RADIO BROADCAST

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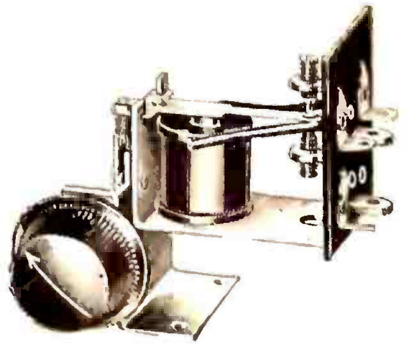

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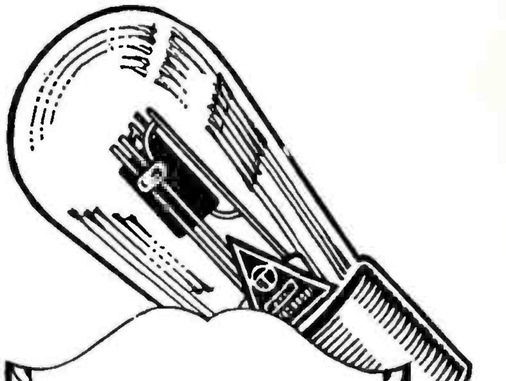

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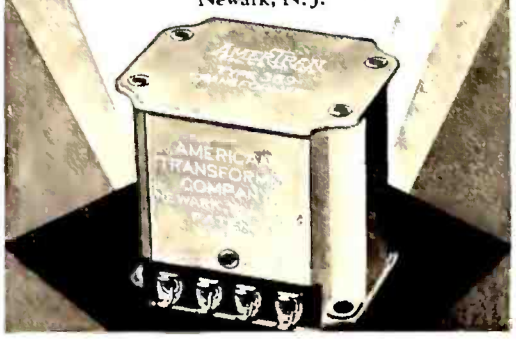

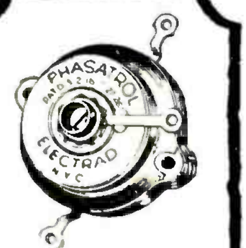

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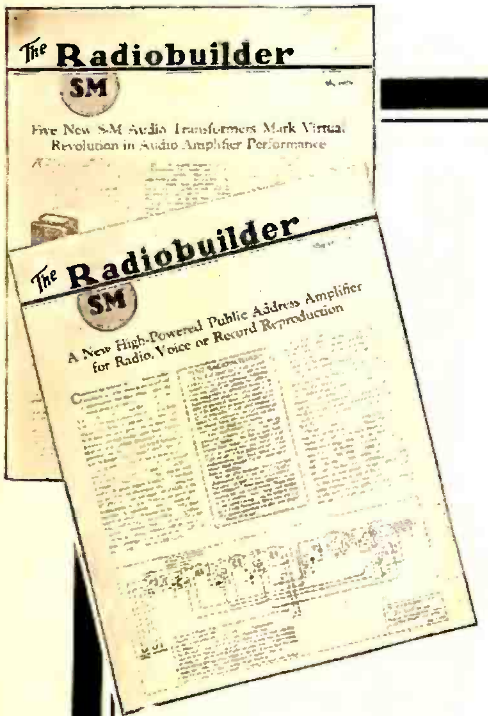

Are you receiving THE RADIOBUILDER *regularly? This little house magazine is printed occasionally to provide you with new and advance information on forthcoming S-M developments, and to pass along operating hints and kinks that will help you to get the most out of radio building. Issues, numbers one and two, pictured above are good examples of what* THE RADIOBUILDER *contains—a practical description of the first light socket public address amplifier available for home construction, and the inside; advance story on the practical phases of the new Clough audio system. with all curves.*

THE RADIOBUILDER *is newsy, and timely, and, above all, it is the condensed, monthly key to all the detailed constructional data you desire, for in it are listed and previewed all new* S M DATA SHEETS *each of which can be had for a two cent stamp.*

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And S-M will lead again in 1928 and 1929 by giving you new developments that enable made-to-order or home-built radio sets to equal in external finish the finest factory productions, parts that place the performance of such sets utterly beyond competition, and, thru knock-down kits, radio receivers that will consistently and positively outperform all ready-made sets at anywhere near their amazingly low prices.

New S-M Offerings

The 720 Screen Grid Six, a six-tube dual control screen grid receiver kit at $69.75 complete with all-metal assembly, individual stage shielding, and averaging 10 KC selectivity against powerful locals—a set that brings in forty to a hundred stations in one evening. This set can be had for A.C. operation at $74.00 for 171, 210 or 250 power tubes.

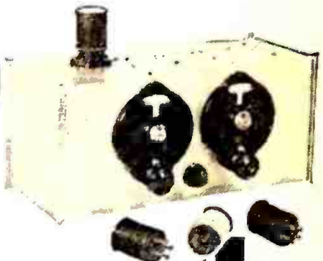
And at $49.75 S-M offers the 740 "Coast to Coast" Screen Grid Four—a kit that is a revelation in four-tube results. Type 700 metal shielding cabinet as illustrated is but $8.50 additional, for either set, finished in attractive duo tone brown. It gives to each a new standard of style and distinction.

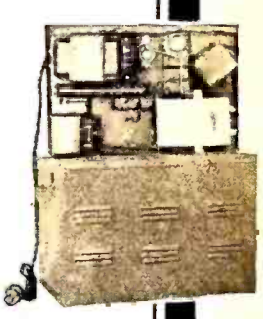
The Sargent-Rayment Screen Grid Six, type 710, is the wonder set of the season, and S-M offers, exclusively, the approved kit at $120.00. It is complete with aluminum shielding cabinet and will bring in 100 stations on any average evening.

The S-M "Round the World" Short Wave sets are the trimmest, most efficient short wave sets yet, priced from $36.00 to $51.00 complete with shielding cabinet. New S-M condensers are marvels of rigidity and flexibility in Universal single, and triple types. The 685 Public Address Unipac—the first really high-powered amplifier yet offered—is priced at only $160 wired, or $124 for the kit. It will turn out music or voice that can be heard by 1000 to 10,000 people.

Of course, the most startling audio development of the last two years would logically come from S-M laboratories, as it did two years ago. The new Clough audio transformers have been deservedly the sensation of the June radio trade show. In open comparative tests S-M 255 and 256, $6.00 transformers have excelled the performance of all competitive types tested, regardless of cost. The 225 and 226 transformers at $9.00 each simply leave the most skeptical marveling.

These and many other startling new S-M parts leave small wonder at S-M leadership. They prove that *you* can get the best radio for the least cost from S-M.





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RADIO BROADCAST

AUGUST, 1928

WILLIS KINGSLEY WING, Editor

KEITH HENNEY
Director of the Laboratory

EDGAR H. FELIX
Contributing Editor

Vol. XIII. No. 4

CONTENTS

The contents of this magazine is indexed in *The Readers' Guide to Periodical Literature*, which is on file at all public libraries.

AMONG OTHER THINGS. .

TELEVISION, for the moment, appears to be drawing perhaps more than its just share of attention. Our leading article in the July number explained some of the most serious limitations of television systems and pointed out the greatest obstacles which are yet to be overcome. In this issue, Mr. Clarkson discusses the results which can be had from some of the systems which may be before the public. If RADIO BROADCAST does not rush into print with "constructional" articles on television sets, our readers may forgive us. We strongly doubt that even the most enthusiastic of experimenters will be content with the results he can achieve from the transmissions now taking place. Television, we fear, is now rather a glittering idea than an accomplished fact. As the apparatus made available to the experimenter improves, we shall publish instructions on how to use it. It should be noted that the transmission of television signals on broadcast frequencies now seems to offer definite limitations in quality. The short waves—already nearly overcrowded with other services—offer the only possibility, both in still and motion picture transmissions, for improved quality (unless some new system is developed), and it is our belief that they should be employed at the start of our technical gropings in this field.

ONE hears the argument that if only the experimenter is permitted to investigate television—and still picture transmission—the play of his ideas will hasten the day when seeing by radio at a distance is general. It is certain that almost everyone, except those who are technically informed, feels that radio motion pictures, in sufficient detail and size to be comparable with good fidelity and volume in broadcast reception, are shortly to be attained. Attained in some mysterious way, like the radio transmission of power, for example. Television apparatus thus far shown is little more than a laboratory toy, remarkable perhaps, but still a toy. And, while the tightly closed doors of large laboratories may even now contain experimental secrets which will in time smooth the way, so far as the published facts go, television is still a laboratory matter.

THE Trade Show recently concluded at Chicago offered nothing startling. The complete sets presented showed some features of interesting design—a six-tube battery operated set consuming 8 mA. in plate current, for example. There was no great stir over automatic or semi-automatic tuning control as offered in some receivers. The parts and accessories presented were of better design and were lower in price. It is quite apparent that the set builder in the coming season can choose from highly satisfactory apparatus, can assemble it at a low cost, and the result will be not only a good-looking set of fine performance, but one which will compare favorably in cost with completely assembled sets. Every maker, it seems, has a dynamic type loud speaker, many of which are excellent.

A REGRETTABLE error occurred on page 128 of the July number of RADIO BROADCAST, in the article, "What Hope for Real Television?" The captions for the two diagrams on this page were reversed. The diagram at the upper left is the Clarkson television camera, and that at the lower right the television projector.

—WILLIS KINGSLEY WING.

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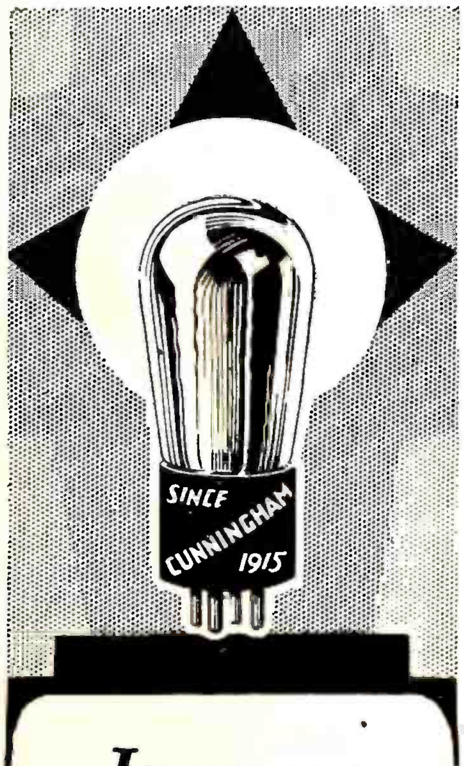

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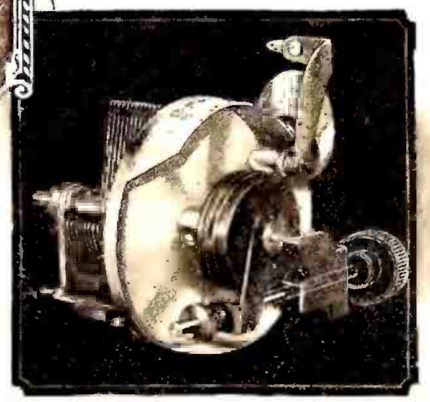

Back View
Note position of the Control Knob. By using a Condenser Shaft of suitable length, the Control Knob may be placed at any desired distance from the dial, thus giving a pleasing balance to the front of the panel.

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Radio Brings the Stock Exchange to the Wilderness

At Bow Lake, in the Canadian Rockies, the portable receiver carried by Lewis R. Freeman, on the Harmon-Freeman Expedition of 1924, brought in United States and Canadian stations from coast to coast. This picture shows Mr. Freeman typing off the broadcast quotations from the San Francisco Stock Exchange. On one occasion, when these quotations indicated a movement in a certain stock, Mr. Freeman sent an order to his broker by carrier pigeon which resulted in a substantial profit. The portable set used, though it was banged about and even submerged in water on occasions, functioned admirably for the whole trip.

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HE PLANS TELEVISION FOR WRNY

Theodor Nakken is shown here with a television receiver designed to receive the television broadcasts from WRNY. *The Nipkow disc and its driving motor are set at an angle, and the sloping panel which covers the front of the receiver has a small window through which the images are viewed.*

What Can We See By Radio?

By R. P. Clarkson

Author of "The Hysterical Background of Radio"

MORE and more the most enthusiastic radio fans are wondering what all the shooting is about. They realize that rue television is not here but it is apparent that something is happening. Just what is being done, how it is being done, and what any fan can do to be "in the swim" is the purpose of this article in RADIO BROADCAST.

First of all, the fan will come to realize that he aces a new handicap. He has been used to twirling the dials and getting one program as easily as nother. The set that reproduces any music from WGY will also give any music played at WRNY. Now, he is to find that while he may tune-in on the pictures from either station, the television receiver which works on WGY's experiment won't do a thing on WRNY, and vice versa. This, it seems to many of us, is particularly unfortunate at the beginning of the new pastime, particularly as there is no reason for this condition except the whim of the sender or the desire of the manufacturer to be exclusive.

The heart of all present television devices is the Nipkow disc, which dates back to 1884. It is a rotating plate with a series of spirally arranged holes; aluminum is the material generally used for the disc. The speed of the disc is always determined by the number of pictures sent per second. This speed is capable of variation, of course, because the disc is driven by an electric motor and the motor speed can always be changed. In the commercial devices I have seen, however, there is no provision made for any considerable speed change. The fan who builds his own device can insert a speed control to advantage.

