Speech and Music." W. H. Martin and H. Fletcher. *Journal A. I. E. E.* Vol. XLII, No. 3. March, 1924.
3—"The Relation between the Loudness of a Sound and Its Physical Stimulus," J. C. Steinberg. *Physical Review*. October, 1925.
4—"Design of Telephone Receivers for Loud Speaking Purposes," C. R. Hanna. *Proc. I. R. E.* August, 1925.
"Theory of Magneto-Mechanical Systems," R. L. Wegel. *Journal A. I. E. E.* October, 1921.
"The Electromagnetic Theory of the Telephone Receiver," A. E. Kennelly and H. Nukiyama. *Proc. A. I. E. E.* April, 1919.
5—"Fouriers Series and Spherical Harmonics," Byerly.
6—"Function and Design of Horns for Loud Speakers," C. R. Hanna and J. Slepian. *Journal A. I. E. E.* February, 1924.
"Acoustical Impedance and Theory of Horns and of the Phonograph," A. G. Webster. *Proc. National Academy of Sciences*. 1919. Vol. 5.
"Experiments on the Vibration of Air in Conical Horns," A. G. Webster. *Proc. National Academy of Sciences*. 1920. Vol. 6.
"Theory of Sound," Lord Rayleigh. Vol. 2.
"Performance and Theory of Loud Speaker Horns," Goldsmith and Minton. *Proc. I. R. E.* August, 1924.
7—"Methods of High-Quality Recording and Reproducing of Music and Speech Based on Telephone Research," J. P. Maxfield and H. C. Harrison. *Bell System Technical Journal*. July, 1926.
8—"Physical Measurements of Audition and Their Bearing on the Theory of Hearing," Harvey Fletcher. *Journal of Franklin Institute*. Vol. 196, No. 3. September, 1923.
9—"Auditory Masking and Dynamics of the Inner Ear," R. L. Wegel and C. E. Lane. *Physical Review*. February, 1924.
10—"Physical Criteria for Determining the Pitch of a Musical Tone," H. Fletcher. *Physical Review*. September, 1923.

¶ Radio Broadcast *is the official publication of the Radio Club of America, through whose courtesy, the foregoing paper has been printed here.* Radio Broadcast *does not, of course, assume responsibility for controversial statements made by authors of these papers. Other Radio Club papers will appear in subsequent numbers of this magazine*

The *Radio Broadcast* LABORATORY INFORMATION SHEETS

INQUIRIES sent to the Questions and Answers department of RADIO BROADCAST *have until recently been answered either by letter or in "The Grid." The latter department has been discontinued, and all questions addressed to our technical service department are now answered by mail. In place of "The Grid," appears this series of Laboratory Information Sheets. These sheets contain much the same type of information as formerly appeared in "The Grid," but we believe that the change in the method of presentation and the wider scope of the information in the sheets, will make this section of* RADIO BROADCAST *of much greater interest to our readers.*

The Laboratory Information Sheets cover a wide range of information of value to the experimenter, and they are so arranged that they may be cut from the magazine and preserved for constant reference. We suggest that the series of Sheets appearing in each issue be cut out with a razor blade and pasted on filing cards, or in a note book. The cards should be arranged in numerical order. Several times during the year, an index to all sheets previously printed will appear in this department. The first index appeared in November.

Those who wish to avail themselves of the service formerly supplied by "The Grid," are requested to send their questions to the Technical Information Service of the Laboratory, using the coupon which appears on page 612 of this issue. Some of the former issues of RADIO BROADCAST, *in which appeared the first sets of Laboratory Sheets, may still be obtained from the Subscription Department of Doubleday, Page & Company at Garden City, New York.*

No. 81 RADIO BROADCAST Laboratory Information Sheet April, 1927

Ohm's Law

SOME EXAMPLES

IF A tube's filament has a resistance of 20 ohms and five volts are applied to it, a current of ¼ ampere will flow. If the filament resistance is one half this figure (10 ohms), then the current, for the same applied voltage, will be twice as large, or ½ ampere.

To determine these currents, we have used a fundamental relationship regarding the current, voltage, and resistance of any circuit, known as Ohm's Law, which states that the current in a circuit is always exactly proportional to the voltage and inversely proportional to the resistance. Therefore, in the above example, halving the resistance doubled the current, and doubling the resistance would have halved the current. Inversely, doubling the voltage doubles the current, and halving it gives half the current.

These facts can be expressed in the form of a simple algebraic equation as follows:—

$$(1).\quad I = \frac{E}{R}$$

in which I is the current in amperes, E the voltage, and R the resistance in ohms.

The equation shows that the current is equal to the voltage divided by the resistance. It can be rearranged so as to make it easy to solve for voltage or resistance as well as current.

To determine an unknown voltage, use the equation in the following form:

$$(2).\quad E = I \times R$$

For determining an unknown resistance:

$$(3).\quad R = \frac{E}{I}$$

Let us take up a few simple examples in which these equations are used.

EXAMPLE 1:

A tube's filament has a resistance of 20 ohms, and its rated voltage is 5. What current does it require?

In the problem the voltage and resistance are given and we can substitute in equation number 1 as follows

$$I = \frac{E}{R} \therefore I = \frac{5}{20} = 0.25 \text{ Amperes}$$

EXAMPLE 2:

If a 199 tube filament takes 0.06 amperes at 3 volts, what is its resistance?

Using formula No. 3.

$$R = \frac{E}{I} \therefore R = \frac{3}{0.06} = 50 \text{ Ohms}$$

EXAMPLE 3:

A filament is designed with a resistance of 4 ohms, and its rated current is 1.25 amperes. What voltage must be placed across the tube to make the rated current flow?

Using formula No. 2, we have:

$$E = I \times R \therefore E = 1.25 \times 4 = 5 \text{ Volts.}$$

No. 82 RADIO BROADCAST Laboratory Information Sheet April, 1927

Oscillation Control

A COMPARISON OF TWO COMMON METHODS

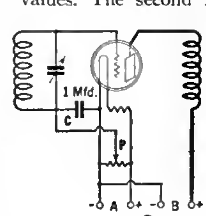
IT IS the purpose of this Laboratory Sheet to compare two methods commonly used to control oscillations in the radio-frequency amplifiers of receivers.

The first method to be discussed is that using a potentiometer to vary the bias on the grid of the tube. This method is illustrated in Fig. 1, in which P is the potentiometer, and C is a bypass condenser functioning to bypass the radio-frequency energy directly to the negative filament.

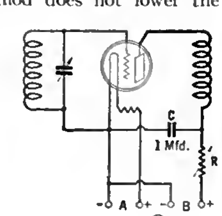
When the potentiometer arm is connected to the negative side, the amplifier operates most efficiently and the result is that it oscillates. To prevent the oscillations from occurring, the potentiometer arm is moved toward the positive side and this makes the grid positive, lowers the efficiency of the circuit, and thereby prevents oscillations.

The second method is indicated diagramatically in Fig. 2, in which case the oscillation control is a variable resistance, R, in the plate circuit of the tube. In this case a bypass condenser is again used to bypass the radio-frequency energy to the negative filament. This oscillation control functions by lowering the value of voltage impressed on the plate of the tube. In this manner the plate impedance of the tube is increased and oscillations prevented.

The second method is to be preferred over the first since it has several distinct advantages. In the first place the plate current consumption, using the second method, is quite low, whereas, in the first method, in order to prevent oscillations it is necessary to make the grid positive, which causes the plate current to increase to comparatively large values. The second method does not lower the



①



②

selectivity of the receiver. This is not true of the first method because, when the grid becomes positive, a load is placed on the tuned circuit, and the resistance of the circuit is thereby increased. The result is that it tunes broadly, or, in other words, the selectivity of the receiver is lowered.

In practice, the resistance used in Fig. 2 generally has a maximum value of about 500,000 ohms.

(*Continued on page 602*)

No. 83 Radio Broadcast Laboratory Information Sheet April, 1927

Tube Characteristics

MUTUAL CONDUCTANCE

ON LABORATORY Sheet No. 84 is given a group of curves for a 120 tube, while on this Laboratory Sheet we will calculate the mutual conductance of the 120 tube with the aid of these curves.

The mutual conductance is a measure of the effect of a varying grid voltage on the plate current for a constant plate voltage. Stated as a formula, the mutual conductance equals:—

$$\frac{\text{CHANGE IN PLATE CURRENT (AMPERES)}}{\text{CORRESPONDING CHANGE IN GRID VOLTAGE}}$$

We are giving below some examples that will make simple the calculation of the mutual conductance of any tube provided its characteristic curves are available:

EXAMPLE 1

Calculate the mutual conductance of a 120 type tube using the curves given on Laboratory Sheet No. 84. Locate any point on curve No. 3, as for example, that indicated by the cross. This point corresponds to a plate current of 3.4 milliamperes, a plate voltage of 120, and a grid bias (E_g) of minus 25 volts. Follow along on the 120-volt line to curve No. 2, and we find that the plate current is 5.4 milliamperes for a grid bias of minus 22½ volts. We now have two values of grid voltage and two values of plate current for the same plate voltage. Changing the milliamperes to amperes, and substituting in the formula, we have:

$$(0.005 - 0.0034) \div (25 - 22.5)$$

$$= \frac{0.0016}{2.5} = 0.00064 \text{ mhos} = 640 \text{ micromhos}$$

EXAMPLE 2

Calculate the mutual conductance of the 120 tube for a lower value of plate voltage, say 95. To do this we will locate the point on curve No. 2, corresponding to 95 volts on the plate, and this point, indicated by a cross, gives a plate current of 3.2 milliamperes for a grid bias of minus 22½ volts. This same voltage on curve No. 1 gives a plate current of 4.7 milliamperes for a grid bias of minus 15 volts. Substituting these values in the formula:

$$(0.0047 - 0.0032) \div (22.5 - 15)$$

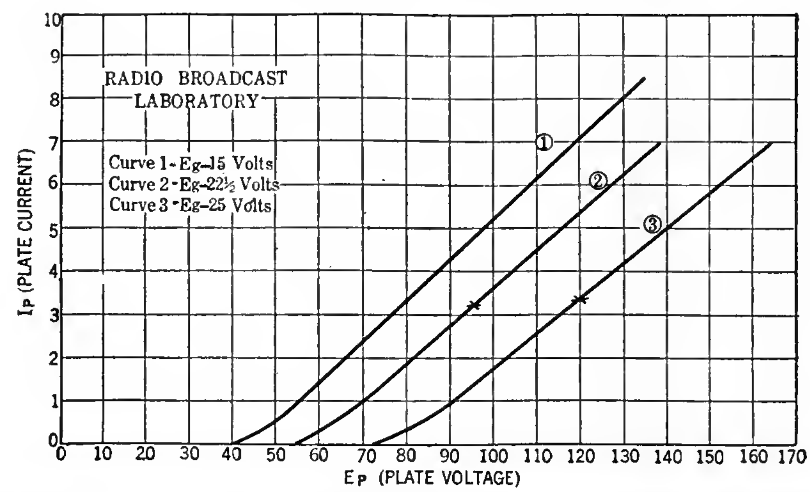
$$= \frac{0.0015}{7.5} = 0.0002 \text{ mhos} = 200 \text{ micromhos}$$

It is evident from these two values of mutual conductance that the 120 give very low values when low plate voltages are used. Practically the only voltages which can be used on the 120 tube with satisfactory results are 135 volts on the plate and minus 22½ on the grid.

Readers interested in calculating the other constants of a tube are referred to Laboratory Sheets No. 67, February, 1927, and No. 80, March, 1927.

No. 84 Radio Broadcast Laboratory Information Sheet April, 1927

The UX-120 Tube Characteristic Curve



No. 85 Radio Broadcast Laboratory Information Sheet April, 1927

C Voltages

FACTORS DETERMINING VALUE

THE C-battery voltage that can be placed on any tube indicates the amplitude of the signal voltage that the tube can handle without seriously overloading. For example, the 171 tube with 180 volts on the plate requires a 40.5-volt C battery. Any signal can be impressed on this tube, therefore, whose peak value does not exceed 40.5 volts.

Ordinarily we do not talk of the maximum values of alternating current voltages but speak instead of the effective values, which are equal to 0.707 times the maximum or, so called, peak value. In other words, a voltage with a peak value of 40.5 has an effective value of 28.6. If signals greater than this are impressed on the tube, the grid voltage will swing until at times it becomes positive and it will then draw a small amount of grid current, which it does not do when negative. Even very small grid currents flowing through the secondary of a transformer have a very serious effect on their operation. Consequently in amplifier work it is an axiom that the grid voltage must never be permitted to swing an amount exceeding the value of the C battery.

The handling capacity of a tube can be increased by increasing the grid voltage up to a certain point. Beyond this point an examination of the tube characteristic would indicate that the signals will cause the grid to operate on the lower curved portion of its characteristic. The manufacturers' C-battery ratings are generally the highest that can be used and still operate the tube on the straight portion of the characteristic. As an example, when the 201-A tube is used in an amplifier with 90 volts on the plate it is recommended that the C-battery voltage be 4½, and this can be taken as the value of C-battery which will permit the tube to handle the greatest amount of undistorted power.

The C-battery voltage used on the last tube of an amplifier determines what C battery is required on the other amplifier tubes because it will take a certain definite value of signal voltage on the grid of the preceding tube in order to place the maximum allowable signal voltage on the grid of the last tube. See Laboratory Sheet No. 88. Consequently, the voltage on the grid of the tube preceding the last tube need only be sufficiently great to prevent its grid from going positive on the maximum signal necessary to give maximum voltage on the grid of the second tube

No. 86 Radio Broadcast Laboratory Information Sheet April, 1927

A Double Impedance-Coupled Amplifier

THE NECESSARY PARTS

A SCHEMATIC diagram of a double-impedance amplifier is shown on Laboratory Sheet No. 87. The material required to build such an amplifier is described below:—

L_1—Impedances designed for use in the plate circuit of an impedance-coupled amplifier. Four of these coils are necessary. They should have an inductance of at least 60 henrys; somewhat better results will be obtained if the inductance is about 100 henrys, however. The exact value of inductance is not very important so long as it be at least 60 henrys. The choke coil in the plate circuit of the power tube, T_3, must be capable of carrying the plate current drawn by this tube. For a 171 tube with 180 volts, the plate current will be as high as 20 milliamperes.

L_2—Grid impedances. These should have a value of inductance of about 100 henrys. Three of these coils are required.

C—Coupling condensers, having a capacity of 0.1 mfd. These condensers must be well constructed since, if poor units are used, a certain amount of leakage occurs across the condensers. Well-constructed paper condensers are quite satisfactory.

C_1—4-mfd. output condenser.

R—Fixed filament control resistance of a type depending upon the kind of tubes used. It must be capable of passing the total filament current of the three amplifier tubes.

J—Single-circuit jack.

S—Filament switch.

T_1, T_2—Two high-mu tubes. Two 201-A's may be used but the amplification will not be as great.

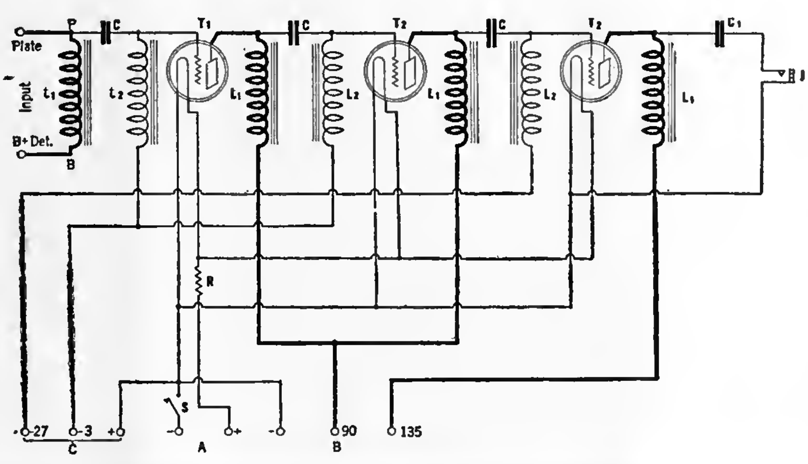
T_3—Power tube of either the 112 or 171 type. The C-battery voltage on the last stage will depend upon the type of tube and the plate voltage that is used.

It will be found that an amplifier of this kind will give excellent quality. It can be used in conjunction with any receiver, it merely being necessary to connect the input of the amplifier circuit to the detector circuit of the receiver. The terminal marked plate on the input connects to the plate of the detector tube and the B plus det. terminal connects to the plus 45-volt B battery terminal. In those receivers using a tickler, the B+ detector terminal would connect to one end of the tickler winding instead of directly to the plate of the detector tube.

People frequently ask if the primaries or secondaries of old audio transformers might not be used as impedances in an amplifier of the type under discussion. This is not feasible, for the characteristics which cause old-style transformers to give poor quality, also make them unsuitable for use as impedances. High inductance windings and well-designed cores are not to be found in old transformers, and it is desirable that an impedance unit have both of these.

No. 87 Radio Broadcast Laboratory Information Sheet April, 1927

A Dual-Impedance Coupled Amplifier



No. 88 Radio Broadcast Laboratory Information Sheet April, 1927

Audio Amplifying Systems

NO. 1. TRANSFORMER AMPLIFIERS

THE conventional transformer-coupled amplifier consists of two stages. The over-all amplification of such a system is generally around 300, and this is sufficiently high to give loud speaker reproduction with a moderately strong signal available at the output of the detector. The transformer-coupled system has the advantage that only two stages are required and can, therefore, be made quite compact.

The plate current consumption of such an amplifier is fairly low and only moderately high voltages are necessary on the first stage. The quality of the results obtained depends primarily upon the transformers used and for this reason a certain amount of care is necessary in choosing the transformers that are to be incorporated in such an amplifier.

The transformer feeding out of the detector stage should have a primary impedance that is somewhat higher than is necessary for that transformer used in the second stage. The higher impedance is necessary in the transformer feeding out of the detector tube due to the fact that the detector place circuit generally has a somewhat higher impedance than the plate circuit of a tube used as an amplifier.

If two transformers of different ratios are to be used, the rule is almost invariably to place the low-ratio transformer in the first stage and high-ratio transformer in the second stage. For commercial reasons, most manufacturers put a fixed number of turns on the secondaries of their transformers irrespective of the ratio required. The different ratio values are then obtained by winding on the necessary number of primary turns, this latter figure of course varying proportionally with the ratio. Thus, the lower the ratio, the greater the number of primary turns and likewise, the greater the primary impedance.

Proper C battery on the amplifier tubes is absolutely essential if good quality is to be obtained. The C battery voltage on the first stage should not be higher than is necessary to prevent overloading. Placing an unnecessarily high bias on the first tube increases the plate impedance of the tube, and it is essential that the plate impedance be kept low.

If a 171 tube is used in the last stage with a 40 volt C bias, we can impress signals on the grid of this tube which have a peak value up to 40 volts. If the transformer has a ratio of 4:1, the peak value of the voltage in the primary will be 10 volts. If a 201-A tube is used in the interstage, we can obtain the value of peak voltage on its grid by dividing the voltage in the plate circuit, 10, by the amplification constant of the tube, 8, which gives $1\frac{1}{4}$ volts. It follows then, that a C battery bias of $1\frac{1}{4}$ volts on the first tube will be sufficient to prevent overloading.

Equipment for the Home-Constructor

How to Use Some of the New Equipment Tested and Approved by the "Radio Broadcast" Laboratory

By THE LABORATORY STAFF

THE Freed-Eisemann B power-supply device differs in several respects from the average one on the market, and it can be used in connection with almost any type of receiver which does not require more than 135 volts on the highest tap. It operates directly from the 110-volt 60-cycle house current. There are three direct-current voltage taps, 135, 90, and 22½ volts for use, respectively, on the last stage, the r. f. and first audio stages, and the detector stage. Three different C voltages are available; minus 4½, minus 9, and minus 27, which provide the proper grid bias for the various audio tubes. The 4½-volt tap is usually used with the first audio stage, the 9-volt tap when a type 112 tube is used, and the 27 volts when the type 171 is used in the output stage. The rectifying element is a 213 type double-wave rectifying tube which gives ample output capacity for sets using from five to seven tubes. A regulating tube of the 874 type is used to keep the voltage constant at varying loads. This tube is gas filled, and current conduction is accomplished by the ionization of the enclosed gases. When such a tube is connected across the line it has the peculiar property of holding the voltage constant at 90, no matter what load is taken from the line. In this power device, the tube is connected to the 90-volt terminal, and upon test in the Laboratory with a 171 type tube on the 135-volt circuit, the voltage on the 90-volt tap was found to be practically constant for all loads from zero up to approximately 25 milliamperes. This current value is ample to take care of the requirements of nearly every receiver. The regulating tube is connected in circuit in such a way that if the tube is removed during operation, the rectifier will not function. This is a safety feature which prevents excessive voltages from building up, and perhaps causing the filter condensers to be broken down. Another safety feature is that an automatic switch cuts off the line power whenever the cover over the terminal board is opened, thus making it impossible for the operator to get a shock or short-circuit the terminals when wires are to be changed. Manufactured by the Freed-Eisemann Radio Corporation, Brooklyn, New York. Model 16. Price $45.00 without tubes.

VARIABLE CONDENSER

THE Hammarlund Midline condenser can be used in any circuit requiring a variable capacity. As the name "Midline" implies, it is a compromise between the three most common types of variable condensers—the straight wavelength-line, the straight capacity-line, and the straight frequency-line condensers. The tuning graph as shown in Fig. 1 gives the dial readings for different frequencies for the four different types of condensers. With the older straight capacity-line condensers, the station readings were crowded at the lower dial readings. The straight wavelength line condensers were somewhat better in this respect. Later, the straight frequency-line condensers were introduced which reversed the crowding. The "Midline" tends to separate the stations equally over the whole dial.