A PICTURE $1\frac{1}{4}$ INCHES SQUARE

NOW, as to the size of the picture, nobody needs to ask what size is being transmitted. It makes no difference to the receiver so long as the picture is square. Your receiving projector can be arranged to give you any size your heart desires, *limited only by the size of the illuminated plate in the neon receiving lamp*. The Raytheon type of neon lamp with $1\frac{1}{2}''$ plates will safely cover a picture image $1\frac{1}{4}''$ square. Probably no manufacturer will go much larger. Commercial receivers now planned are of that size or smaller, although at least one will put a magnifying lens in front of the viewing plate. This will enlarge the image and decrease the quality but make the picture more easily seen by a group.

While the plate of the neon tube will absolutely limit the maximum picture size you can *get*, the spacing of the holes in the spiral disc and the pitch of the spiral will determine what size picture is actually *projected* at the receiving end. That is, if the holes are spaced one inch apart and the inner hole is one inch nearer the center of the disc than the outer hole, your picture will be one inch square. The spacing of the holes determines the width of the picture. The pitch of the spiral determines the depth of the picture. The size of the holes themselves is automatically determined by the size of the picture you want and the number of "lines" to the picture. Divide the depth of the picture by the number of lines transmitted and the result will be the diameter of the holes. Preferably, they will be a few thousandths of an inch larger than this calculation gives, so that each line will overlap the preceding one very slightly.

These technical details are all that distinguish one apparatus from another. First, the speed of the disc, which must turn each second the same number of times as there are pictures per second transmitted. Second, the number of holes in the spiral, which must be equal to the number of lines per picture transmitted. These two facts must be known, and undoubtedly will be published by each station as it takes up television transmitting. At present, WGY sends 24 lines per picture and 21 pictures per second. WRNY will send 36 lines per picture and 10 pictures per second. Hence, the speed for a disc to receive WGY must be 21 revolutions per second or 1260 r.p.m. For the Nakken pictures from WRNY there must be a disc speed of 10 revolutions per second or 600 r.p.m. On the other hand the WGY disc will have 24 holes in a spiral while the Nakken disc will have 36 holes. For the same size of picture, therefore, the Nakken disc must be larger, but it goes at half the speed and will give better definition.

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Of course, if you can vary the motor speed 100 per cent. through the range of 600 r.p.m to 1260 r.p.m., the substitution of discs will let you receive either station at will. Or, it is possible to have two sets of holes in the same disc. The spirals may be concentric and the speed changed, or a large disc used and the WGY spiral placed only half way round, with two such spirals for each disc, and the WRNY spiral all the way round. The disc would then need a speed of about 600 r.p.m. to receive either number of pictures. These matters will be brought out in various constructional articles and are mentioned here only to indicate the details in which one receiver will differ from another. The point is that it is only in the disc that any distinct difference will lie between the various television systems, with the exception of the Baird arrangement—and he will probably come to this sooner or later, just as Jenkins and Alexanderson have.

NEON TUBES FOR SALE!

This window display in New York's Radio Row offers the television fan neon tubes at the modest charge of fifty-five cents, and a glimpse at a distinctly experimental set-up for television reception. The size of picture possible may be judged from the opening in the board behind the magnifying glass. Obviously the magnifying glass is a very necessary part of the set-up

WHO IS DOING THE WORK?

THE roll of sponsors for television apparatus at present include Nakken, who is manufacturing; Jenkins, who is negotiating with a view to manufacturing; Baird, who has interested American manufacturers; Alexanderson, whose firm seems at present only interested in broadcasting pictures experimentally at WGY; and a Boston group of experimenters who announce that WLEX will be on the air with pictures before long. Nakken will use WRNY.

While all the other devices use simple neon lamps in the set output instead of (or in series with) the loud speaker, the lamp being viewed through the holes of a rotating Nipkow disc, Baird has been using a lamp, a Nipkow disc, a slotted disc, another disc, a mirror, and a collection of prismatic cells at the receiving end. At present this assorted collection is being sold abroad. It is believed, however, that the American type of the Baird receiver may be simply a Nipkow disc, a slotted disc, and the collection of cells, together with the neon lamp. This was illustrated in the July RADIO BROADCAST in the article "What Hope for Real Television?" (p. 125)

So far as reception itself is concerned, any receiver with sufficient amplification and a power output can be used. Actually, the audio amplifier should preferably be changed to straight resistance coupling until transformers are available which do not have a distinct cut-off of frequencies above 5000 cycles.

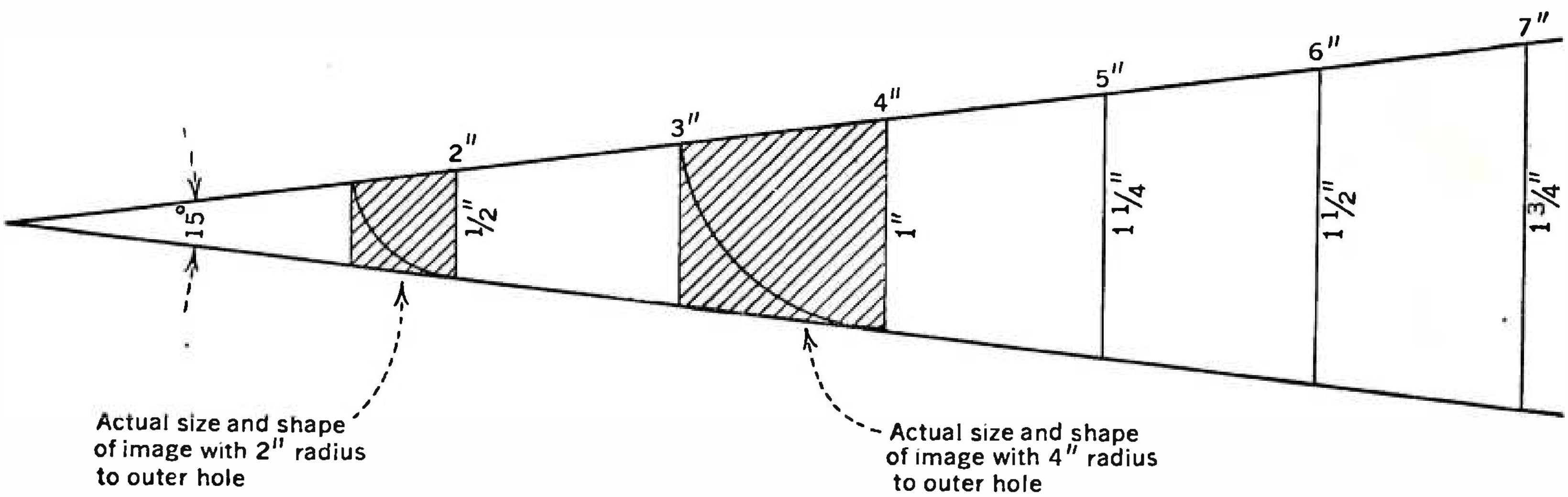
For the present, however, there is a legal limit of plus and minus 5000 cycles for the width of sidebands and this limit will not be exceeded. While the WGY figures give a possibility of 12,096 impulses per second, basing the modulation of each line as equal to the number of lines, actually the simplicity of the picture and quantity of white space in the background cuts down the line modulation. Likewise, Nakken's intention to send 36 lines and 10 pictures per second would run into 12,960 impulses per second if each line had 36 modulations. Here, too, the simplicity of the figures and the abundance of white background will act to bring the actual picture within the legal 5000 impulses per second.

It is not meant to imply that any regulations specifically limiting television have been adopted, so far as known. The fact remains, however, that the legal sideband possible without interfering with the next station is 5000 impulses, and it makes no difference, so far as interference is concerned, whether these impulses arise from sound variations at the studio or light variations which are transformed into electric impulses. It is true that WGY was given almost *carte blanche* on the occasion of one demonstration to the press. Various editors and writers still tell how much better that demonstration was than anything else they have seen, apparently not realizing that the use of 20,000 or more impulses to the pictures naturally would be infinitely superior in results to any picture, regardless of how it was sent, that uses 5000 impulses or less. The difference would be much greater than that between a newsprint half-tone of poor quality and the fine prints made for framing. The legal limitation must be overcome by some new method of transmission before even the crude possibilities of present television devices can be realized.

The contrast of the picture will depend upon the relative light intensities of the neon plate under slight voltage fluctuations or on the extent that those fluctuations are varied. The brilliancy of the image will depend largely on the size of the holes in the disc and the speed of the disc. High speed and small holes will make an image hard to see

WHAT WILL THE FAN SEE?

THIS brings us, of course, to a consideration of what is to be sent and what you can see through these whirling discs. There is much talk of sending the pictures of performers so that you can see them and hear them, too. There may be an occasional attempt at this. Only the head will be sent, and no groups, such as orchestras, will be included. A single head can be put across, but it will be hardly recognizable except for the outline. You will know it is a head and distinguish between a man or woman. With proper make-up on the face, which art may be developed especially for a televisor, possibly a distinctive type of face and head can be recognized. A sneeze on the part of the artist, and the face will disappear. I am also inclined to believe that any attempt at singing by the artist while before the televisor will result in a blank



THE ACTUAL SIZE OF PICTURE POSSIBLE

This shows how the size of the scanning disc determines the size of the received picture. When the size of the disc is such that the radius from the center to the outer hole is two inches then the received image has a size and shape as indicated in the left hand shaded portion in this diagram. If the disc has a radius of four inches to the outermost hole then the size of the picture is as indicated in the shaded portion at the right. In both cases, however, the total number of scanning lines is the same and therefore with the four-inch radius the number of lines per inch is only half as many as with a two-inch radius. Consequently the larger the radius the less apparent detail there is to the picture.

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screen, judging from the fact that in a demonstration a slight yawn on the part of one subject caused his face to drop off the screen.

Actually, no proponent of the new art seriously contemplates this type of broadcast. Every one of them has in mind transmitting, not from living images, but from photographically recorded cartoons, using outline figures and silhouettes of the type shown in the comic strips. With these some degree of motion can be seen and the figures themselves can be so different in outline, as in the case of Mutt and Jeff, that the observer will be able to follow the action. You can tell whether little Jeff is leaning disconsolately against a lamp post or sitting at a table taking refreshment, but it will not be possible to distinguish whether Mrs. Mutt hits her distinguished husband with a rolling pin or a frying pan. You will be able to see the hit but not the sparks nor the lump that grows on the bruised spot.

RADIO ROW SEES A NEW BOOM

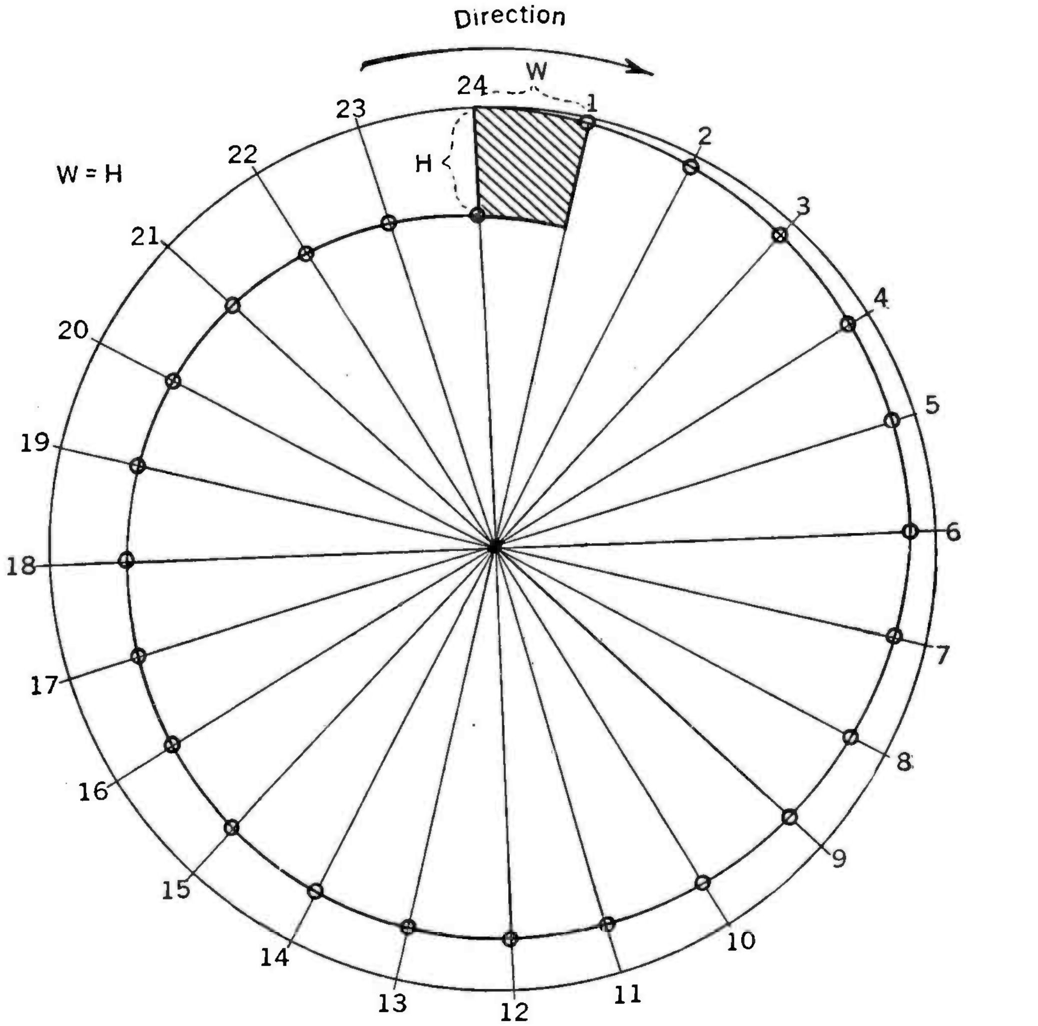
Down in New York's Radio Row, the crowds are thronging in the old 1923 fashion. The reason is apparent in the arrow-shaped sign at the top of this picture

Knowing what is being sent, how it is being sent, to what degree it will be received under the best conditions, and how to receive it, still leaves a good deal to be said. Nobody at this moment knows how satisfactory home built apparatus is going to prove, or how the broadcasts are going to go over in the face of possible static and other interference from internal and external sources. We do know that even mechanical vibration of the receiver makes the screen blank. In that particular, we recall the old cat's-whisker-and-crystal days when every member of the household had to sit rigid and hold his breath at the moment of an announcement. The rumble of a truck or the passing of a trolley might upset the sensitivity. All this is true of such home-built apparatus as has come to our attention. It may be equally true of commercially built receivers.