This condenser is well made mechanically and electrically. The brass plates are soldered firmly into slots. The stator is insulated from the frame by a single strip of bakelite insulation, firmly connected to the frame by a large screw. The frame for holding the stator and rotor is a die-casting of light but strong construction. Screws are provided for mounting the condenser either on the panel or on the baseboard. A screw bushing is also provided at one end to permit single-hole mounting. The adjustable bearings are of the cone type. The tension on the turning movement is provided by a small adjustable felt brake band. Spring connections are provided between the frame and the rotor for carrying the current.

The rotor plates are mounted on a hollow tube

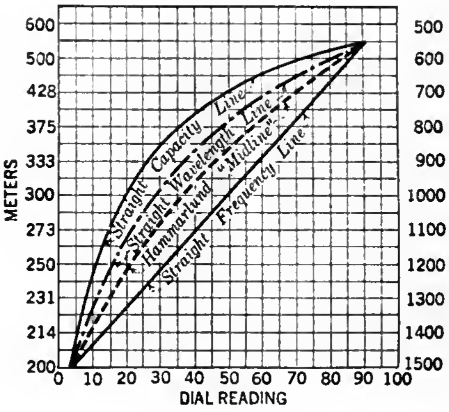


FIG. 1

Showing how the curve of the Hammarlund "Midline" compares with those of other type condensers

a center shaft within it being removable by loosening two screws, making it possible to alter the length of the projecting shaft so that it may be adjusted to fit any type of dial. When the builder must avoid hand capacity, an insulating shaft may be substituted for the metal one. An extension shaft may be provided upon which may be mounted other condensers, rotating coils, cams, gears, or other apparatus. The shaft may be pushed through from either end thus giving a clockwise or counter clockwise movement of the dial. The span of the condenser is four inches which makes it easily adaptable to experimental layouts. These condensers are made up in different capacities with a price range, in the case of the dual units, of from $7.00 to $8.50. The price list of the single units is given below. Manufactured by the Hammarlund Manufacturing Company, New York City.

Code Number	Maximum Capacity	Prices
ML-23	0.0005 Mfd.	$5.00
ML-17	0.00035 "	$4.75
ML-13	0.000275 "	$4.65
ML-11	0.00025 "	$4.50
ML- 5	0.0001 "	$4.25

B SOCKET-POWER TESTING APPARATUS

WITH the increasing use of power supply devices for operating the radio receiver directly from the lighting circuit comes a new problem in testing. The low-resistance voltmeter which ordinarily served with the dry cell batteries, takes an appreciable load current, and consequently does not give a true reading on a power device. In order to provide a simple instrument for test purposes on a B power device, the Sterling Manufacturing Company, of Cleveland, Ohio, has brought out a small combination testing outfit which has, included in it, a milliammeter with a scale reading of 0—100 milliamperes and a high-resistance voltmeter with a scale reading of 0—300 volts. A rheostat of the proper resistance is provided to form a variable load. The wiring diagram of the tester is given here in Fig. 2, and shows how the meters are connected inside the metal case. Three binding posts are provided for the milliammeter. When the outside two are used, the rheostat is in series with the milliammeter, while if connected to the other two, marked "plus" and "minus," "rheostat out," the meter can be used as a separate unit. The other two posts are connected to the voltmeter so that it may also be used as a separate instrument. When the change-over switch is in the position indicated in the diagram, the two instruments are connected together and the voltage is measured directly across the loading rheostat. It is interesting to note that the small current taken by the voltmeter is also included in the reading of the milliammeter. With the switch in the other position the instruments can be used individually.

It is very important to know, in testing a socket-power device, exactly what voltage will be obtained with any given load. Thus if it were known that a receiver of a given type needed from 25 to 30 milliamperes at 150 volts, a power device which would give only 80 volts at this load would be entirely inadequate. If the tester were at hand it would be a simple matter to tell. Connect the milliammeter plus post with the plus of the power device and the negative, "rheostat in," post with the negative of the power device. Then with the switch in the "meters coupled" position, the rheostat is turned on until the milliammeter reads 30 mils. The voltage which would be obtained is read on the voltmeter. If 150 or more volts are indicated, it shows that that particular power device would be ample for the reouirements of the receiver specified.

A plug and cable is also furnished with the test set which can be plugged into the socket of a receiver and the voltage at the socket determined. In this case the leads from the socket would be connected to the plus and minus binding posts of the voltmeter with the switch in the "meters separate" position. Such a test meter should be of great service both to the dealer who is servicing receivers and to the experimenter who wishes to make B power device tests. By taking the voltage readings at different values of current, the data may be placed on a curve sheet and will show the regulatory characteristics of the power device. Manufactured by the Sterling Manufacturing Company, Cleveland, Ohio. Tester R-410. Price $40.00.

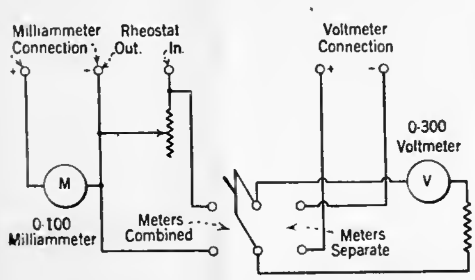
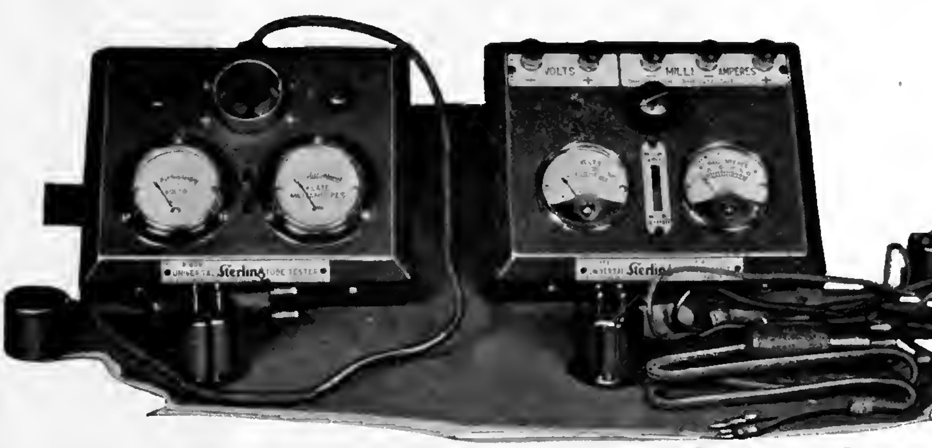


FIG. 2

VACUUM TUBES

TWO very interesting tubes have been announced recently. One is from the Van Horne Company, and is patterned after the suggestions of Mr. B. F. Miessner in a recent Radio Club of America paper, published in RADIO BROADCAST in February, 1927. This tube operates with a terminal filament voltage of 0.6 volts and consumes 2 amperes. The filament is of the oxide coated type and has a thermal inertia much greater than existing tubes. A tube of this type can be operated from un-rectified a. c. with practical freedom from hum due to its inertia and to the fact that its filament resistance is so low, 0.3 ohms, that a. c. voltages developed across it will be extremely small. This is a very important development in the tube industry and many interesting possibilities are opened up thereby in the realm of a. c. operated receivers.

The other tube is a rectifying tube designed to pass currents as high as 300 milliamperes. With such a tube, together with the necessary chokes and smoothing equipment, it will be possible to run 201-A type tubes with the filaments in series with rectified current supplied by this tube. Up to the present, the maximum rectified current that was available generally was not over 100 milliamperes and since a 201-A type tube requires 250 milliamperes for its operation, it has not been possible to light the filaments with rectified a. c. This important tube is due to the Q. R. S. Music Company and has been announced in the advertising pages of RADIO BROADCAST.



RADIO BROADCAST Photograph

TWO STERLING TESTING INSTRUMENTS

To the left is shown the "Universal" tube tester, the circuit for which is given in Fig. 3 overleaf. The tester to the right is shown diagrammatically in Fig. 2 on this page

(*Continued on page 608*)

A KEY TO RECENT RADIO ARTICLES

By E. G. SHALKHAUSER

This is the eighteenth installment of references to articles which have appeared recently in various radio periodicals. Each separate reference should be cut out and pasted on 4" x 6" cards for filing, or pasted in a scrap book either alphabetically or numerically. An outline of the Dewey Decimal System (employed here) appeared last in the January Radio Broadcast, *and will be reprinted in an early number.*

R325.1. Direction Finders. Direction Finders.
Bureau of Standards Paper No. 536. Oct., 21, 1926.
"A Portable Radio Direction Finder for 90 to 7700 Kilocycles," F. W. Dunmore.
A description of a portable radio direction finder having but two controls (balancing and tuning) and designed to operate over the frequency band from 90 to 7700 kilocycles (3300 to 39 meters), is given. The entire set, with the exception of the direction-finding loop, is contained in an aluminum box.
The receiver is of the super-heterodyne type, employing a standard Signal Corps amplifier. The wide range of frequencies is obtained by using a set of seven interchangeable plug-in direction-finder loops, each with a corresponding heterodyne generator coil. The loops vary in size from 12½ to 24½ inches square, the former having only two turns and the latter sixty turns. A small telescoping brass rod extending vertically through the center of each direction finder loop, and connected to the movable plates of the balancing condenser, serves as an auxiliary antenna for the purpose of sharpening the point of minimum signal strength. Means are provided so that bearings may be taken with respect to the magnetic north.

R144. High-Frequency Resistance. Resistance, *High-Frequency.*
Bureau of Standards Paper No. 330. Oct., 27, 1926.
"Resistance of Conductors of Various Types and Sizes as Windings of Single-Layer Coils at 150 to 6000 Kilocycles," E. L. Hall.
Experimental data are presented on the resistance, at frequencies between 150 and 6000 kilocycles (2000 to 50 meters), of single-layer coils wound with various sizes of solid bare copper wire, litz wire, copper tubing, and aluminum ribbon. The measurements were made by the resistance-variation method, and the results are shown on curves, which are directly comparable. These curves are of great value when selecting the size of wire having the least resistance for a given frequency.

R251.2. Thermo-Element Ammeter. Ammeter, *Thermionic.*
Wireless World (London). Nov., 3, 1926. Pp. 611–612.
"Thermionic Aerial Ammeter," G 2 AB.
A description of a rather accurate method of measuring small high-frequency currents by the use of a vacuum tube of the proper size in a special circuit arrangement, is given. The method as described is said to have the following distinct advantages: (1) It is cheap; (2) The resistance of the filament may be in the neighborhood of 2 ohms as compared with 12–14 ohms in the case of thermo-couple instruments; (3) The thermo-couple instruments can usually be supplied only in the current-squared calibration, whereas this instrument can be calibrated for direct reading.

R382. Inductors. Induction Coils.
Wireless World (London). Dec., 8, 1926. Pp. 754–759.
"Designing Low Loss Receiving Coils," S. Butterworth.
Data is given on the correct design of low loss receiving coils. Experimental curves are shown which will enable the non-technical man to build coils to specifications.