The problem of synchronization is not solved in any commercial type of apparatus yet disclosed. The best that any manufacturer contemplates is manual speed control of the motor. This is a hand operated rheostat, and it needs but little imagination to see that it is very difficult to hold the image in this way for more than a fleeting glance now and then, especially if the line voltage variation or fluctuation is very frequent. I am inclined to think much better results could be obtained with a six-volt motor on a storage battery. Any fan could do that, of course, as the particular source of the energy which turns the disc is of no importance. Even a spring motor would work if the speed were great enough, the power sufficient, and the period of operation long enough. I am informed that at least one manufacturer plans a device fixed automatically for only one speed, being even more accurately governed than a phonograph. Any variation in speed is detected by observing a second neon lamp through an auxiliary spiral of holes in the scanning disc.

Personally, I have confidence only in the establishment of a synchronizing station, perhaps one of the smaller ones forced from the broadcast field under the new law. For the television camera described by me last month, such a station sending constantly a 10-cycle sideband or a 1000-cycle sideband, or both, would not only take up little room in the spectrum, but furnish synchronizing means to transmitter and receiver alike. Such a station might well be subsidized by the larger ones and, moreover, would tend toward standardizing the speed of all receivers and prevent the growth of a multitude of separate forms of transmission which ultimately must be brought together. Sooner or later the purchaser will demand that his receiver be such that he can get any image broadcast. Imagine any radio receiver manufacturer trying to merchandise nationally a radio set which would receive only one station or one fixed wavelength! Yet that is just what the televisor producer plans to-day.

The cost of the commercial television attachment for a radio receiver will run to about $150. That means home-built apparatus for most fans. He can buy a first quality neon tube for $12.50, with the promise that this will go down to about $7.50 as soon as there is a demand that warrants a quantity production. The motor will cost from $9 upwards. It need not be over $\frac{1}{8}$-horsepower and, if belted to the disc, even a smaller motor may be suitable. The big difficulty will be in getting a suitable disc, unless manufacturers wake up to the fact that this piece of the apparatus must be of a high degree of accuracy. The cost of a suitable aluminum plate with the spiral holes cleaned out and countersunk will be quite high but well worth while in comparison with the paper discs now making their appearance in conjunction with a little neon night lamp now being widely sold for television purposes—for which it is worthless. This little bulb is good, however, to indicate whether you have a.c. or d.c. current, as it glows on both plates only with a.c.



A SCANNING DISC LAYOUT FOR WGY RECEPTION

The number of holes in the disc is determined by the constants of the apparatus at the transmitting end—24 holes is the correct number to receive the pictures beings transmitted by WGY. W is the width of the picture and H is the height of the picture as it appears to the observer, the shaded portion therefore representing the actual size of the picture received with a disc of the above dimensions.

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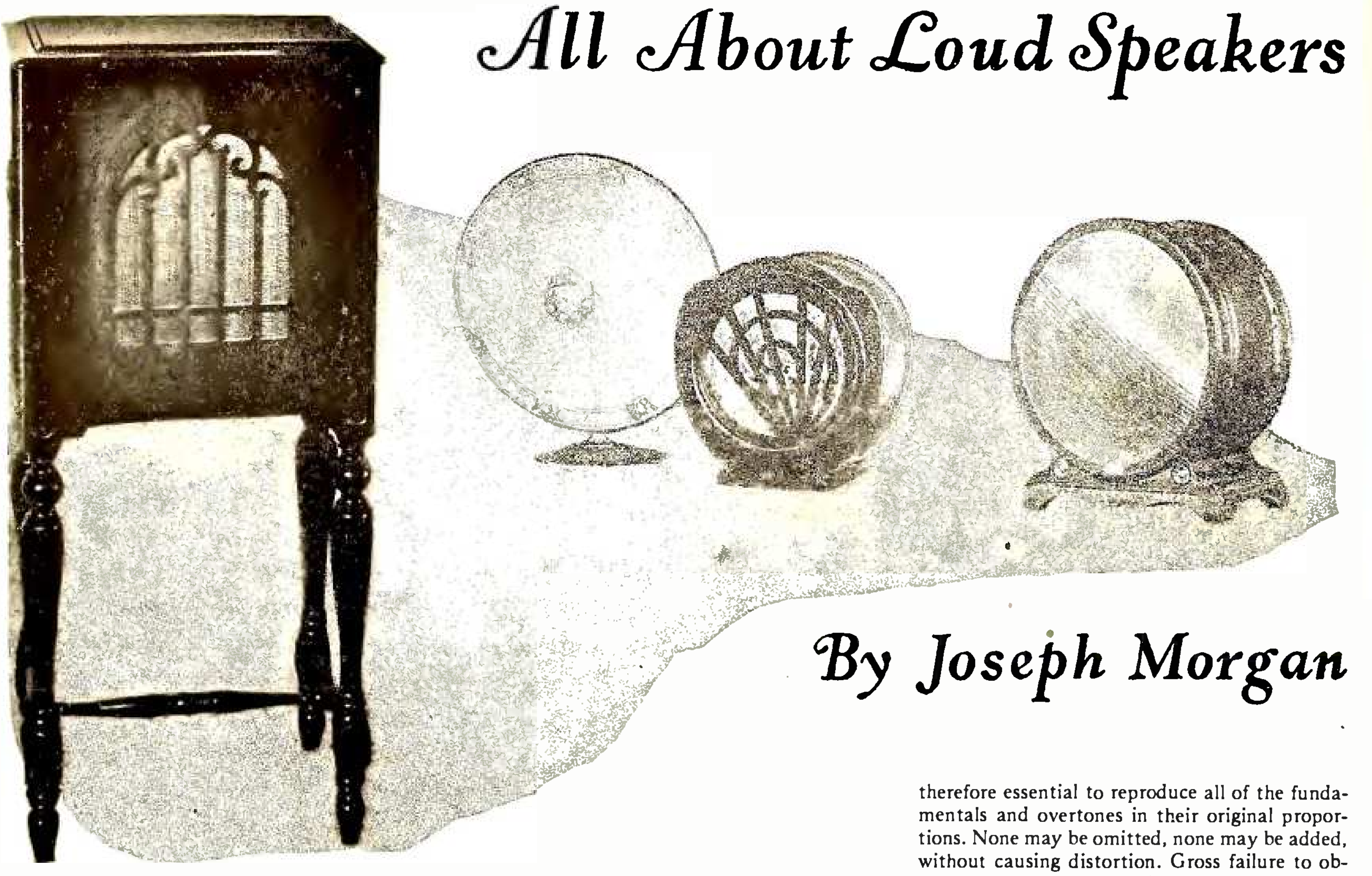
All About Loud Speakers



By Joseph Morgan

THIS article comes as a very timely comment on the present sweeping interest in loud speakers. The recent Trade Show at Chicago proved that the field of loud speaker development is at present the most active branch of radio. Mr. Morgan covers the whole field in a clear and concise manner, summing up the theoretical requirements of the ideal loud speaker, the various kinds of units that have been devised to meet these requirements and the results that may be expected from the present day types of loud speakers. Although the specific makes of units on the market to-day are not mentioned by name, the data in the text and the accompanying response curves should enable the reader to decide upon the type of loud speaker that will give him the kind of service he desires. In addition, Mr. Morgan gives some valuable hints on the proper way to make a non-technical comparison of loud speakers.

—The Editor.

THERE is no part of a broadcasting system, beginning with the studio and ending with the listener, which does not add its quota of distortion to the original performance which takes place in the broadcasting studio. Since the loud speaker is the last link in the chain of technical apparatus used in the system and the device which finally emits the reproduction of the original performance, it is natural, in fact almost traditional, to render judgment against the loud speaker for the accumulated deficiencies of the entire system, including the listener.

While it is true that the loud speaker has been a gross offender in the past, and until recently the weakest link in the chain, there are many possible imperfections of the system which are in no way chargeable to this much maligned device.

THE NATURE OF MUSIC AND SPEECH

ALTHOUGH much has been written concerning the physical nature of speech and music, a brief review may not be out of place here, since it is fundamental to any study of loud speakers.

Sounds are more or less regular vibrations in material media. The most important of these media is air. The most important properties of sound are pitch, intensity, and timbre.

The pitch of the sound is determined by the number of vibrations per second of the sounding body. When we speak of a musical note being high or low, we are speaking of the pitch of that note.

The intensity of a sound we ordinarily refer to as the loudness of the sound.

The quality of the sound is called the timbre. For example, the violin and the trumpet have different qualities or different timbres.

All musical instruments emit certain vibrations which are called fundamentals. We can, for example, play middle C on the piano or violin, and the pitch of these tones will be, let us say, 256 vibrations per second. We are, however, enabled to distinguish the middle C's of the piano and the violin by what are called "overtones." These overtones are, in general, exact multiples of the fundamental pitch. For example, a certain instrument may have a fundamental (middle C in this instance) of 256 vibrations per second, with overtones of 512, 1024, 2048, and 4096; while in another instrument the overtones of 1024 and 4096 may be practically or entirely missing. Therefore, the middle C would sound quite different when played on the two instruments. In other words the overtones which are present in a tone, and their relative intensities with respect to the fundamental, determine the timbre of that tone.

The piano, for example, has 88 notes or fundamentals. Each fundamental is associated with its own group of overtones, and this particular grouping of tones gives the piano its characteristic quality.

In the reproduction of speech and music it is therefore essential to reproduce all of the fundamentals and overtones in their original proportions. None may be omitted, none may be added, without causing distortion. Gross failure to observe these facts results in music which is unnatural and in which the various instruments are indistinguishable, and in speech which is unnatural and unintelligible.

FUNCTION OF THE IDEAL LOUD SPEAKER

WHAT constitutes the ideal loud speaker from the point of view solely of tone quality? Assuming the broadcasting, the transmission of the radio waves through space, and the remainder of the receiving apparatus to be ideal, should the loud speaker reproduction be an exact replica of the original performance in the studio? The answer to this question is not so simple as one might, at first glance, suppose. In this apparently simple question there are involved physical, psychological, and physiological factors. It is not possible in this article to analyze the many factors involved, even aside from the fact that the relative importance of some of these factors is not yet known. A few illustrative points, however, may not be out of place.

Amongst the important physical factors to be considered is the relationship which exists between the broadcast performance studio and the broadcast listener's room. The voice of a speaker delivering an address to an audience in a large auditorium will sound anything but natural if accurately reproduced in a very small living room. An orchestra, playing in a hall which has good acoustics, will sound most unnatural if accurately reproduced in a small resonant room; one, for example, with bare floors and walls, and containing very little furniture. It is very probable that a loud speaker could be constructed with certain intentional distortions which would give a better illusion of reality, in such a case, than a loud speaker causing no distortion.

As to the psychological factors, there are people who actually prefer certain types of faulty reproduction to the original, and there can be no question that a poor loud speaker may under certain conditions flatter a poor performer.

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For example, a loud speaker whose response is poor at the higher audio frequencies will fail to reproduce much of the unpleasantness of a nasal voice or scratchy violin playing.

It requires little stretch of the imagination to believe it possible that distortions of various types may, in the future, be intentionally introduced into the system in order to produce new musical effects.

As an illustration of the physiological side of the problem let us consider the question of volume. It is a fact, unfortunately not sufficiently well observed, that even accurate sound reproduction will produce serious distortion in the ears of the listener if the volume of the reproduction is too great. This distortion is an "overloading" of the ear of a similar nature to the overloading of a vacuum tube.

We see from this brief discussion that the system does not end with the loud speaker, but with the listener; and further, that the problems which arise after the loud speaker has completed its task are not by any means unimportant.