R130. Electron Tubes. Grid Potential, *Effect of.*
Wireless World (London). Oct., 6, 1926. Pp. 491–493.
"Grid Potentials," C. H. Stephenson.
Six possible methods of connecting the grid return to a vacuum-tube filament are described. The proper way of connecting the grid will depend upon the characteristics of the tubes, and whether they are used as radio-frequency amplifiers, detectors, or audio amplifiers.

R344. 3 Transmitting Sets. Transmitter, *Short-Wave.*
Wireless World (London). Oct., 26, 1926. Pp. 577–579.
"Transmitting on 45 Meters," G. A. Exeter.
A description of a 6663-kc. (45 meter) transmitter with small input power, and using third harmonic excitation, is given. The Armstrong tuned-grid tuned-plate circuit is used. The radiating system consists of a Hertz antenna with parallel feeders from the coupling coil.

R376.3. Loud Speaking Reproducers. Loud Speakers.
Radio News. Dec., 1926. Pp. 642-ff.
"Loud Speakers and Their Characteristics," M. L. Muhleman.
The inherent characteristics of loud speakers are compared with the widely different responses of the human ear at different frequencies. What is termed the "response factor" of the human ear to loud speaker reproduction depends on the individual, and it is stated that a change of 10 per cent. in volume is not readily distinguishable.
Horn and cone speakers differ only mechanically, the one causing the diaphragm to move the air through a horn, and the other through an oversized diaphragm. The shape and length of the horn affect the tone, all of the frequencies being audible only when the horn is at least 20 feet long. Cone speakers are said to have better frequency characteristics than horns, although this depends on the size of the diaphragm and other factors. Reference is made to horns and cones of various makes, and these are illustrated.

R131. General Properties of Electron Tubes. Microphonic Action.
Wireless World (London). Oct., 20, 1926. Pp. 553–554.
"Microphonic Action," F. E. Henderson.
An outline of the cause and cure of so-called microphonic noises in vacuum tubes, especially relating to tubes having a fine filament which burns at a cherry red, is presented. Usually the cause is vibration of the filament, and, according to the author, by a suitable mounting, or proper shielding, the effect may be eliminated.

R582. Transmission of Photographs. Photographic Transmission.
Radio News. Dec., 1926. Pp. 626-ff.
"New Television Apparatus," L. Fournier.
The construction and operation of the Belin and Holweck television apparatus is described by the writer. The transmitting apparatus utilizes an arc lamp, a condensing lens, two oscillating mirrors, a transparent screen, and a photo-electric cell. The transmitting and receiving apparatus are synchronized with a 500-cycle current. The Holweck cathode ray oscillograph is used at the receiving end for producing the image. Photographs show the apparatus used.

R382. Inductors. Inductors, *Browning-Drake.*
Radio News. Dec., 1926. Pp. 660–661.
"Home-Made Coils for the Browning-Drake and Similar Circuits," C. A. Oldroyd.
The writer gives simple constructional data on radio-frequency coils such as are used in the well-known Browning Drake and similar circuits. Mounting devices, and various methods of placing the primary in relation to the secondary, are described at some length.

R342.2. Resistance Coupling. Coupling, *Resistance.*
Proc. I. R. E. Dec., 1926. Pp. 759–763.
"Notes on the Design of Resistance-Capacity Coupled Amplifiers," S. Harris.
An analysis of the coupling in the resistance-capacity coupled amplifier is given, in which the variation of the voltage ratio with frequency is considered. A method is given for determining the values of the resistances and capacities, for which the variation of the voltage ratio over a given frequency range will be a definite and known amount.

R374.3. Balanced Crystals. Crystals, *Zincite.*
Radio News. Jan., 1927. Pp. 788-ff.
"The 'Singing Crystal'," Dr. J. Pietsch.
The experiments conducted by Doctor Seidl at the University of Vienna with various crystals show that crystals, especially red zinc ore, can be made to oscillate and to give audible sounds. In turn, crystals can be used as microphones. In analyzing the experiments, it is shown that the atmospheric pressure affects the oscillations, as well as the changes in potentials and the pressures applied to the crystal.

R551. Time Signals Broadcast. Time Signals Broadcast.
Radio News. Jan., 1927. Pp. 790-ff.
"Broadcasting Time Signals," S. R. Winters.
A description is given of the automatic time signalling apparatus used by the Bureau of Standards. An accuracy of 0.1 of 1 per cent. is obtained by employing a standard pendulum swinging between a light source and a photo-electric cell, thus avoiding all actual mechanical contact. The impulses are amplified by means of vacuum-tube apparatus.

R553. Meteorological Signals. Weather Map Broadcasting.
Radio News. Jan., 1927. Pp. 791-ff.
"The Broadcasting of Weather Maps by Radio Accomplished," S. R. Winters.
Using the Jenkins system of photographic transmission, the U. S. Weather Bureau, through the Naval Station at Arlington, is broadcasting weather maps directly to ships at sea. The process is outlined, and a description of the apparatus used is given.

R334.3. Transmitting Sets. Transmitters, *Crystal-Controlled.*
QST. Jan., 1927. Pp. 14–18.
"Low-Power Crystal-Controlled Transmitters," J. M. Clayton.
An outline is given of a number of possible circuits that can be used in connection with 160- and 80- meter (1874- and 3748-kc.) crystals. Data are given for the construction of a low-power crystal-controlled transmitter, using two UX-210 tubes, and a.c. for power throughout. The author also gives a circuit using a.c. for the filaments and d.c. for the plate supply. The methods of tuning and making necessary adjustments on each transmitter are outlined in detail.

R330. Electron-Tube Relays. Relays, *Radio Tube.*
QST. Jan., 1927. Pp. 19ff.
"A Direct Radio Control Relay," R. S. Kruse.
A description of a relay tube, with contacts within the vacuum of the tube itself, is given. Use is made of the unequal expansion of two dissimilar metals, which on heating, cause the circuit to close. These relays are said to operate very satisfactorily for: (1) Railway signal and automatic train control purposes; (2) Remote control of lighting circuits; (3) General call signal operation; (4) Demonstrating the dynamic effect of electron bombardment.

R140. Radio Circuits. Armstrong and Miessner Circuits.
QST. Jan., 1927. Pp. 27–31.
"How Our Tube Circuits Work," R. S. Kruse. Part 2.
Continuing the discussion from a previous article (Dec., 1926, pp. 9–13), two more circuits are taken up—the Miessner and the Armstrong. The former circuit is progressively developed, starting with the plate-tickler circuit of the previous discussion. It is stated that both the Miessner and the Hartley circuits cannot be made to oscillate below a certain wavelength limit, because of inherent circuit difficulties. A Miessner circuit is shown which will operate well at 3748 kc. (80 meters).
The Armstrong circuit has a tuned-grid, tuned-plate circuit arrangement, the tube capacity serving in the feedback circuit to maintain oscillations. A practical transmitting circuit is shown.

R343. Electron-Tube Receiving Sets. Receiver, *5-Meter.*
QST. Jan., 1927. Pp. 36–39.
"Five-Meter Receivers," R. S. Kruse.
The writer discusses the operation of a 59,960-kc. (5-meter) receiver which was built after trying out various circuits such as the Hartley, the ultra audion, and the Armstrong. Details on tuning and construction are given.

R134.45. SUPER-REGENERATIVE ACTION. RECEIVER,
QST. Jan., 1927. Pp. 40-43. *Super-Regenerative*.
"A Short-Wave Super-Regenerative Receiver," E. B. Dallin.

Reference is made to the difficulty in regenerative tuning just at the point of oscillation where the sensitivity is greatest. In the super-regenerative receiver the following points are worth mentioning: (1) The tuning control has no effect on beat note or sensitivity; (2) The note control has no effect on tuning or sensitivity; (3) Its sensitivity is either controlled automatically or by another dial.

It is stated that by varying the grid of the detector at a very high frequency—just at the "oscillation point"—it is possible to obtain great amplification on short waves. The modulator frequency depends directly upon the frequency of the incoming wave. The operation of the circuit is fully described, and complete constructional data are presented.

R330. ELECTRON TUBES. UX-213 AND UX-874.
QST. Jan., 1927. Pp. 44-46.
"The UX-213 Rectron and the UX-874 Voltage Regulator," O. W. Pike.

The UX-213, a full-wave rectifier tube, is described, and performance curves are shown. It is rated as a 440-volt tube and will give 65 milliamperes direct current output at 180 volts.

The UX-874 is a regulator tube which is designed to maintain a voltage (90) constant over a certain current range output (10 to 50 milliamperes). The ionized inert gases at low pressure within the tube determine the conduction of current between the electrodes. Constructional data are given for an a.c. operated power-supply device using the above-mentioned tubes.

R144. HIGH-FREQUENCY RESISTANCE. RESISTANCE,
Popular Radio Dec., 1926. Pp. 770-ff. *High-Frequency*.
"How Circuit Resistance Affects Selectivity," G. H. Browning.

The author presents a mathematical and graphical discussion pertaining to the effect of resistance in coils on sharpness of tuning. Six different coils are shown and their characteristics analyzed. The single-layer solenoid coil, space-wound, presents the best all-around characteristics.

R132. AMPLIFYING ACTION OF ELECTRON TUBES. AMPLIFIERS, *Vacuum Tube*.
Proc. I. R. E. Dec., 1926. Pp. 735-757.
"The Output Characteristics of Amplifier Tubes," J. C. Warner and A. V. Loughren.

A review is made of the different methods of using amplifier tubes in radio receiving circuits. The small UX-199 type of tube, the UX-201-A type, and the new so-called "power tube," are compared, their amplification factors being discussed, and their characteristic curves of performance being considered from the standpoint of maximum undistorted output. An appended table gives some of the constants of the more commonly used Radiotrons.

R420. CONTINUOUS-WAVE SYSTEMS. BEAM STATIONS,
RADIO BROADCAST. Feb., 1927. Pp. 351-355. *Short-Wave*.
"Linking Continents with Twenty Kilowatts," K. B. Humphrey.

The advantages of the short-wave beam stations now being used by Britain in linking up with her colonies, as compared to the high-power long-wave stations, are said to be: (1) Much lower cost of equipment; (2) More economical operation and maintenance; (3) Greater sending speed is possible.

Reflectors are used at both the transmitting and receiving ends. The antenna and the reflector wires are arranged so as to constitute grids parallel to each other, the antenna wires being energized simultaneously from the transmitter at a number of feeder points. The directional effect is said to be a function of the dimensions of the system relative to the wavelength utilized. The receivers used are of the super-heterodyne type with two intermediate step-up amplifier frequencies before detection is affected. The location of the present beam stations, and future installations, are listed.

R344.4. SHORT-WAVE GENERATORS. SHORT-WAVE
RADIO BROADCAST. Feb., 1927. TRANSMITTERS.
Pp. 361-364.
"Some Experiments on One Meter," H. E. Rhodes.

The experiments of Mr. J. H. Hallberg with frequencies from 300,000 to 60,000 kilocycles (1 to 5 meters), are described. Details are given explaining how these waves were produced, how they were measured, and what circuits were used in obtaining results. Beam transmission was tried, using different types of reflectors arranged in the form of a parabola. A description is given of the transmitter and receiver, the former being capable of broadcasting microphone-modulated energy.