For the purposes of the following discussion, however, we shall assume that it is desirable for the loud speaker to produce an exact replica of the original performance, and leave the special considerations of the listener, and the listener's room, for a later time.

THEORETICAL REQUIREMENTS

BASED on this simplified view of the problem, what should an ideal loud speaker do, if used in an ideal system?

Theoretically such a loud speaker should reproduce *all* the frequencies from 8 cycles per second to 12,000 cycles per second—nearly eleven musical octaves—without omission of any frequencies, and it should reproduce this entire band of frequencies without discrimination; in other words, without frequency distortion. It should not produce any frequencies not present in the original sound; in other words, it should not introduce non-linear distortion. It should be capable of delivering its output at sufficient volume without the introduction of distortion due to overload or mechanical striking of any of its parts. It should be efficient; that is, the ratio of the sound output power to the electrical input power should approach as nearly as possible to unity. Its performance should be independent of ordinary atmospheric conditions. It should be rugged and durable. It should be either inconspicuous or decorative—or both.

Needless to say, an instrument possessing all of the desirable qualities stipulated above cannot be found this side of paradise. Fortunately, however, we may fall short of this perfection and still obtain excellent results.

We shall examine in detail each of the above qualifications to see how much variation is consistent with a practical loud speaker, and we shall then compare these practical considerations with the actual limitations of present-day loud speakers.

First, let us consider the item of frequency range. It has been demonstrated that a frequency range of 30 cycles per second to 10,000 cycles per second is consistent with practically perfect reproduction of both speech and music. In fact, a system which reproduces 30 to 6000 cycles is distinguishable only by direct comparison from one which reproduces the entire range.

As to amplitude, it has been determined that a variation throughout the frequency range of less than 5 TU is almost negligible, and of more than 15 TU is serious.

As to non-linear distortion, it has been estimated that the presence of frequencies in excess of 5 per cent. (based on the energy of the original sound) is disturbing.

The efficiencies of most loud speakers are low, a value of one half of one per cent. being average. In other words, the power tube of the last audio stage delivers 200 units of electrical power to the loud speaker for each unit of sound power delivered by the loud speaker to the air. Of loud speakers built for home use, there are few which have an efficiency of as much as 2 per cent. The losses occuring in loud speakers are: (1) The heat losses in the coils; (2) The hysteresis and eddy-current losses in the magnetic circuit; (3) The work done in bending the diaphragm; (4) Losses due to air friction which do not contribute to the production of sound waves. If it were not for the very low efficiencies due to these losses it would not be necessary to use large power tubes in the last audio stage, to deliver the necessary power without overloading this stage.

An example may make this more clear. Suppose that a given good speaker, having an average efficiency of ½ per cent. is used in an average living room, and that it is necessary to use a type 210 tube in the last stage of a two-stage audio amplifier to obtain reasonable volume without appreciable distortion. If this same reproducer had an efficiency of 50 per cent., the same volume could be obtained with no increase in distortion by using a type 199 tube in the last stage. In other words the smallest of the standard dry-cell tubes operating with a plate voltage of only 90 volts would be quite as effective as the high-voltage power tube.

The desirability of increased efficiency is obvious, since a large part of the complication and cost of a good modern receiver is brought about by the necessity of using power tubes. Power tubes are more expensive and require, in general, high plate voltages and high plate currents. This in turn means power supply devices with expensive transformers, rectifiers, and filters. It is safe to say that a large proportion of the total cost of a good broadcast receiver is chargeable to the low efficiency of the usual loud speaker.

PRINCIPLES OF DESIGN

TELEPHONE receivers and loud speakers have been designed upon a number of basically different principles. The electrostatic attraction between two charged metal plates; the reaction between the current in a coil and eddy-currents set up in a large metal disc; the expansion and contraction of crystals under the influence of an alternating electric field; the expansion and contraction due to the generation of a gas from a chemical placed between two plates, resulting from the passage of the audio-frequency current through the chemical; the variation of the surface tension of a liquid with

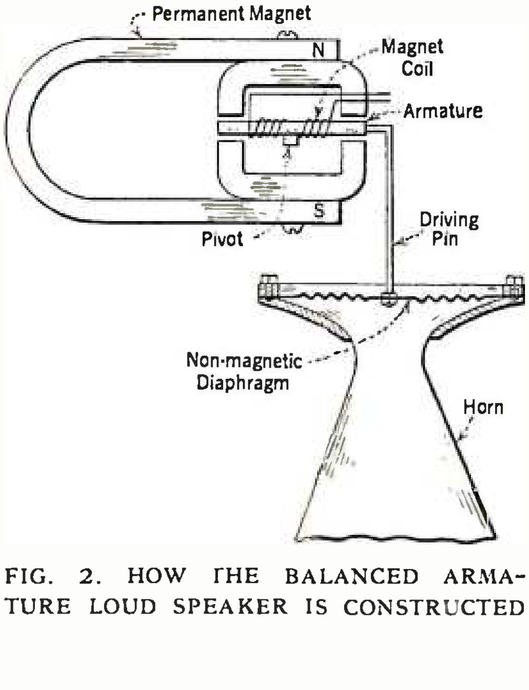

FIG. 2. HOW THE BALANCED ARMATURE LOUD SPEAKER IS CONSTRUCTED

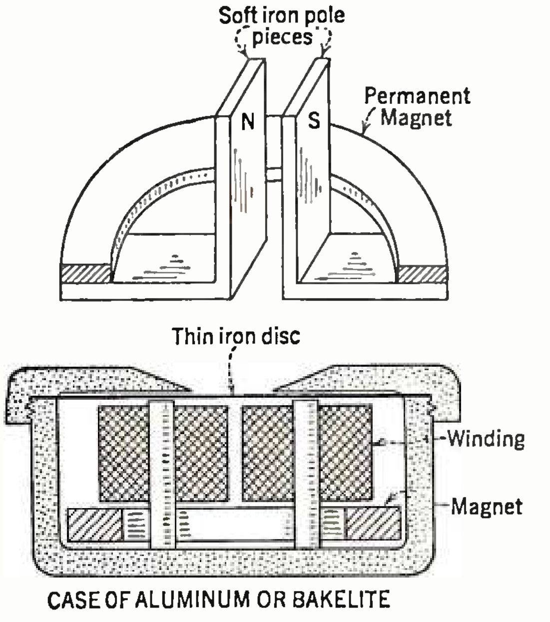

FIG. 1. CONSTRUCTION OF THE IRON DIAPHRAGM TYPE OF LOUD SPEAKER UNIT

electromotive force; thermal expansion and contraction of a wire with variation in current through the wire; the "talking" arc—all these and many other schemes have been used with more or less success.

However, practically all speakers in use today depend upon the variation in pull of a fixed magnet or electromagnet on an iron diaphragm, iron bar (armature), or a coil carrying current. The essential parts of a speaker working on this principle, no matter of what type, is a constant magnetic field upon which is superimposed a second magnetic field which varies in accordance with the audio-frequency current, thereby causing the motion of a diaphragm, an armature, or a moving coil in accordance with audio-frequency current.

CLASSIFICATION OF LOUD SPEAKERS

THE reproducers obtainable at present may be divided into several classes.

The first classification refers to the method of exciting the constant field. Those which use a permanent magnet are called magnetic. Those in which the field is excited by means of a current-carrying coil wound on a soft iron core are called electromagnetic.

A second classification divides speakers into iron diaphragm, balanced armature, and moving coil types.

The iron diaphragm unit has the same general construction as an ordinary watch-case telephone receiver. In this type the iron diaphragm is magnetically attracted to the pole pieces of the magnet, against its own spring tension. The diaphragm is the emitter of sound. Fig. 1 illustrates the construction of this type.

The balanced armature type consists of a short iron bar or armature which acts as the core of a small coil carrying the audio-frequency current. This bar is pivoted at its center and is free to move in a small arc about its center. It is usually restrained by a light spring. Each end of the bar is near one of the pole pieces of a strong permanent horse-shoe magnet. This bar imparts its motion to a non-magnetic diaphragm (to be discussed later) through a simple rod or in some cases through a more or less complicated system of levers. Fig. 2 shows the construction.

In the moving-coil type a very small, exceedingly light cylindrical coil, carrying the voice and music current, moves back and forth in the magnetic field. In this case the coil is attached (usually directly) to a non-magnetic diaphragm. See Fig. 3.

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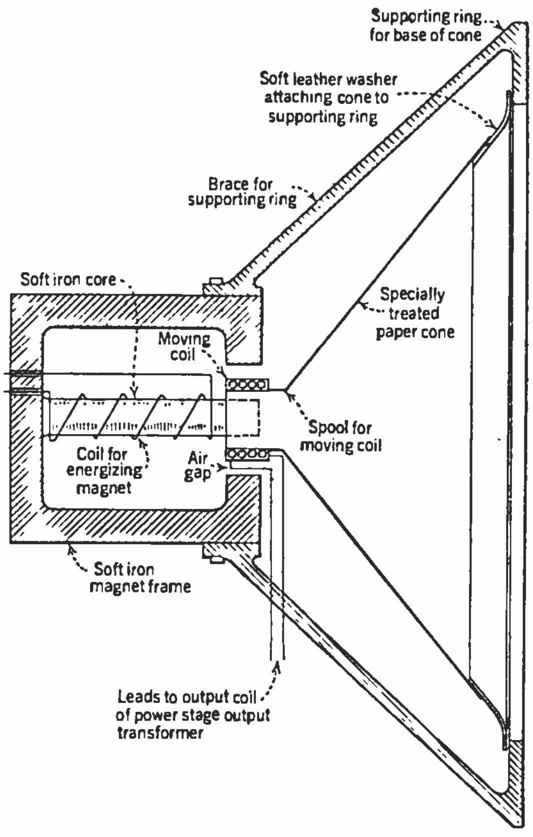

FIG. 3. CONSTRUCTION OF THE MOVING COIL TYPE OF LOUD SPEAKER

The third classification consists of "horn" and "hornless" speakers. This classification is self-explanatory. The function of the horn is to load the diaphragm and to radiate the power which it causes the diaphragm to deliver. The greater the loading, the less the objectionable effect of diaphragm resonances. The loading of an exponential horn increases with decrease in the initial throat area. However, the throat area must not be so small as to introduce appreciable air friction. The less the rate of increase of the cross-sectional area of the horn, the more uniform the loading will be. The larger the final opening, the less pronounced will be the horn resonances. Therefore, a good exponential horn should have a small initial throat area, a slow rate of taper and a large final opening.

With a very few specific exceptions, all loud speakers fall within the above system of classification.

While it is evident that there are many possible combinations of the above-mentioned elements, there are at the present time five principal types which will be described as representative of most of the speakers on the market.

The commonest or ordinary "horn speaker" is the combination of the permanent magnet, iron diaphragm, watch-case telephone receiver unit, with a more or less conical horn, usually about two feet in length. The characteristic of a good speaker of this type is shown in Fig. 4. This type of speaker has almost every inherent fault possible. The permanent magnet is usually so small that non-linear distortion is certain to be present if the speaker produces reasonable volume. Due to the fact that the diaphragm is essentially a spring and therefore has a natural period or frequency of its own, frequency distortion is present in a high degree. Furthermore the conical horn discriminates against the lower frequencies. See Fig. 7. The only advantage which can be claimed for this type of speaker is that it tends to cover up the distortion due to overloaded tubes, since it cannot reproduce the high audio frequencies.

The second or "exponential horn" type of speaker employs a large watch-case telephone receiver unit with an exponential horn. If properly designed, this speaker is decidedly superior, particularly since a correctly proportioned exponential horn will radiate a wide band of frequencies with good uniformity.

The combination of a permanent magnet, balanced armature, small non-magnetic diaphragm (usually mica or aluminum) with an exponential horn can give a still better frequency-response curve and can also be more efficient. The frequency-response curve of an example of this type of speaker is shown in Fig. 8.

A fourth and very common speaker called the cone speaker employs a permanent magnet and a balanced armature which is connected by a rod or lever system to the apex of a large conical diaphragm, commonly made of specially prepared paper, which resists changes in shape or stiffness due to heat or moisture. In the most usual type, the base of this conical diaphragm is fastened to the base of a second conical diaphragm at the common periphery. This is a type of "fixed-edge" cone. The diameter of the cone varies from one foot to three feet, eighteen inches being a very common size. If well designed this type of speaker has a good frequency-response curve. Such a curve for a fixed-edge cone speaker of well-known make is shown in Fig. 5. It will be noticed that there are a number of peaks in this curve, partly due to the fact that the cone does not vibrate as a whole, and therefore has several modes of vibration resulting in numerous resonances.

Speakers of this type in the smaller sizes have the advantage of compactness, but they must be handled with care since the cone is usually quite fragile. In most speakers of this type an adjusting pin is provided to compensate the small alterations in the tension of the paper cone due to atmospheric changes.

The impedance of a well-known example of this type of speaker is 1000 ohms at 100 cycles per second and 40,000 ohms at 5000 cycles per second, and is chiefly reactive. This variation in impedance is characteristic of all types of loud speakers so far considered. The ideal speaker would have a constant impedance at all audio frequencies. It is further desirable that this impedance should be as nearly pure resistance as possible.