R140. RADIO CIRCUITS. GRIMES
RADIO BROADCAST. Feb., 1927. INVERSE DUPLEX.
Pp. 365-367.
"Further Notes on the Inverse Duplex System," David Grimes.

This second of a series of articles discusses the importance of good audio amplification and the method used in the Inverse Duplex circuit in obtaining it. The three-stage audio amplifier utilizes a resistance-coupled stage between two transformer-coupled units in order to prevent audio regeneration. It is recommended that a low-ratio transformer follow the detector tube, a high-ratio one being better for the last audio stage. The resistance-coupled stage serves as an efficient audio stage, as a filtered radio-frequency feed-back circuit, and as a choking circuit to prevent the modulation howl. A potentiometer across the secondary of the first audio transformer keeps the audio volume below the choking point so that the last tube may not be overloaded. Data are given on the winding of the r.f. coils used in the circuit.

R142. COUPLED CIRCUITS. COUPLING,
Radio. Nov., 1926. Pp. 36ff. *Loud-Speaker*.
"Coupling the Loud Speaker," A. Hobart.

With the introduction of the new power tubes, which take more plate current, it is necessary to bypass the direct-current component so it will not magnetize the loud speaker beyond its limit. Methods employed are described whereby either a condenser or a transformer may be used. Too much current may also cause burnouts in the windings of the magnet.

R343.5. HETERODYNE ACTION HETERODYNE.
Radio. Nov., 1926. Pp. 35ff.
"Additions to the Shielded Super-Heterodyne," G. M. Best.

Additional information is presented concerning the construction and simplification of control on the shielded super-heterodyne described in detail in the October, 1926 issue of *Radio*, pp. 19ff.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER,
QST. Dec., 1926. Pp. 27-31. *Shielded*.
"Devising a Shielded Receiver Kit," M. Silver and K. Clough.

A shielded receiver, using Silver parts, is described in detail. It is stated that in a three-stage r. f. receiver, the first stage should be tuned separately, the remaining three circuits then being tuned with one control, the component parts of which can be assembled to test within 2 per cent. Oscillations due to a high coefficient of coupling are prevented by individual shielding, using grid resistances in every stage, and by the use of a third winding coupled to the transformer. The antenna stage, the detector stage, and the audio stages are also discussed at some length.

R402. SHORT WAVES. SHORT WAVES.
Transmitter. Nov., 1926. Pp. 10-11. *60,000 kc. (5 meters)*.
"Experiences on 5 Meters," J. K. K. Grindle.

Experiments conducted on 60,000 kc. (5 meters) are discussed, and diagrams of the receiver and transmitter with their constants are shown. It is stated that for best results all measuring instruments should be left out of the transmitter circuit after it is tuned. For an antenna a brass spring was stretched out until the proper length was obtained.

R070. EDUCATION; TRAINING. EDUCATION.
Radio. Nov., 1926. Pp. 20ff.
"What Radio Means Today," E. W. Stone.

Comparing radio engineering with power engineering shows, according to the writer, that much higher requirements are necessary in radio engineering. Commenting on the engineering specifications necessary in designing a radio receiver, the author states that the following points must be considered: (1) Selectivity; (2) Uniform amplification for band between 500 and 1500 kilocycles (600 and 200 meters); (3) Uniform amplification for the entire audio range.

It is pointed out that considerable progress has been made in the application of 60-cycle a. c. toward furnishing power for receivers. Linked with the engineering field are the patent situation, merchandising, and broadcasting, which subjects are treated in a general way.

R384. 1. WAVEMETERS. WAVEMETER,
Radio. Nov., 1926. Pp. 29-30. *Oscillator*.
"A Multi-Purpose Oscillator-Wavemeter." W. H. Stirling.

An oscillator-wavemeter, for purposes of calibrating condensers, receivers, transmitters, wavelength and capacity of antennas, and other tests relative to resonance, is described. Four sets of plug-in coils cover the range from 3750 to 272 kc. (80 to 1100 meters). Circuit diagrams and operating instructions are given.

R201.5. SHIELDING AND GROUNDING. SHIELDING.
Radio. Nov., 1926. Pp. 30-31.
"Shielding," H. M. Bishop.

When shielding is attempted in receivers to prevent external interference, care must be taken to prevent an increase in effective resistance in the circuit, according to the author. Shielding is used to keep out the external electrical disturbances and to confine electromagnetic fields in the set within definite areas.

This paper presents fundamental principles of successful shielding, and gives suggestions as to practical application of the principles outlined.

R148. 1 DISTORTION. DISTORTION,
Radio. Nov., 1926. Pp. 33ff. *B Battery*.
"Effect of B-Battery Impedance on Amplification," J. E. Anderson.

The high a. c. resistance in the B-battery circuit is said to be the cause of considerable distortion, and the remedy is a reduction in impedance. This conclusion is arrived at by mathematical calculations applied first to the two- and the three-stage resistance-coupled amplifier, and secondly to the two- and three-stage transformer-coupled amplifier. It is pointed out why conditions in a two-stage amplifier, as compared to a three-stage amplifier, are quite different, and what troubles are met with when attempting to use more than two stages. Every equation presented is discussed in detail and applied. The information is very complete.

R800 (621.383.21) RELAYS. RELAYS.
QST. Dec., 1926. Pp. 34-36.
"A Break-in Relay," M. S. Brainard.

A relay, with two contacts, one controlling the motor-generator and the filaments, and the other controlling the oscillatory circuit, is described. Details of the assembly, parts, and its operation, are given.

R565. NAVAL RADIO. MARINE RADIO
Radio. Dec., 1926. Pp. 28ff. SETS.
"Modern Practice in Marine Radio," D. B. McGown.

Several improved transmitting sets, as used on shipboard, are presented. The theory, construction, and operation of the following outfits are given: (1) The converted spark set. (2) The Telefunken system (3) the Federal 2-kw. arc set. Circuit diagrams and photographs of each are shown.

R343. ELECTRON-TUBE RECEIVING SETS. RECEIVER,
Radio. Dec., 1926. Pp. 33ff. *Grimes Inverse Duplex*.
"The New Inverse Duplex System," D. Grimes.

The author goes into considerable detail concerning the design of the new Inverse Duplex circuit. The present arrangement comprises four tubes with three stages reflexed. A set, completely assembled, is illustrated.

Employs Q. R. S. Rectifier

The Greene-Brown B-current supply device employs a Q. R. S. rectifying tube and not a Raytheon, as stated in the February RADIO BROADCAST.

(*Continued from page 605*)

At the present time, very little data are available concerning either of these important additions to the tubes now supplied radio users, but a great deal may be promised in the near future.

TUBE TESTER

THE "Universal" tube tester is a combination of two meters, suitable switches, and a tube socket mounted on a metal case, for making tests on vacuum tubes and radio receiver circuits. The milliammeter has a scale reading of 0-15 milliamperes and is suitable for measuring the plate current of a tube. The voltmeter has two scales; one 0-7½ for measuring the filament voltage, and one 0-150 for measuring the plate voltage. A plug, connected with a cord to the tester, can be plugged into any socket in the receiver, and a reading thus taken on a tube placed in the test socket. Provision is made for the different style bases on the tubes by means of adapters. A C battery is incorporated in the tester and this may be connected in series with the grid bias normally on the tube when in the receiver by pushing down the button marked A. This has the effect of increasing the grid bias a definite amount. In testing a tube the milliammeter is first read with the button up giving the regular plate current. The button is then pushed and the milliammeter reading again taken. The difference is noted and then the worth of the tube may be obtained by referring to a table. This table gives figures on the 201-A, 112, 171, 200, 200-A, 199, and 120 type tubes. This is only one of the tests which may be made with this instrument. The plate voltage may be obtained on the tube by means of the voltmeter and if a varying grid voltage is used on the tube, its static characteristic curve may be obtained. In fact any test may be made for which a voltmeter and milliammeter are required. With the plug in the receiver and tube in the test socket, the continuity of the various circuits can be tested. No deflection on the plate voltage instrument would indicate an open circuit either in the B-lead or in the transformer. The voltage readings on the two different scales are obtained by the button to the right marked B in the diagram (up low voltage, and down high voltage). The reversing switch is provided to change over the filament circuit as the receiver may be connected either way.

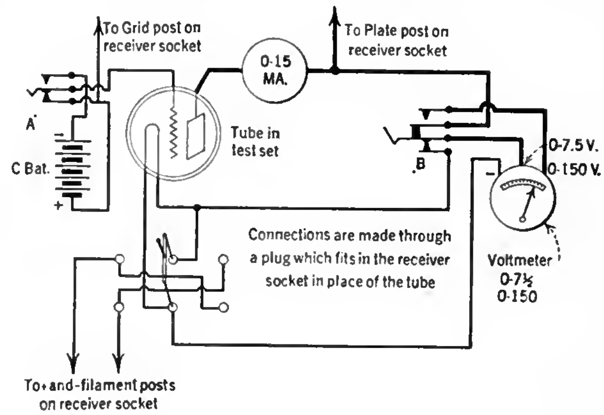


FIG. 3

Here are a few of the tests which can be made on a receiver with the "Universal" tester:

Tests for plate current taken by any given tube while in the receiver circuit.
Tests for open grid circuits.
Voltage test for both A and B batteries.
Location of defective tube sockets.
Defects or open circuits in transformers.
Tests for poorly soldered joints in wiring.
Tests for contacts throughout the circuit.

All of these various tests are elaborated upon in the directions which come with the tester. *Note.* In testing power tubes, too much voltage should not be used as the capacity of the milliammeter is only 15 mils. A diagram of the tester is given in Fig. 3.

Manufactured by the Sterling Manufacturing Company, of Cleveland, Ohio. Universal Tube Tester R-408. Price $22.00.

REGULATOR TUBE

THE model UX-874 Radiotron is a regulating tube used to keep the output of a socket power device at a constant value around 90 volts. It is used in the R. C. A. socket power devices, but may be adapted to almost any socket power device to good advantage where a constant voltage is required over a wide range of loads. The regulator has two elements, an anode and a cathode, surrounded by a mixture of gases. Current conduction is accomplished by the ionization of these gases. The useful property of this tube as a regulator is that, for current through the tube up to maximum of 50 milliamperes, the voltage across it is approximately 90. That is, as the voltage increases, the current through the tube increases in such a way that the voltage is again lowered to the proper point. The device might be likened somewhat to a spillway in which, as the water level increased, the flow increased to such a rate that the level was caused to rise only a very small amount. The cylinder forms the cathode, or negative electrode, and the wire forms the anode, or positive electrode. It should never be operated in the reverse direction, and the amount of current going through it should never exceed 50 milliamperes. A resistance should be included in series with the tube in order to limit the current should the receiving set be turned off. The positive or onode connection to the regulator tube is made to that terminal corresponding to the grid post of the ordinary amplifier tube, and the negative lead is connected to the pin diametrically opposite. The other two

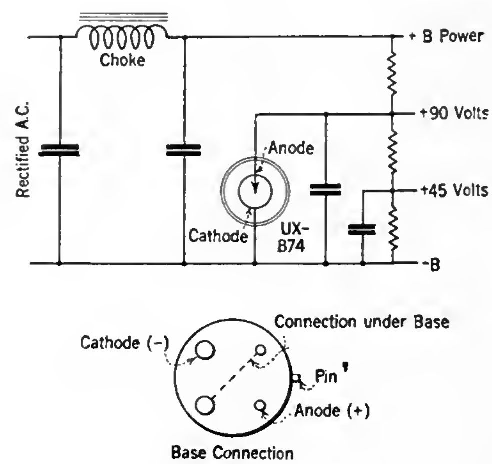


FIG. 4
The connections for an UX-874 voltage regulator tube

pins are connected together through the base, and these two contacts may be connected in the main a. c. line, to open the circuit and prevent a sudden surge in voltage should the regulator tube be removed from the socket. The usual method of connection is shown in the accompanying diagram, Fig. 4. Manufactured by the Radio Corporation of America. Model UX-874. Price $5.50.

Manufacturers' Booklets Available

A Varied List of Books Pertaining to Radio and Allied Subjects Which May Be Obtained Free by Using the Accompanying Coupon

As an additional service to Radio Broadcast *readers, we print below a list of booklets on radio subjects issued by various manufacturers. The publications listed below cover a wide range of subjects, and offer interesting reading to the radio enthusiast. The manufacturers issuing these publications have made great effort to collect interesting and accurate information.* Radio Broadcast *hopes, by listing these publications regularly, to keep its readers in touch with what the manufacturers are doing. Every publication listed below is supplied free. In ordering, the coupon printed on page 512 must be used. Order by number only.*—The Editor.

Parts

1. Filament Control—Problems of filament supply, voltage, regulation, and effect on various circuits. Radiall Company.
2. Hard Rubber Panels—Characteristics and properties of hard rubber as used in radio, with suggestions on how to "work" it. B. F. Goodrich Rubber Company.
3. Transformers—A booklet giving data on input and output transformers. Pacent Electric Company.
4. Resistance-Coupled Amplifiers—A general discussion of resistance coupling with curves and circuit diagrams. Cole Radio Manufacturing Company.
5. Carborundum in Radio—A book giving pertinent data on the crystal as used for detection, with hook-ups, and a section giving information on the use of resistors. The Carborundum Company.
6. B-Eliminator Construction—Constructional data on how to build. American Electric Company.
7. Transformer and Choke-Coupled Amplification—Circuit diagrams and discussion. All-American Radio Corporation.
8. Resistance Units—A data sheet of resistance units and their application. Ward-Leonard Electric Company.
9. Volume Control—A leaflet showing circuits for distortionless control of volume. Central Radio Laboratories.
10. Variable Resistances—As used in various circuits. Central Radio Laboratories.
11. Resistance Coupling—Resistors and their application to audio amplification, with circuit diagrams. DeJur Products Company.
12. Distortion and What Causes It—Hook-ups of resistance-coupled amplifiers with standard circuits. Allen-Bradley Company.
15. B-Eliminator and Power Amplifier—Instructions for assembly and operation using Raytheon tube. General Radio Company.
15a. B-Eliminator and Power Amplifier—Instructions for assembly and operation using an R. C. A. rectifier. General Radio Company.
16. Variable Condensers—A description of the functions and characteristics of variable condensers with curves and specifications for their application to complete receivers. Allen D. Cardwell Manufacturing Company.
17. Bakelite—A description of various uses of bakelite in radio, its manufacture, and its properties. Bakelite Corporation.
19. Power Supply—A discussion on power supply with particular reference to lamp-socket operation. Theory and constructional data for building power supply devices. Acme Apparatus Company.
20. Audio Amplification—A booklet containing data on audio amplification together with hints to the constructor. All-American Radio Corporation.
21. High-Frequency Driver and Short-Wave Wavemeter—Constructional data and application. Burgess Battery Company.
46. Audio Frequency Chokes—A pamphlet showing positions in the circuit where audio frequency chokes may be used. Samson Electric Company.
47. Radio Frequency Chokes—Circuit diagrams illustrating the use of chokes to keep out radio frequency currents from definite points. Samson Electric Company.
48. Transformer and Impedance Data—Tables giving the mechanical and electrical characteristics of transformers and impedances, together with a short description of their use in the circuit. Samson Electric Company.
49. Bypass Condensers—A description of the manufacture of bypass and filter condensers. Leslie F. Muter Company.
50. Audio Manual—Fifty questions which are often asked regarding audio amplification, and their answers. Amertran Sales Company, Incorporated.
51. Short-Wave Receiver—Constructional data on a receiver which, by the substitution of various coils, may be made to tune from a frequency of 16,660 kc. (18 meters) to 1999 kc. (150 meters). Silver-Marshall, Incorporated.
52. Audio Quality—A booklet dealing with audio-frequency amplification of various kinds and the application to well-known circuits. Silver-Marshall, Incorporated.
56. Variable Condensers—A bulletin giving an analysis of various condensers together with their characteristics. General Radio Company.
57. Filter Data—Facts about the filtering of direct current supplied by means of motor-generator outfits used with transmitters. Electric Specialty Company.
59. Resistance Coupling—A booklet giving some general information on the subject of radio and the application of resistors to a circuit. Daven Radio Corporation.
60. Resistors—A pamphlet giving some technical data on resistors which are capable of dissipating considerable energy; also data on the ordinary resistors used in resistance-coupled amplification. The Crescent Radio Supply Company.
62. Radio-Frequency Amplification—Constructional details of a five-tube receiver using a special design of radio-frequency transformer. Camfield Radio Manufacturing Company.
63. Five-Tube Receiver—Constructional data on building a receiver. Aero Products, Incorporated.
64. Amplification Without Distortion—Data and curves illustrating the use of various methods of amplification. Acme Apparatus Company.
65. Radio Handbook—A helpful booklet on the functions, selection, and use of radio apparatus for better reception. Benjamin Electric Manufacturing Company.
66. Super-Heterodyne—Constructional details of a seven-tube set. G. C. Evans Company.
70. Improving the Audio Amplifier—Data on the characteristics of audio transformers, with a circuit diagram showing where chokes, resistors, and condensers can be used. American Transformer Company.
71. Distortionless Amplification—A discussion of the resistance-coupled amplifier used in conjunction with a transformer, impedance, or resistance input stage. Amplifier circuit diagrams and constants are given in detail for the constructor. Amsco Products Incorporated.
72. Plate Supply System—A wiring diagram and layout plan for a plate supply system to be used with a power amplifier. Complete directions for wiring are given. Amertran Sales Company.
80. Five-Tube Receiver—Data are given for the construction of a five-tube tuned radio-frequency receiver. Complete instructions, list of parts, circuit diagram, and template are given. All American Radio Corporation.
81. Better Tuning—A booklet giving much general information on the subject of radio reception with specific illustrations. Primarily for the non-technical home constructor. Bremer-Tully Manufacturing Company.
82. Six-Tube Receiver—A booklet containing photographs, instructions, and diagrams for building a six-tube shielded receiver. Silver-Marshall, Incorporated.
83. Socket Power Device—A list of parts, diagrams, and templates for the construction and assembly of socket power devices. Jefferson Electric Manufacturing Company.
84. Five-Tube Equamatic—Panel layout, circuit diagrams, and instructions for building a five tube receiver, together with data on the operation of tuned radio-frequency transformers of special design. Karas Electric Company.
85. Filter—Data on a high capacity electrolytic condenser used in filter circuits in connection with A-socket power supply units, is given in a pamphlet. The Abox Company.

Accessories

22. A Primer of Electricity—Fundamentals of electricity with special reference to the application of dry cells to radio and other uses. Constructional data on buzzers, automatic switches, alarms, etc. National Carbon Company.
23. Automatic Relay Connections—A data sheet showing how a relay may be used to control A and B circuits. Yaxley Manufacturing Company.
25. Electrolytic Rectifier—Technical data on a new type of rectifier with operating curves. Kodel Radio Corporation.
26. Dry Cells for Transmitters—Actual tests given, well illustrated with curves showing exactly what may be expected of this type of B power. Burgess Battery Company.
27. Dry-Cell Battery Capacities for Radio Transmitters—Characteristic curves and data on discharge tests. Burgess Battery Company.
28. B Battery Life—Battery life curves with general curves on tube characteristics. Burgess Battery Company.
29. How to Make Your Set Work Better—A non-technical discussion of general radio subjects with hints on how reception may be bettered by using the right tubes. United Radio and Electric Corporation.
30. Tube Characteristics—A data sheet giving constants of tubes. C. E. Manufacturing Company.
31. Functions of the Loud Speaker—A short, non-technical general article on loud speakers. Amplion Corporation of America.
32. Meters for Radio—A catalogue of meters used in radio with connecting diagrams. Burton-Rogers Company.
33. Switchboard and Portable Meters—A booklet giving dimensions, specifications, and shunts used with various meters. Burton-Rogers Company.
34. Cost of B Batteries—An interesting discussion of the relative merits of various sources of B supply. Hartford Battery Manufacturing Company.

35. Storage Battery Operation—An illustrated booklet on the care and operation of the storage battery. General Lead Batteries Company.
36. Charging A and B Batteries—Various ways of connecting up batteries for charging purposes. Westinghouse Union Battery Company.
37. Choosing the Right Radio Battery—Advice on what dry cell battery to use; their application to radio, with wiring diagrams. National Carbon Company.
53. Tube Reactivator—Information on the care of vacuum tubes, with notes on how and when they should be reactivated. The Sterling Manufacturing Company.
54. Arresters—Mechanical details and principles of the vacuum type of arrester. National Electric Specialty Company.
55. Capacity Connector—Description of a new device for connecting up the various parts of a receiving set, and at the same time providing bypass condensers between the leads. Kurz-Kasch Company.
61. Dry Cells—Information on the construction and operation of dry cells with a description of the methods used in testing them. The Carbon Products Company.
68. Chemical Rectifier—Details of assembly, with wiring diagrams, showing how to use a chemical rectifier for charging batteries. Cleveland Engineering Laboratories Company.
69. Vacuum Tubes—A booklet giving the characteristics of the various tube types with a short description of where they may be used in the circuit. Radio Corporation of America.
77. Tubes—A booklet for the beginner who is interested in vacuum tubes. A non-technical consideration of the various elements in the tube as well as their position in the receiver. Cleartron Vacuum Tube Company.