The fifth type of speaker to be described is the dynamic speaker. It has a strong constant field which is excited usually either by a 6-volt storage battery ($\frac{1}{2}$ ampere), or by 90 volts d.c. (40 milliamperes). The field consumes approximately 3 watts. In the low-voltage type the field can be excited from the usual A battery. A common method of exciting the field of the high-voltage type is to use this field as one of choke coils in the filter system of the B-supply device. This second way is of course more efficient. A recent model utilizes rectified 110-volt a.c. to excite the field. In this model the field consumes 25 watts. This permits the use of larger air-gaps, and hence more rugged construction. The magnetic field in the air-gap is radial. The moving coil, which consists of about 150 turns of very fine wire wound on a thin cylindrical shell of fibre or like material, has a very low impedance at all audio frequencies. In one well-known make this impedance is about 5 ohms at 100 cycles and 10 ohms at 6000 cycles. Its impedance is almost pure resistance and therefore is nearly constant throughout the audio-frequency range. This is a distinct advantage, since it is desired to have the speaker respond alike to all frequencies. The coil has the smallest practicable clearance in the air-gap. A cone, usually made of paper, is attached rigidly at its apex to the moving coil. The base of the cone is fastened loosely by some soft and flexible material, such as thin leather, to an outside supporting ring such as is shown in Fig. 3. Two, or sometimes three, thin flat metal springs keep the moving coil concentric in the air-gap and act as conductors of current to the coil.

It may be seen from this description that the cone is almost full floating. The lightest touch of the finger will displace the cone in some cases as much as a quarter of an inch along its conical axis. Such a cone is said to have a "free-edge." The resonant frequency of the cone, coil and spring combination is made very low, usually less than 50 cycles per second, so that the speaker is practically a non-resonant pure resistance load on the amplifier, for most of the audio-frequency range.

In order to utilize this type of speaker to the best advantage it is necessary to mount it in some kind of cabinet or stiff baffle board. Since the cone moves as a whole, the waves from the front and from the back tend to interfere, particularly at the lower frequencies (under 300 cycles per second), unless the shortest path from front to back of the speaker is of the order of magnitude of the length of the low frequency waves. The distance from the *front* edge of the cone to the back edge by the shortest mechanical path through the air around the cabinet or baffle should be at least one quarter wavelength of the lowest note to be reproduced, 32 inches for 100 cycles, 110 inches for 30 cycles. It might be thought that if the speaker were completely enclosed in a small box that this problem would be solved. However, such is not the case, since disturbing resonances will be produced. Therefore, the speaker should either be mounted in a console cabinet, or, better still, in a large wall.

Such a speaker properly mounted and used with a good amplifier is capable of excellent results. The frequency-response curve for a speaker of this type is shown in Fig. 6. It will be noted that the solid curve shows a peak for the band of frequencies from 2000 cycles per second to 5000 cycles per second. This is due in part to the horn effect of the small cone at the higher frequencies and in part to vibration of the cone. In a recent model, a ribbed cone is used which is claimed to minimize this vibration. Some dynamic speakers contain equalizer-filters which tend to correct this defect, as shown in the dotted curve in Fig. 6.

Since the impedance of the moving coil of the usual dynamic speaker is exceedingly low in com-

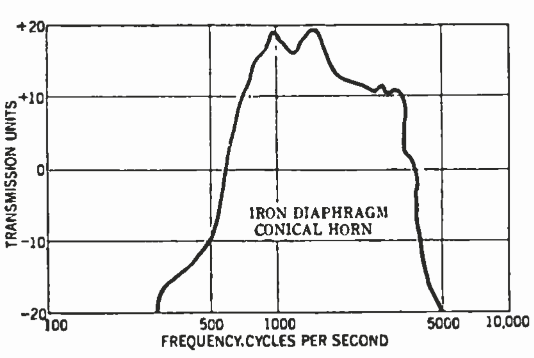

FIG. 4

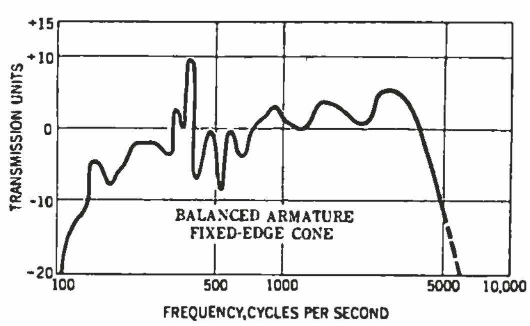

FIG. 5

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parison with the output resistance of standard radio tubes, it is necessary to use a transformer designed particularly to bring these impedances into the proper relationship. In some speakers this transformer is included in the housing of the speaker. Separate transformers are now available, which have been designed to be used between the moving coils and the standard power tubes. When purchasing one of these transformers, the particular power tube, or tubes (if the last audio stage is push-pull) used in the set must be specified, as different transformation ratios are desirable for different tubes. Most of these transformers are so designed that the impedance looking from the tube into the primary of the transformer is twice the plate resistance of the tube. This condition gives maximum *undistorted* output. In the dynamic speaker, if this relationship is made right for a frequency of about 1000 cycles per second, it is approximately right for the entire audio range.

It is very important to mention that while some types of speakers are theoretically inherently better than others, in practice, due to inadequate design, this is frequently not so. The writer has seen more than one make of cone speaker which was inferior in almost every way to the average conical horn speaker. A dynamic speaker recently came to the attention of the writer which was one of the poorest speakers he had ever examined. The type of unit determines its *theoretical* excellence, but careful design makes a good loud speaker.

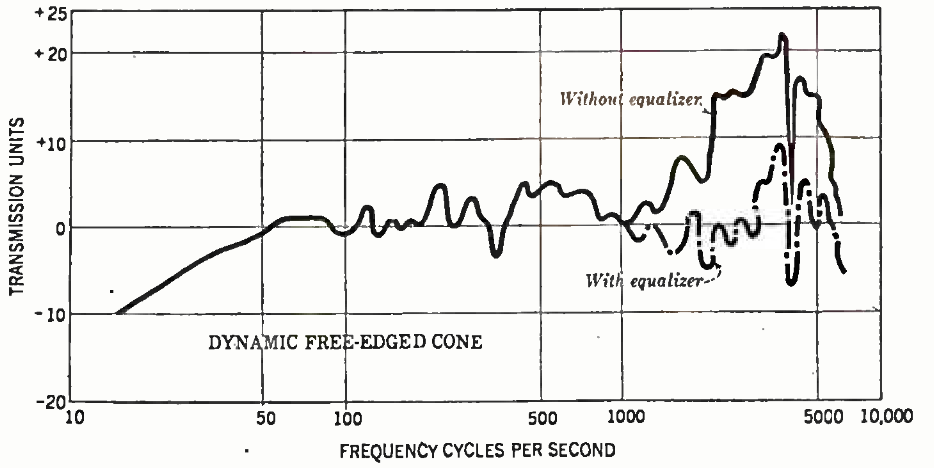

FIG. 6

REQUISITES FOR A BROADCAST RECEIVER

THE question of judging the quality of a loud speaker is, properly considered, a laboratory study. However, the *relative* merits of different speakers can be determined with a fair degree of practical accuracy if they are *intelligently* compared while listening to a good local broadcasting station through an adequate receiving set.

Before describing the method of comparison it will be well to discuss in general terms the requisites for a good broadcast receiver from the point of view of audio quality. In the first place the set must not be more selective than is absolutely essential for the separation of stations. As a rough measure of this, the set should *not* be capable of separating two stations of equal strength and distance, separated by 20 kc. in wavelength. Selectivity, in general, is incompatible with quality, since the more selective a set is the more it sacrifices the higher audio frequencies.

An overloaded detector is a frequent cause of distortion. There is no need to overload the detector provided the audio amplifier has sufficient gain. Such an amplifier should have a gain of at least 60 TU and preferably 70 TU. With such an amplifier sufficient volume is obtainable from the loud speaker with a small detector output and without the use of regeneration in the detector circuit.

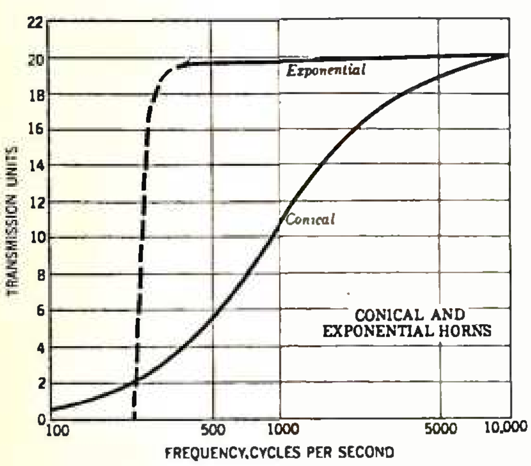

FIG. 7

These curves were made for the natural response of a cone or an exponential horn, without driving units

The audio-frequency amplifier is a source of almost every known type of distortion. The modern transformer-coupled amplifiers using the best makes of transformer and connected according to the manufacturer's directions, paying particular attention to obtaining the correct A, B, and C voltages on all tubes, are capable of excellent performance. Unfortunately, there is no reliable way of testing such amplifiers without laboratory equipment of a type which is not generally available.

The design of the power stage of the audio-frequency amplifier is very important. It is safe to say, that in order to obtain, in an average room, reasonable volume without appreciable distortion it is necessary to have available at least one watt of undistorted output, if the loud speaker has a good frequency-response characteristic. This requires a last stage at least the equivalent of a type 210 tube. With the best types of speaker available at the present time it is desirable to use a push-pull circuit for the last stage, with type 171 or type 210 tubes. There is now available on the market a tube (type 250) with a still greater output. One of these tubes is sufficient to give a large undistorted output for a loud speaker used in quite a large room. Two such tubes used push-pull with proper associated apparatus will deliver sufficient power to fill a fairly large auditorium.

The method of coupling the speaker to the power stage is a matter of much importance. Two schemes are in common use; the transformer, and the choke coil and condenser. If the tube and loud speaker have the proper impedance relationship the choke and condenser scheme is efficient, but if the impedance relationship is not correct, a transformer should be used which has been designed for that particular combination of tube and speaker.

In any case the maximum undistorted power is delivered to the speaker when the impedance looking from the plate circuit of the tube into the primary of the coupling transformer is twice the plate resistance of the tube.

Loud speakers should never be compared by listening to their reproduction when connected to a poor receiving set, since the better of the speakers will sound worse. This is due to the fact that the better the frequency-response curve of the speaker the more the defects of the receiver (especially overloading), will appear in the reproduction.

If, however, two loud speakers are connected to a double-pole double-throw switch, the knife posts of which are connected to the output of a *good* set, which set is tuned to a *good local* broadcasting station, a useful comparison may be made. The relative intelligibility of speech is an indication of the presence of the higher audio frequencies. If "f," "s," "v," "b," "p" and "th" are *clearly* distinguishable, the loud speaker has a good high-frequency characteristic. If, when listening to the piano, the tones are deep and rich, the low-frequency characteristic is good; on the other hand, if the piano sounds thin and tinny the low-frequency characteristic of the speaker is deficient. If the voice is full and clear and intelligible, and yet has an unnatural metallic quality, there is at least one high peak in the middle or upper range of the frequency-response curve.

As shown by the curves in Figs. 4 to 8 inclusive, any or all of the above defects may be found in loud speakers. If, however, the comparisons are made intelligently, noting the above-mentioned points, a practical choice of speakers can be made on a rational basis, but the observer must assure himself that the defects noted are speaker defects and not defects arising from inferior broadcasting or an inadequate receiving set.

The development of the art and science of broadcasting has been very rapid, and remarkable results have been achieved in every branch. A large and reliable manufacturer announced only a few months ago the perfection of a loud speaker for use in public address and other commercial systems, which has an efficiency of 50 per cent. and a practically flat frequency-response curve from 20 to 8000 cycles, devoid of all sharp resonances!

It is likely that little time will elapse before such an instrument will be available to the broadcast listener.

Perfect radio reception is no longer a remote phantasy.