Miscellaneous

38. Log Sheet—A list of broadcasting stations with columns for marking down dial settings. U. S. L. Radio, Incorporated.
39. Behind the Scenes in a Broadcasting Station—Operation in general, and specific facts about wkrc. Kodel Radio Corporation.
40. Static—A brief discussion of the disturbances which may cause trouble in a receiver. Sun Manufacturing Company.
41. Baby Radio Transmitter of 9xh-9ek—Description and circuit diagrams of dry-cell operated transmitter. Burgess Battery Company.
42. Arctic Radio Equipment—Description and circuit details of short-wave receiver and transmitter used in Arctic exploration. Burgess Battery Company.
43. Short-Wave Receiver of 9xh-9ek—Complete directions for assembly and operation of the receiver. Burgess Battery Company.
44. Aluminum for Radio—A booklet containing much radio information with hook-ups of basic circuits, with inductance-capacity tables and other pertinent data. Aluminum Company of America.
45. Shielding—A discussion on the application of shielding in radio circuits with special data on aluminum shields. Aluminum Company of America.
58. How to Select a Receiver—A common sense booklet describing what a radio set is, and what you should expect from it, in language that any one can understand. Day-Fan Electric Company.
67. Weather for Radio—A very interesting booklet on the relationship between weather and radio reception, with maps and data on forecasting the probable results. Taylor Instrument Companies.
73. Radio Simplified—A non-technical booklet giving pertinent data on various radio subjects. Of especial interest to the beginner and set owner. Crosley Radio Corporation.
74. The Experimenter—A monthly publication which gives technical facts, valuable tables, and pertinent information on various radio subjects. Interesting to the experimenter and to the technical radio man. General Radio Company.
75. For the Listener—General suggestions for the selecting, and the care of radio receivers. Valley Electric Company.
76. Radio Instruments—A description of various meters used in radio and electrical circuits together with a short discussion of their uses. Jewell Electrical Instrument Company.
78. Electrical Troubles—A pamphlet describing the use of electrical testing instruments in automotive work combined with a description of the cadmium test for storage batteries. Of interest to the owner of storage batteries. Burton Rogers Company.
79. Insulation—A comprehensive book giving valuable information on all types of insulating material used in electrical work. More for the technical man than for the average set owner. Mitchell-Rand Manufacturing Company.

USE THIS COUPON

Radio Broadcast Service Department
Radio Broadcast, *Garden City, New York.*
Please send me (at no expense) the following booklets indicated by numbers in the published list

. . . .

. . . .

. . . .

. . . .

Name . . . .

Address . . . .
(*Number*) (*Street*)

. . . .
(*City*) (*State*)

ORDER BY NUMBER ONLY
This coupon must accompany every request. RB 427

Book Review

Resistance in Radio

How to Use Resistance in Radio: *Published by the Ward Leonard Electric Company, Mount Vernon, New York. 31 pages. Numerous diagrams. Price 15 cents.*

WHEN engineers first began to specify fixed resistance units in radio circuits, considerable trouble was experienced by the radio set manufacturer and home-constructor in obtaining them. The most consistent source of trouble in the earlier types was their low current-carrying capacity, or in other words, their inability to dissipate sufficient energy. This was particularly true of the high-resistance units used in socket power devices. This book takes up the development, the design, the manufacture, and the application of wire-wound "Vitrohm" resistors. These resistors are designed to dissipate the required number of watts without overheating and consequent burn-outs. Circuit diagrams are given showing their uses in socket power units for A, B, and C current, direct-current battery chargers, 32-volt direct-current A supply units, a.c. trickle chargers, and other special units. Methods are given for calculating the correct value of resistor needed for different circuits and of safe carrying capacity. In all, it is an interesting booklet which should be in the hands of every set builder, experimenter and manufacturer who is interested in socket power devices or other apparatus using high resistances.

K. B. H.

Uses of the Fixed Condenser

Seventeen Ways to Improve Your Set: *Published by the Dubilier Condenser Corporation. 32 pages with circuit diagrams. Price 10 cents.*

THE small fixed condenser is an indispensable unit in any modern radio receiver. Consequently, an authoritative book which gives information on when, how, where, and why they are used, naturally holds a good deal of interesting material for the experimenter and the home-constructor. Many of us know quite a few uses of the fixed condenser, but it is extremely doubtful if all their uses could be named without hesitation. Among some of the uses given and explained with suitable diagrams are: Tuning a circuit to resonance; blocking direct current; bypassing radio- and audio-frequency currents; smoothing out pulsating currents in filter circuits, and many other uses. Each one of the seventeen points given specifies where the condenser should be placed in the circuit, its value, and its functions. Methods of testing and calculating the values of condensers are also given. This booklet is of especial interest to the non-technical set constructor who wishes to get the best possible results from his radio receiver.

K. B. H.

The Amateur's Vade Mecum

Radio Amateur's Handbook: *By Francis Edward Handy. Published by the American Radio Relay League, Hartford, Connecticut. 178 pages. Fully illustrated. Price, $1.00.*

FOR some time the American Radio Relay League, Incorporated, of Hartford, has been threatening, and promising, to produce a book for the amateur, one that will tell him what, how, and when. At last the book has appeared under the name of the *Radio Amateur's Handbook* and from the pen of Communications Manager Handy. The book should be in every amateur's library.

For the freshmen in this democratic fraternity of brass pounders there are many pages, and for the well initiated owners of keys and tubes there are methods of controlling transmitters by quartz crystals.

The well-known Hartley circuit seems to be the one under the glass case at Hartford, for very little is said about others—especially the "tuned plate-tuned grid," which is reputed to be more efficient than the Hartley. But in spite of this small deficiency, there is dope galore on the code, the communication laws, and a great deal of information that an amateur somehow can't find in other books.

It is to be hoped that Stuart Ballantine's book, *Wireless Telephony for Amateurs,* will some day be brought up to date, for there is technical data here that is difficult to find elsewhere; chiefly because Ballantine used reason in his deductions and not trial-and-error methods that most amateurs follow. But, until this book appears in new form, and with new data on tube circuits and all that is now used in amateur stations, the Handy handbook will be a *vade mecum* for all amateurs.

KEITH HENNEY.

Non-Technical Radio

THE RADIO KEY BOOK: *By E. N. Rauland in collaboration with Harry K. Randall. Published by the author, Chicago, Illinois. 48 pages. Numerous illustrations and diagrams. Price 10 cents.*

THE home-constructor who has had some radio experience, and has some idea of the terminology used in the subject, is often up against it for a simple explanation of the various phenomena encountered in this ever fascinating subject. For him especially, and for the person who likes to know the why and wherefore of things, this book can be recommended. Perhaps the best way to give an idea of the contents is to outline the subject matter chapter by chapter. The first chapter takes up the things every listener should know, and outlines just what takes place from the time the signal starts out in the form of sound waves at the broadcasting studio until it is received by the listener in his home. Chapter II takes up the new things in radio, especial attention being given to the quality of the received music or speech. Chapter III gives a list of the parts used in a typical receiver together with an explanation of their functions. Chapter IV is entitled "Hook-Ups and How to Read Them." Chapter V gives some practical hints on servicing and "trouble shooting," together with notes on building receivers and other apparatus. Chapter VI is a review of some outstanding circuits which have been developed lately, together with diagrams, lists of parts, and photographs of the finished receivers.

K. B. H.

TECHNICAL INFORMATION INQUIRY BLANK

Technical Service,
RADIO BROADCAST Laboratory,
Garden City, New York

GENTLEMEN:

Please give me fullest information on the attached questions. I enclose a stamped addressed envelope.

☐ I am a subscriber to RADIO BROADCAST, and therefore will receive this information free of charge.

☐ I am not a subscriber and enclose $1 to cover cost of the answer.

Name..................................

Address..................................

R. B. A.

WHAT OUR READERS WRITE

Was Marconi First?

THE letter below disputes with much emphasis the often-made statements to the effect that Marconi should be given full credit for the invention of radio. This is such a touchy question that we would not dare to attempt a verbose argument at this point with so little space available. However, we do think that many readers who have not a copy of the July, 1926, RADIO BROADCAST at hand, will be interested in the following sentences quoted from a letter which appeared in that issue, and which was from the pen of M. E. Packman, vice-president of Dodge's Telegraph, Railway Accounting, and Radio (Wireless) Institute, of Valparaiso, Indiana:

Very recently a claim has been put forward by the Russian Soviet to the effect that Prof. Alexander Popoff was the inventor of wireless telegraphy. In an interview relative to this, Marconi stated, "The Soviet's claim was never once put forward by Professor Popoff himself. When I was in Petrograd in 1902, Popoff sent me a telegram—'Greetings to the father of wireless.'"

The following is the letter championing the cause of Professor Popoff:

PROFESSOR A. S. POPOFF

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

As a frequent reader of RADIO BROADCAST, may I not correct the impression received by many of your readers from some of your recent articles, namely, that Senatore Marconi is the undisputed father of practical wireless telegraphy.

While it is not generally known, it is nevertheless true that at least several authorities on the history of radio development attribute the honor of being the first inventor of wireless telegraphy to the late Professor A. S. Popoff of Russia, rather than to Senatore Marconi, who, according to the majority of radio historians and the general public, should be given credit for the first practical system of wireless telegraphy.

Popoff started to experiment upon wireless in 1894, sometime after the English physicist Lodge had announced the results of his experiments with the then newly invented coherer. Professor Popoff, in an attempt to repeat certain of Lodge's as well as Hertz's experiments, had struck upon the idea of coupling an antenna and ground to the coherer so that it might be more sensitive to static discharges, since this was the purpose of Popoff's first wireless installations.

According to material recently published in the *Telefonia Telegrafia Bez Pravodov*, a contemporary Russian radio publication, Popoff made public his first wireless installation as early as May 7, 1895. On that date, according to the above publication, in a paper presented before the Russian Physical and Chemical Society, Professor Popoff among other things said: ". . . I want to express my belief that my apparatus, when duly developed and perfected, could be made use of for the transmission of signals at a distance by means of high frequency electromagnetic oscillations, once a source of such oscillations shall have been found."

By March, 1896, Professor Popoff already had found such a source of electromagnetic oscillations, and on the 24th of that month had demonstrated working models of a wireless transmitter and receiver.

Professor Wallson, an eye-witness of the above demonstrations has the following to say: ". . . From your letter I find that you are interested in the details of the meeting of the Russian Physical Society during which A. S. Popoff had first demonstrated his methods of wireless communication. I was present at that meeting and remember all of the attendant details. The transmitter was located in the Chemical Institute of the University, while the receiving arrangement was placed in the auditorium of the old physical laboratory, a distance of about 250 meters. The letters were transmitted according to the Morse code and each signal was plainly audible.

"By the blackboard was standing Professor F. F. Petrushevsky, who was president of the Physical Society. In one hand he held a copy of the Morse code and in the other a piece of chalk. After every transmitted signal he looked into the code paper and then marked upon the blackboard the corresponding letters. These letters he wrote down in the Latin type, and after the demonstration had been finished, we could read the words 'Heinrich Hertz'. It is difficult to describe the enthusiasm of all those present and the ovation that Professor Popoff received when those two words were written. The meeting took place in the beginning of 1896. I do not, however, remember the exact date."

Very truly yours,
BORIS S. NAIMARK,
New York City.

Radio Conditions Forecast

THE time is near at hand, we prophesy, when we shall pick up our paper of a morning with the specific purpose of learning whether or not radio conditions will be favorable enough to ask Smith in this evening to listen to our four-tuber pulling in the DX. Just as of yore we glanced at the weather prophet's prognostications for the day with the object of making a decision regarding the advisability of wearing rubbers to the office, we now shall glance at the radio conditions paragraph to learn whether fading is going to spoil reception from that elusive distant station to-night. Had we picked up a recent copy of the Milwaukee *Journal*, we should have noticed the following in the meteorological department:

> *Journal's* radio forecast: Good volume and distance to the East Monday night; poor distance and probably fading

South; probably poor distance West and Southwest.

Apropos this new policy of the *Journal's* to include a radio weather report in its columns, the following letter comes to RADIO BROADCAST:

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

SIR:

Since the first of December, 1926, the Milwaukee *Journal* has been publishing a regular daily forecast of radio weather. The radio forecast is incorporated with the weather report printed on the first page of the daily and Sunday editions.

The reports are based on analysis of the weather map and forecast after the method set forth in Mr. Eugene Van Cleef's article, "How a Low Barometer Affects Radio" and the summary of Mr. Van Cleef's article of May 1925, both of which appeared in the December, 1926 RADIO BROADCAST.

In the five days this service has been in effect (at the time of writing), the prognostications all have been fairly accurate. The *Journal* feels this to be of interest to you, for Mr. Van Cleef's article in your magazine led us to the action, and gives us the information upon which to base our forecasts.

Needless to say, RADIO BROADCAST is the Bible of the *Journal's* radio department.

Very truly yours,
ANDREW HERTEL, Radio Editor,
The Milwaukee *Journal*.

Ware the Cut Rate Wholesaler

MOST radio retailers, we believe, realize the logic of obtaining their goods from legitimate jobbers or direct from the manufacturers. The "gyp" wholesaler, nevertheless, is still in the market with attractive propositions, tempting discounts, and what not.

THE MERWIN COMPANY
RADIO LABORATORY BRANCH
JENSEN, FLORIDA

Editor, RADIO BROADCAST,
Doubleday, Page & Company,
Garden City, New York.

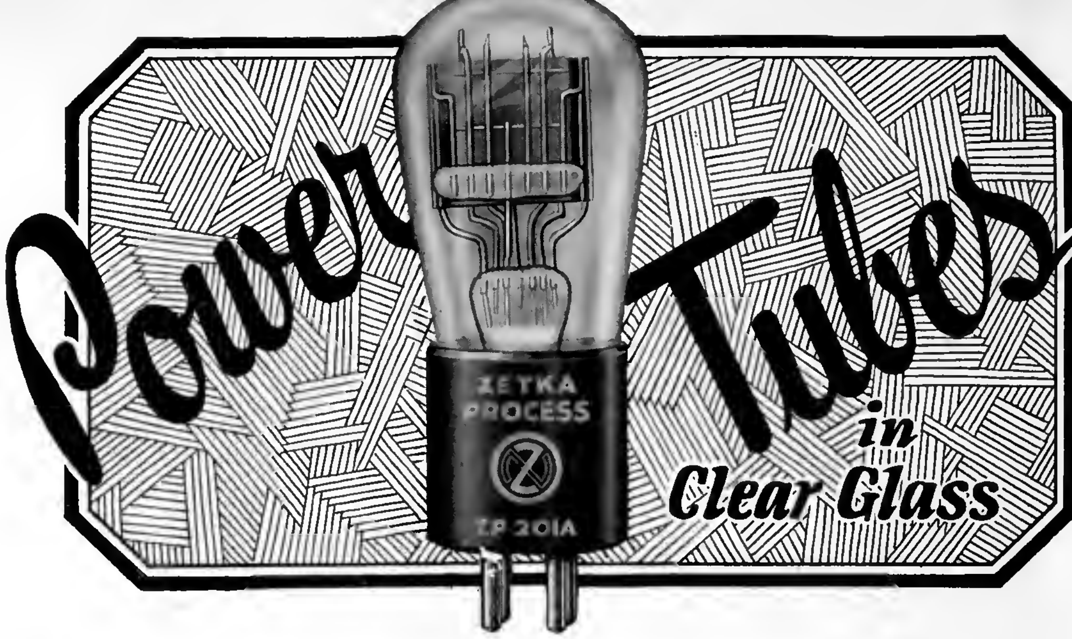
SIR:

I would like to see a paragraph in your magazine protesting against the activities of the cut rate wholesale houses as a warning to retailers who deal with them.

They simply flood the country with catalogues, and sell indiscriminately to private individuals who slip around to the printer for letterheads and call themselves dealers. The legitimate dealer is misled by seeing some standard articles listed along with the trash then sends in an order and gets substitutes "of equally good value." His money is lost, for these unprincipled wholesalers make it impossible to get your money back. It didn't cost us very much to learn this. When we hear of a new piece of apparatus we look for its advertisement in a reliable radio magazine, such as RADIO BROADCAST. If we find the advertisement we write the manufacturer to put us in touch with his distributor. We then play safe. If everybody would do this we would have less "gyp" wholesalers.

We note with pleasure your recent attack on the storage battery situation. The stand you take is splendid.

Very truly yours,
W. HARVEY MERWIN.



* Look for the Blue and Orange Box

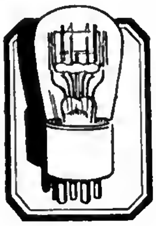
Announcing the new
ZETKA PROCESS
201A POWER TUBE

Zetka Laboratories announce the creation of one of the most remarkable contributions to radio . . . an oxide coated, quarter ampere *clear glass* 201 A *power tube*.

This new tube assures almost unbelievable volume, with perfect preservation of natural tone. No bellow or blast. Full, round, accurate recreation. The ZP 201 A was especially designed for use in all stages served by the regular 201 A type tube, giving the unique result of "*a power tube in every stage*". . . a long-life power tube costing you but $2.50 instead of $4.50.

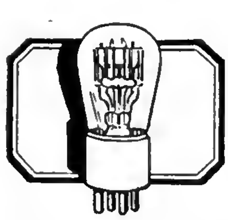
Clear glass *Zetka Process Tubes, made in all standard types, require no rejuvenation—are "*new*" tubes during their entire life. See your nearest Zetka dealer about the new ZP 201 A, then hear what a world of difference it really makes . . . how it brings your old set right up to date, *and perfection!* Clear glass identifies them.

Your set deserves this finer equipment. Prices no higher.



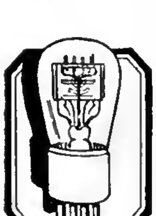
Z 171

A specially designed superior power amplifier. Plate voltage up to 180 volts.



Z 112

Another exceptiona. power tube for voltages up to 135 volts. Designed for superpower performance.



Z 200 A

A super-sensitive ¼ amp. oxide filament detector. Absolutely quiet, extremely sensitive, longer lived.

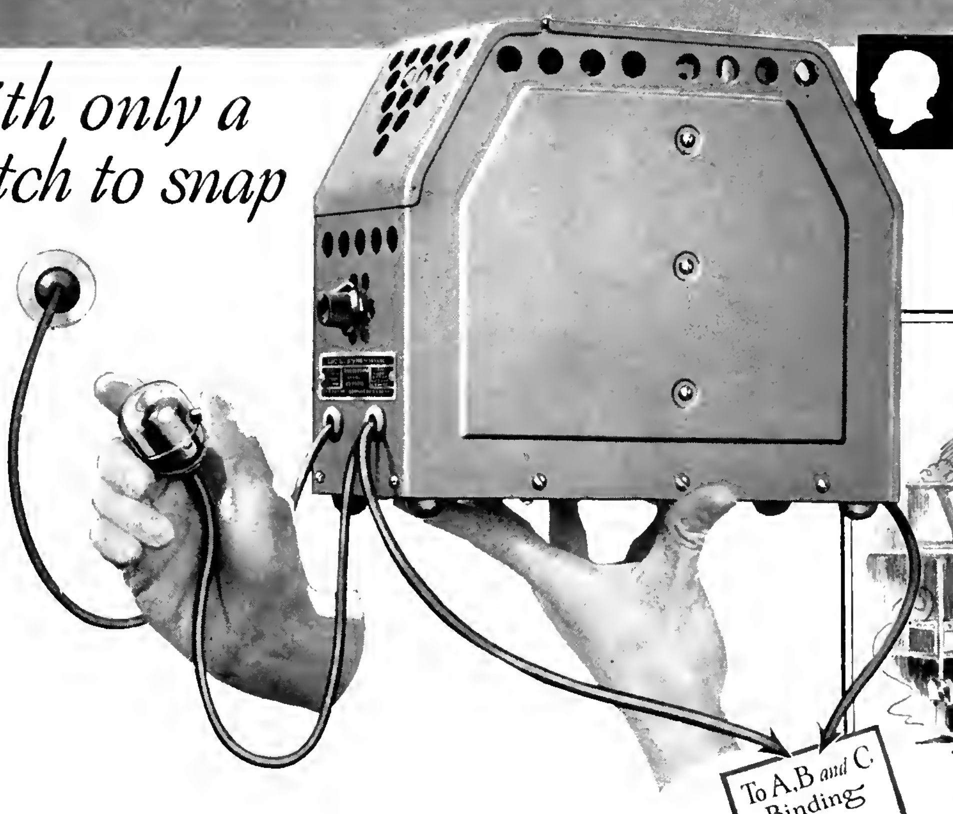
ZETKA
The *Clear Glass* Tube

ZETKA LABORATORIES, Inc.
73 WINTHROP STREET NEWARK, N. J.

Long prophesied
Often attempted
Makeshifts frequently employed
Here at last!

CROSLEY
Radio Energy

with only a switch to snap



A B and C Radio Power

from house current outlet direct into the radio with no more attention or thought than you bestow on a vacuum cleaner or your electric iron.

This wonder box weighs only 13 lbs., stands 9 inches high and is 4 inches wide, and is about half the size of an ordinary A storage battery. It is a mechanical device transforming ordinary 110 volt, 60 cycle house power into smooth, quiet radio energy for the new Crosley radios without slightest interfering hum and with the certainty of an electric motor.

PRICE $50.

Crosley radios designed for use with this marvelous power supply are the AC-7, a 6-tube table model at $70, and the AC-7-C, a 6-tube console at $95. See these wonderful, sets at any Crosley dealers, or write Dept. 20 for descriptive literature.

Crosley sets are licensed under Armstrong U. S. Patent No. 1,113,149, or under patent applications of Radio Frequency Laboratories, Inc., and other patents issued and pending. Prices slightly higher west of the Rocky Mountains.

The CROSLEY RADIO CORPORATION
Powel Crosley, Jr., Pres. Cincinnati, O.

No more batteries to fuss with.

No more batteries or battery charger to water.

No failure of the power plant just as you sit down to a fine program.

No batteries to recharge.

No batteries to renew.

No apologies to make to callers because "the batteries must be getting low."

No upsetting the house to have the radio serviced.

NO MORE annoyances from the vital power supply end of the radio. A snap of the switch is the only demand your radio makes upon you from NOW ON.

THE COUNTRY LIFE PRESS, GARDEN CITY, NEW YORK