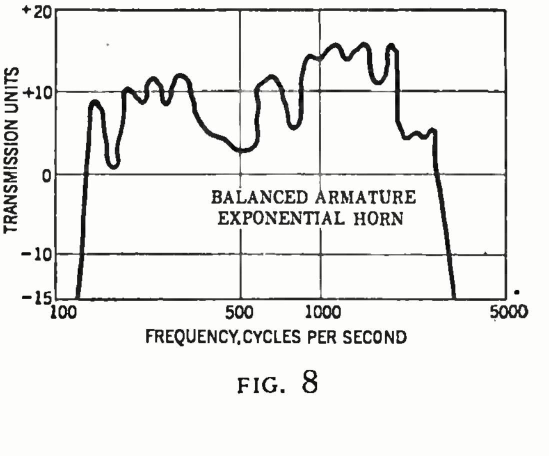

FIG. 8

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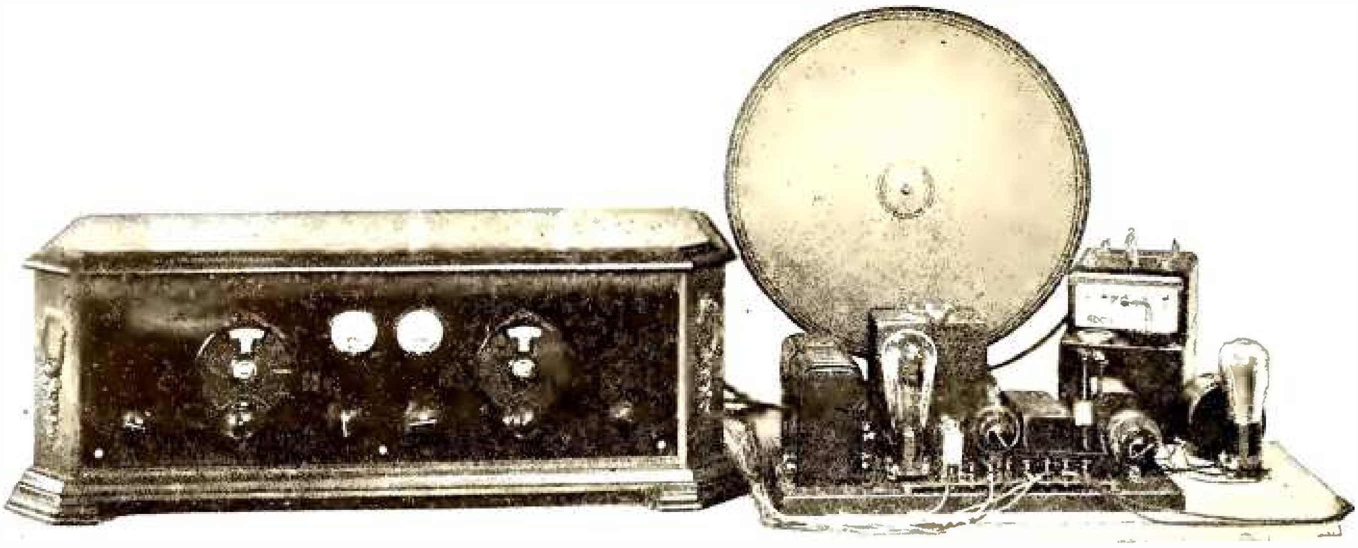

THE RECEIVING ENSEMBLE

At the left is the receiver itself; at the right is the amplifier-power unit designed for use with the receiver, and the other receiving accessories

A Dual Control A. C. Receiver

By Robert Burnham

SOME interesting features have been incorporated in this dual-control receiver employing four stages of tuned radio-frequency amplification. The points of major interest are: Two of the radio-frequency transformers are arranged with adjustable primary windings so that the selectivity of the receiver may be adjusted to the conditions under which it is to be operated; an extra socket is placed in the receiver into which a phonograph pick-up may readily be placed; a combined power amplifier and B-supply unit has been constructed which is designed especially for use with the set and, although standard type CX-301A (UX-201A) tubes are employed, the receiver may be made completely light socket-operated by using an A power unit in conjunction with this B-power unit.

—The Editor

THE problems associated with the construction of a radio receiver are many, and the final design is generally a compromise between various factors, such as the gain, type of tuning control, etc. The final design must be such as to produce an easily operated radio receiver with a reasonable amount of sensitivity and capable of giving good quality signals from any stations within a reasonable distance of the location in which the set is operated.

This has been the mode of approach in the design of the receiver described in this article. The complete receiver contains three tuned stages of radio-frequency amplification followed by a non-regenerative detector and a two-stage audio-frequency amplifier, transformer coupled. The first two tuning condensers are ganged to one tuning dial and the third and fourth tuning condensers are ganged to a second dial. These are the two major tuning controls. Two vernier condensers are connected across the second and fourth tuning condensers so that accurate tuning may be obtained when a comparatively weak signal is being received. In the reception of local stations it is necessary to adjust only the two main tuning controls and the volume control. The receiver is quite selective.

The only additional control on the panel is the filament rheostat, which is used in conjunction with the filament voltmeter to adjust the filament voltage applied to the tubes to the rated value of five volts. The 100-volt voltmeter on the panel is also useful in obtaining and checking the proper operation of the receiver, but it is not absolutely essential and may be omitted if the constructor so desires.

The receiver is shielded by means of the three aluminum shields. The first stage of audio-frequency amplification is located in the receiver proper and the second or power stage uses a 210 type tube and is a part of the combined power amplifier and B supply. A choke-condenser output circuit is used to keep the d.c. plate current of the 210 tube out of the loud speaker circuit. In the radio frequency, detector, and first audio sockets 210A type tubes are used and filament current for these tubes can be supplied from an A-power unit so that the entire installation is light socket operated. An additional socket is placed in the receiver so that a phonograph pick-up can be used.

THE CIRCUIT OF THE RECEIVER

A CAREFUL inspection of the circuit diagram in Fig. 4 will bring out some interesting points regarding the r.f. amplifier. In the first place, two of the r.f. transformers are arranged with primary windings whose coupling to the secondary may be readily varied. As the coupling is decreased, i.e., as the spacing between the primary and secondary is increased, the selectivity is increased; in this manner adjustments may be made to suit the conditions under which the receiver is to be operated.

A second point of interest about the r. f. ampli-

LISTS OF PARTS

FOR THE RECEIVER

L_1, L_2 / L_5, L_6 } R. F. transformers, Hammarlund Type RF-17

L_3, L_4 / L_7, L_8 } R. F. transformers, Hammarlund Type HQ-1

L_9—Hammarlund 85-millihenry r.f. choke
C_1, C_2, C_3—Carter 0.5-mfd. bypass condensers
C_4, C_5 / C_6, C_7 } Karas 0.00037-mfd. variable condensers
C_8, C_9—Hammarlund midget condensers, Type MC-5
C_{10}—Muter 0.002-mfd. fixed condenser
C_{11}—Muter 0.0005-mfd. fixed condenser
C_{12}—Muter 0.00025-mfd. fixed condenser
C_{13}—X-L Variodenser, Type N
R_1, R_3—1,500-Ohm Yaxley grid resistors, Type 71500
R_2—1000-Ohm Yaxley grid resistor, Type 71000
R_4—Muter 6-ohm rheostat
R_5—Electrad 2000-ohm variable resistor, Type F
R_6—Muter ¼-ampere Tubestat
R_7—Muter 3-megohm grid leak
T_1—Karas audio transformer, Type 28
V_1—Filament voltmeter, 0–8 volts, Jewell Type 135
V_2—Plate voltmeter 0–100 volts, Jewell Type 135
3 Karas brackets
4 Alcoa shields
Front panel 7" x 24" x 3/16"—Celoron
Sub-panel 10" x 23" x 3/16"—Celoron
2 National illuminated vernier dials
1 Belden 7-wire fused cable
2 condenser shafts ¼ inch diameter, 10 inches long
Belden Colorubber hook-up wire
6 Benjamin base mounting sockets

FOR THE POWER UNIT

C_1, C_2, C_3, C_4, C_5—Muter power condenser blocks, No. 598
C_6—Muter 0.5-mfd. condenser, No. 507
C_7—Muter 2-mfd. power condenser, 600 Volt
T_1—Power transformer / L_1, L_2—Filter choke coils } Both contained in Thordarson Power Compact, Type R-210
T_2—Karas audio transformer, Type 28
L_3—Muter audio choke, No. 3130
R_1—1500-ohm Ward-Leonard resistor
R_2—150-Ohm Centralab variable power resistor
R_3—Heavy-duty high-range Clarostat
R_4, R_5—Muter 10,000-ohm resistors, Type 2910
8 Eby binding posts
2 Benjamin sockets
Hook-up wire

The following apparatus is also necessary to make the receiver operative:
5 CX-301A tubes
1 CX-310 power amplifier tube
1 CX-381 rectifier tube
Loud speaker such as the Magnavox Dynamic Cone
A-Power unit such as the Abox
Frost 100-foot antenna wire, with ground lead and clamp

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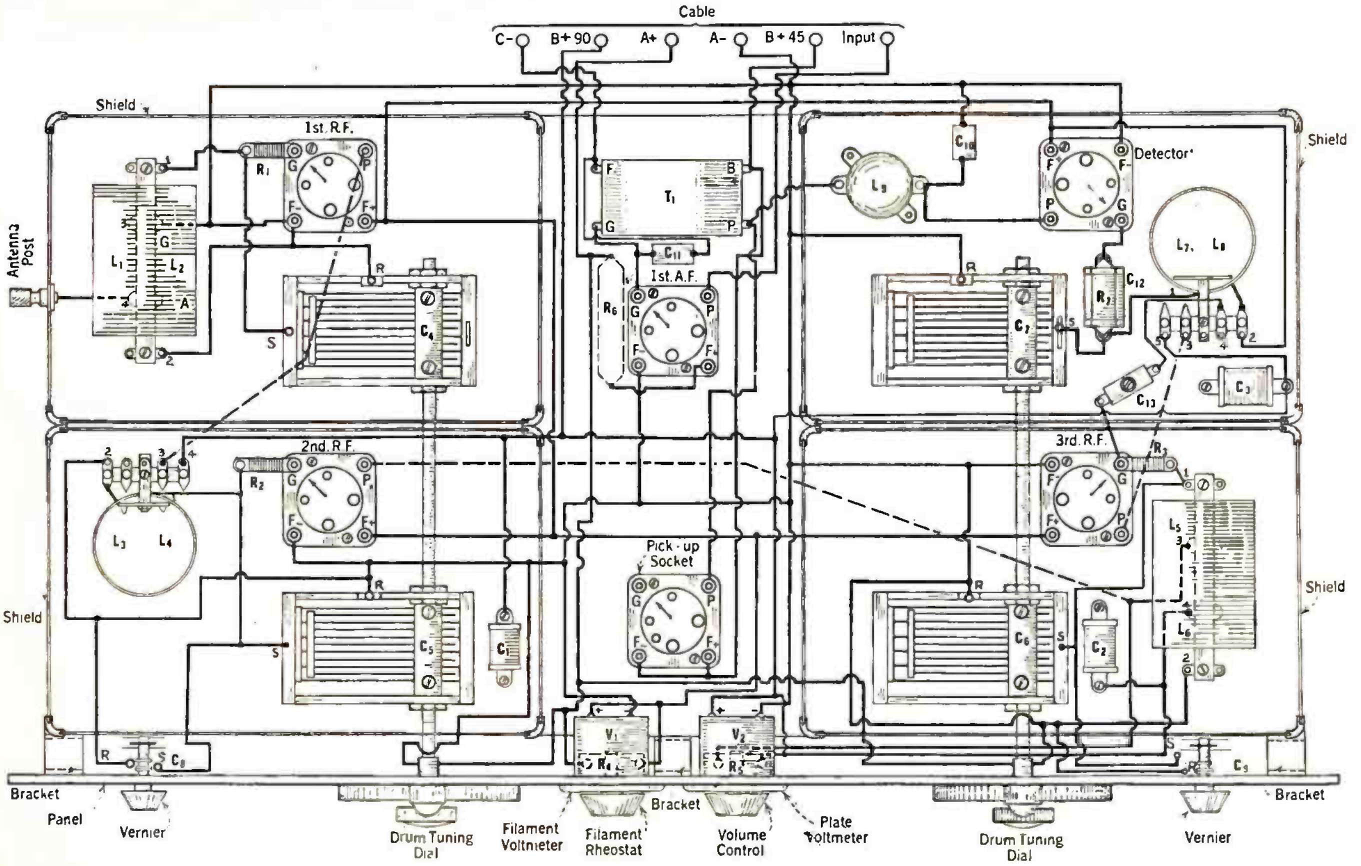

FIG. 1. THE PICTURE WIRING DIAGRAM OF THE RECEIVER

fier is that the various circuits have been stabilized by means of grid resistors. In the final stage a neutralizing condenser is also used. Without the neutralizing condenser in the circuit or with the condenser improperly adjusted the amplifier will oscillate over the entire band. With the neutralizing condenser correctly adjusted, however, the circuit is entirely stable.

The volume control is located in the r.f. amplifier and consists of a variable resistance across the primary of the third r.f. transformer. Care is necessary in the selection of the method of volume control. A filament rheostat on the r.f. tubes would not be very satisfactory because the output voltage of an A-power unit increases when the load is decreased, and therefore, if the volume is lowered by decreasing the filament voltage on the r.f. tubes the filament voltage across the other tubes in the set would rise above normal and shorten their life considerably. A resistance in series with the B-plus lead to the r.f. transformer is also unsatisfactory because it will cause wide variations in the voltages applied to the plates of the detector and first audio tubes. A variable resistance across the primary of an r.f. transformer has none of these disadvantages. It operates very smoothly and does not cause any changes in the plate or filament voltages applied to any of the tubes.

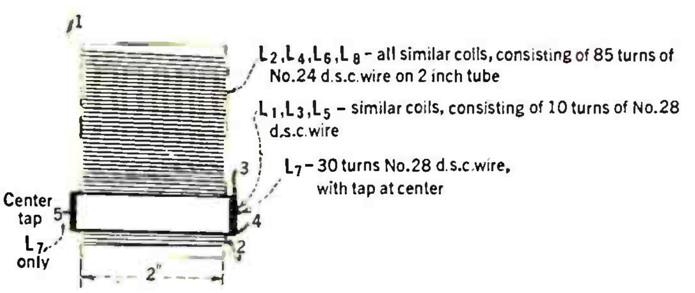

FIG. 2. THE COIL DATA

An r.f. choke is placed in the plate lead of the detector to keep r.f. currents out of the audio amplifier, and a small 0.002-mfd. fixed condenser bypasses the radio-frequency currents from the plate to the filament of the detector tube.

As was mentioned previously, an extra socket is placed in the receiver so that a phonograph pick-up may be used. The plate terminal of this

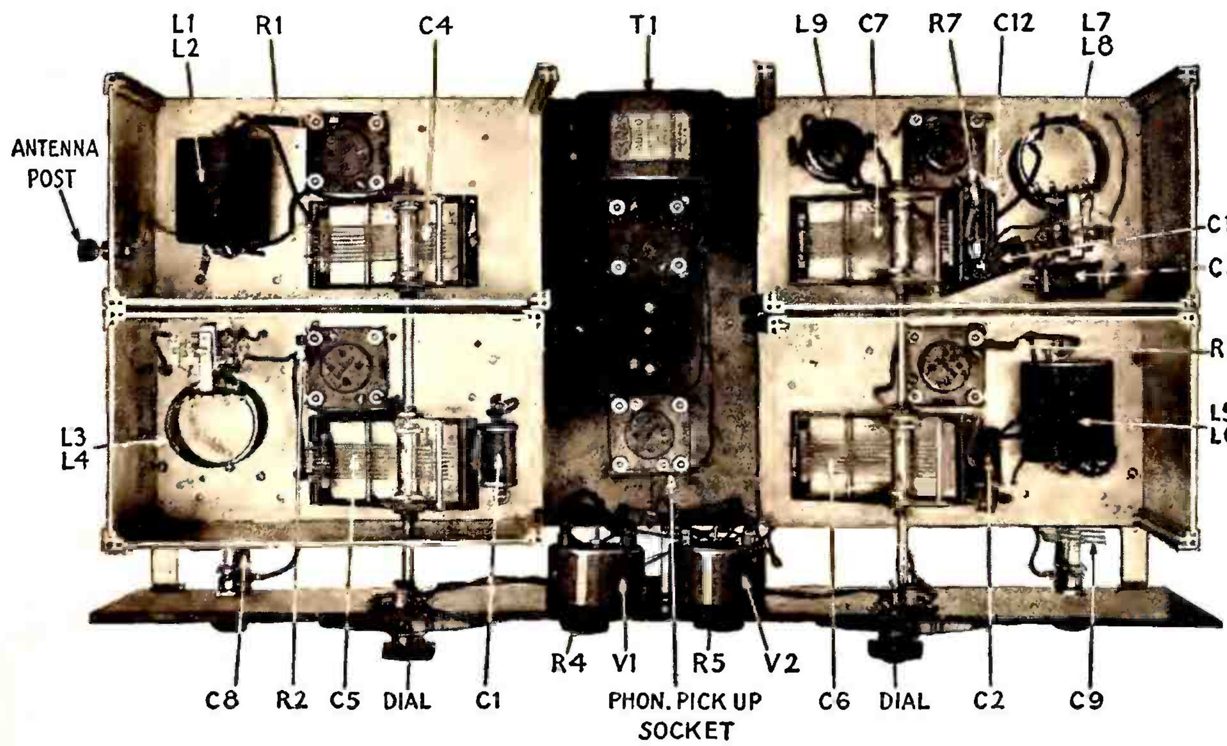

FIG. 3. THE RECEIVER FROM ABOVE

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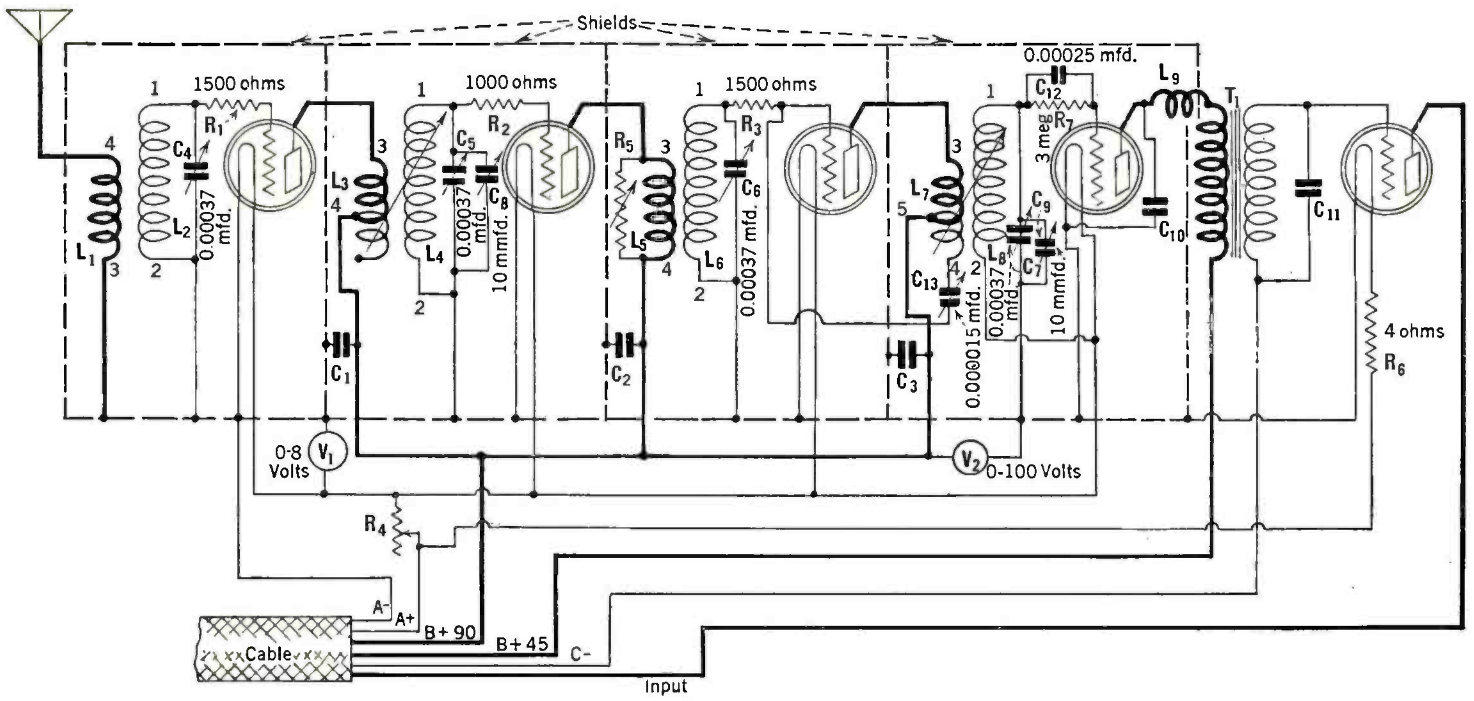

FIG. 4. THE CIRCUIT OF THE RECEIVER

The receiver described in this article consists, as shown by this circuit diagram, of four stages of tuned r.f. amplification, a grid-leak condenser type detector and a single stage of audio amplification, the second stage of amplification being incorporated in the power amplifier and B supply. For those that desire to use a phonograph pick-up it is suggested that an additional socket be included in the set. The placement and wiring of this additional socket is indicated in the picture diagram, Fig. 1.

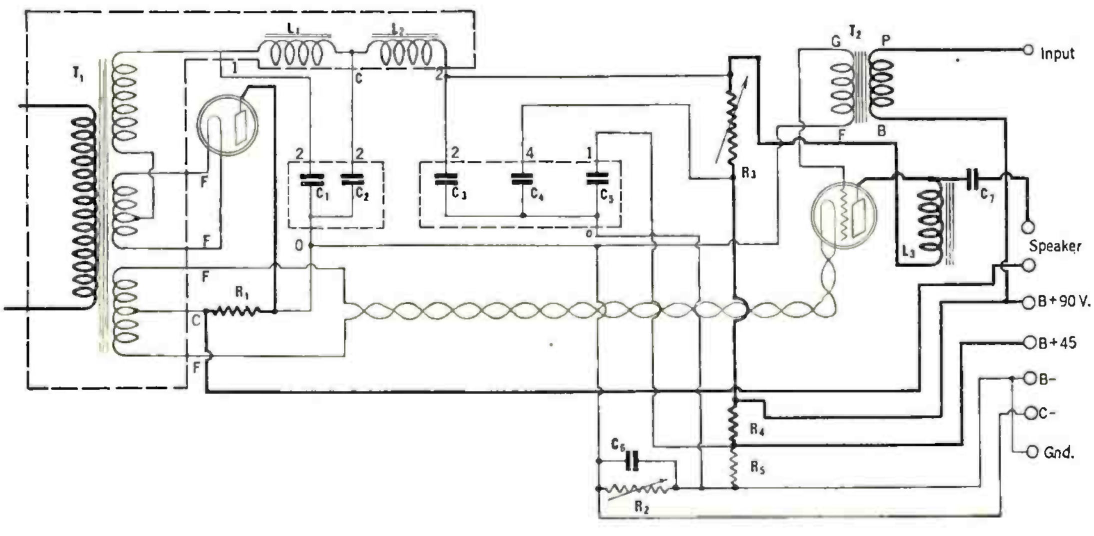

FIG. 5. THE CIRCUIT OF THE POWER UNIT

This power amplifier and B supply, designed for use especially with the receiver described in this article, supplies A, B, and C voltages to the type 210 power amplifier tube and B and C voltages for the receiver itself. This power unit, in conjunction with an A-power unit, such as the Abox, makes possible the operation of this receiver directly from the light socket

extra socket connects to the P terminal of the first stage audio transformer. The two filament terminals are wired together and are connected to the B plus terminal of the same transformer.

Therefore, when the adapter from a phonograph unit is plugged into this socket, the pick-up is connected directly across the transformer primary. When the pick-up is being used, the detector and radio-frequency amplifier tubes may be turned off. This is accomplished by tuning the filament rheostat on the panel to zero, in which position all the filaments except that of the first a.f. tube are turned off.

HOW TO ASSEMBLE THE RECEIVER

THE assembling of the receiver should not be very difficult if the circuit and picture diagrams are carefully followed. The circuit diagram of the receiver is given in Fig. 4 and the picture layout in Fig. 1. Specifications for home-made r.f. transformers are given in Fig. 2, the lettering on the coils corresponding to the same numbers in the circuit diagram. Fixed primaries are used in these home-constructed coils because they are more easily constructed than coils with adjustable primaries. A top view of the receiver is shown in Fig. 3.

If manufactured coils of the make specified in the list of parts are used, it is essential that the first and third coils (L_1 and L_2, and L_5 and L_6) be mounted by means of only one mounting screw at the primary end. If mounting screws are placed through the hole at the grid end, the coil will be short circuited by the shield. The bypass condensers, C_1, C_2 and C_3, should also be mounted with one screw.

The accurate alignment of all four tuning condensers is accomplished by loosening the clamping screws on the tuning condensers and then adjusting, by hand, the position of each rotor so that maximum volume is obtained.

The power unit illustrated in this article has been constructed especially for use with this receiver. It is a combination power amplifier and B supply. The circuit diagram is given in Fig. 5 and the picture layout in Fig. 6. In adjusting the complete installation, the power Clarostat in the power unit is adjusted so that the voltmeter, V_2, on the receiver panel reads 90 volts. The 150-ohm Centralab variable resistance supplies C bias to the first audio tube.

The parts used in the receiver and power unit illustrated in the article are given on page 192. Other equivalent parts may, of course, be used.

The set illustrated in this article was made for RADIO BROADCAST by the Rossiter, Tyler & McDonnell Service.

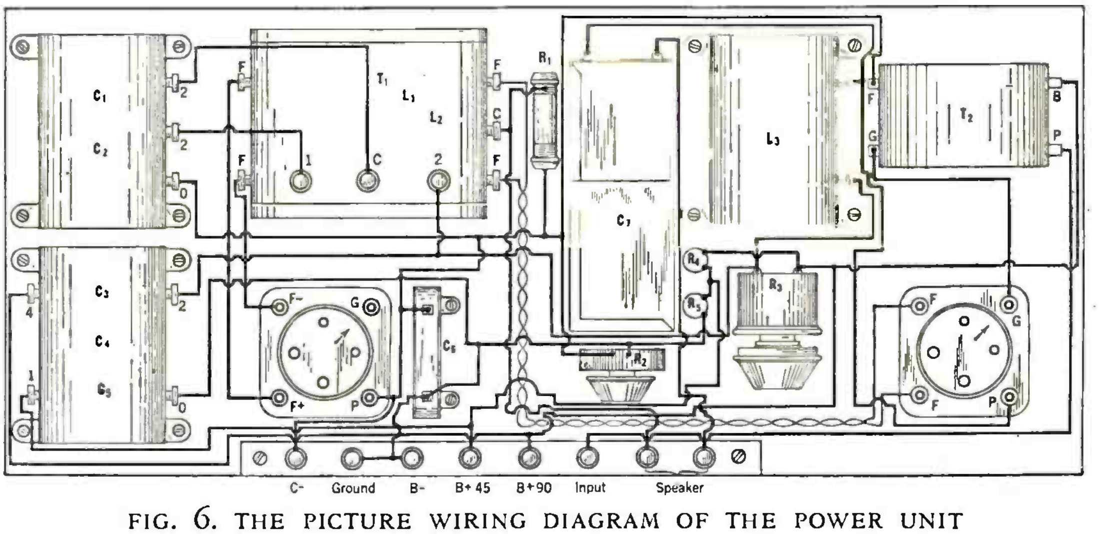

FIG. 6. THE PICTURE WIRING DIAGRAM OF THE POWER UNIT

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THE MARCH OF RADIO

NEWS AND INTERPRETATION OF CURRENT RADIO EVENTS

The War on the Short Waves

WERE a modern Columbus to discover a New World, the nations of the earth would speedily sally forth to seize their share of its virgin lands. In the last decade, science has discovered such a new world in the ether and the nations are rushing feverishly to stake out claims by inaugurating new short-wave services.

Commissioner LaFount stated before the House Committee on Appropriations recently, "It might interest you to know that in the last ninety days, over ninety foreign stations have gone on the air in an effort to control communication—the wireless communication of the world. The United States has placed two on the air. . . . Now it is a fight to get there first. We file or preëmpt in Berne the channels that we think we are going to use, but what counts are the channels that are actually put to beneficial use."

Communications are the nerves of commerce and commerce is the life of nations. Permitted unrestricted growth as private enterprise, American communication companies have made excellent progress in establishing a world-wide communication system (see March of Radio, March, 1928); but we are now entering a new phase of the situation, a bitter war of competition between telegraph and radio interests, further complicated by the ambitions of the host of interests desiring to establish private services. This era of competition should be considered not only in the light of its national importance but for its bearing upon the position of America in international communications.

The keenest competitors for radio territory are Great Britain and the United States. And Holland has not been backward; it looks upon radio communication not only as a medium of commercial exchange but as an ally to maintain unity with her far-flung colonists by means of short-wave rebroadcasting of programs originating from the mother country. Germany also has ambitious plans, already well under way, for an international system of high-speed telegraph, radio, and picture transmission.

The present enviable position of American international communications, now threatened by politics and bitter competition, is as much attributable to former political meddling in England as it is to American commercial and scientific progressiveness. The stage is now set to repeat in the United States all the mistakes Britain has made, just at a time when it may seriously injure our position in the world of the ether. For Great Britain has now attained that solidarity in wireless communications control the lack of which gave the United States an opportunity to come to the front; and we have arrived at a point where internal conflict is becoming a serious impediment to further progress.

Struggles of the British Imperial Radio System

AS EARLY as 1910, a British imperial chain to link the dominions with radio was discussed. The Imperial Conference in June, 1911, recommended a state-owned system of communications and a contract to put it into operation was signed in July, 1913, after protracted negotiations with the Marconi Company. The World War prevented further progress with the plan, which would have placed British interests supreme in the field of communication. In 1919, another imperial wireless telegraph committee was appointed, which drew up a plan for a chain system of stations separated by about 2000 miles. Still another committee was appointed in December, 1920, to carry out the plan.

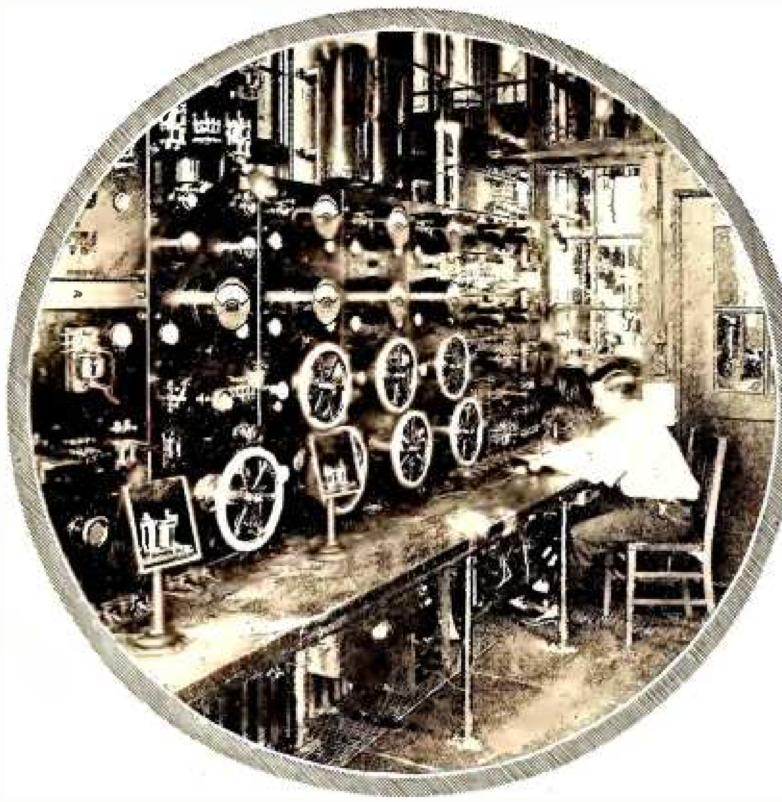
The colonies, however, grew restive at these costly delays and several negotiated directly with the Marconi Company for the erection of stations to link them with the mother country. These independent measures confused the imperial scheme. With the coming of the coalition government in 1923, the imperial plan was again shelved and private enterprise encouraged. After months of negotiation with the Post Office Department, however, the Marconi Company failed to obtain a satisfactory license to enter the field, with the result that still another Commission was appointed, headed by Sir Robert Donald, Chairman of the Council of the Empire Press Union. Its report, made in February, 1924, resulted in a contract with the Marconi interests for the erection of four beam stations to link England with South Africa, Australia, and India. Construction was begun in April, 1925, and service within two years. A traffic totalling 35,000,000 words annually is now being handled.

But even this is not the end of the story. After paying regular and substantial dividends for decades, the British international cable system, erected largely with capital supplied by the government and the dominions, was turned into a losing proposition by radio competition. Still another government commission was appointed with a view to protecting this immense investment and working out a traffic division or merger agreement with the radio interests. Fearing further government blunders, the two interests worked out a merger agreement, announced March 15 of this year. The problems of political interference and cable competition having thus been solved by amicable adjustment, British interests are now forging ahead untrammeled.

The Mackay-R.C.A. Struggle

IN THE United States, the Mackay interests, seeking to protect their cable investment, have embarked upon an ambitious plan to compete with the Radio Corporation in the field of communication. The R. C. A., in turn, has attempted to step into the overland communication business as a competitor to the telegraph. To that end, it has applied for construction permits to erect 65 short-wave transmitters for a domestic service linking 24 cities. At the same time, the Mackay interests are seeking to establish their own national radio system as a supplement to wires. Furthermore, powerful newspaper interests are laying plans to establish their own independent national and international communication systems and have been granted 20 of the 22 channels which they sought by the Federal Radio Commission. On all sides there is effort to duplicate facilities, many of which, experience has shown unmistakably, are unprofitable if competitive.

We are opposed to a communications monopoly, although economic considerations require that no services be paralleled or duplicated unless traffic warrants. The Federal Radio Commission requires the wisest possible counsel if it is to avoid endangering the American position. International communication is a semi-public function and can be regulated to secure the advantages of monopoly without permitting its abuse. We have the most efficient telephone system in the world because it is monopolistic. We also have the lowest telephone rates, and they will remain the lowest because we have the power of regulation through public service commissions.



THE CONTROL ROOM OF A COMMERCIAL TRANSMITTER

This array of meters and tuning controls regulates the short-wave transmissions of the San Francisco station of the Federal Telegraph Company. The control room is located at Palo Alto, California

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A working agreement among telegraph and radio interests is essential to our future in international communications. No one should be excluded from the field who can contribute needed service. The vast system of message collection and distribution of the established telegraph system must be made available to radio, and the revenue equitably divided so that cable, telegraph, and radio can continue to operate profitably without destructive competition. If such agreement is not equitably worked out by the interests involved, government meddling, with its paralyzing influence, will follow. If the problem is tackled with a spirit of conciliation, there is ample room for both the Mackay and the Radio Corporation interests. The American position in international communications is threatened by a destructive warfare of rival interests.

A RADIO DÉBUT IN THE FAR NORTH

Old John Furth, Hudson's Bay factor at Fort McPherson, Mackenzie, Canada, is listening in on KGO *as picked up by the portable receiver which Lewis R. Freeman carried on his expedition in Canada. Furth is standing by a sun dial erected one hundred years ago by Sir John Franklin, the Arctic Explorer*

The Commission Announces Its Short Wave Policy

THE Federal Radio Commission on May 24 allocated 74 short wave channels for transoceanic services, as follows:

Robert Dollar Company, 8 channels; Tropical Radio Telegraph Co., 7; American Telephone & Telegraph Company, 9; American Publishers Committee, 20; the Mackay Company, 15; Radio Corporation of America, 15.

These assignments were made on the basis of a statement of principle adopted by the Commission: "That competitive service be established where there are competing applications to compete with already established service, and that in the grant of competing licenses fairness of competition be established, except that as to an isolated country, which in the judgment of the Commission will not afford sufficient business for competing wireless lines, only one grant of license shall be made, preferably the first application in priority."

The table on this page shows the number of transoceanic channels in use, applications made, approved, and totals in use.

How closely the Commission has adhered to the excellent principle which it has enunciated cannot be judged without knowledge of the specific purposes for which these applications recently approved are to be put. Perhaps in the most doubtful category are the assignments made to the newspaper publishers, inasmuch as most of their services are likely to duplicate existing facilities. The communication companies, so long as their own applications are granted, are not likely to oppose the assigning of channels to the press which, through its public influence, can embarrass them and which, from the revenue standpoint, does not make a desirable customer because of the special rates applying to its needs.

CALDWELL HITS STRAIGHT FROM THE SHOULDER

ACCUSTOMED as we are to soothing propaganda from the Federal Radio Commission, it gives us no little pleasure to report as fully as space permits the remarks of Commissioner O. H. Caldwell, delivered through WOR on May 22.

After pointing out that the Davis Amendment must be enforced and that it offers an opportunity to better conditions for the listener, Mr. Caldwell continued: "Indeed, it is no longer a secret that certain members of Congress, after having secured the passage of the Davis-Dill Amendment hardly six weeks ago, would to-day like to see its enforcement indefinitely postponed, now that they have discovered what will be its effects on the various states (and their own political reputations) when actually applied. . . . The outpourings of a few self-seeking politicians on the menace of high power; tedious legal theories; convenient states' rights arguments borrowed to cloak promoters' profits; or the necessity for Podunkville to have a 1000-watt transmitter which can specialize only in phonograph records and county political oratory—these topics all have very little concern for Mr. Average Listener if only the wavelengths of the great popular stations he dials to, nightly, can be kept clear so that their splendid programs can be received as unspoiled and perfect as when they left the studio. That much, and only that, do the millions of radio listeners really ask of their Congressional representatives, their Federal Radio Commission, and their Government at Washington. And it is high time that they got it.

"What the public itself has been demanding—and has a right to expect from the Commission—is prompt relief from the unhappy radio reception conditions which still persist, and have rendered large parts of our radio spectrum useless, particularly to distant listeners on farms, ranches, and in remote communities.

"The station over which I am speaking, WOR, now recognized as one of the great program sources of the country, frequently has its splendid programs ruined at some places within 30 to 35 miles of Newark and New York by the heterodyne moans and howls produced from another station on the same wavelength, WOS, in Missouri. Meanwhile, WOR inflicts similar interference on the good people of Missouri. The other popular 5000-watt New Jersey station WPG, at Atlantic City, is similarly spoiled at any distance by several Middle West stations—which, in turn, it similarly injures.

"In New York City, reception from WNYC is continuously ruined by a Chicago station; WHN is blasted by transmitters in Louisiana and Iowa; and WABC is injured by cross talk from an adjoining channel. Even WEAF and WJZ suffer Pacific Coast whistles on winter nights.

"In Philadelphia, the popular pair WFI and WLIT are badly heterodyned, right within the city limits, by carrier-waves from Minnesota. In Boston, WNAC has a background of growls which come from Pittsburgh. Massachusetts' big 15,000-watt WBZ station shares its wave with eight other stations, affording the farmer who tries to tune in on its agricultural programs all the variety of howls and roars incident to feeding time at the zoo. And this enumeration of particulars in the listeners' bill of complaints might be extended almost throughout the whole 89 wavelengths.

"This is the real situation which the Commission was created to correct, and which the millions of the public have patiently waited to have remedied. This is the situation of nightly interference which will again be upon us in September, after the summer static has rolled away.

"It can be remedied only by reducing the number of stations permitted to operate simultaneously on the air during night hours. The re-

Short-Wave Transoceanic Assignments in the United States

	Now using	*Applied for recently*	*Approved*	*Total assigned*
Pacific Communications Co.		8	0	0
Robert Dollar Company		15	8	8
Tropical Radio Telegraph Co.		12	7	7
American Tel. & Tel. Co.	3	9	9	12
American Publishers		22	20	20
The Mackay Company	22	19	15	37
Radio Corp. of America	50	55	15	65
TOTAL	75	140	74	149

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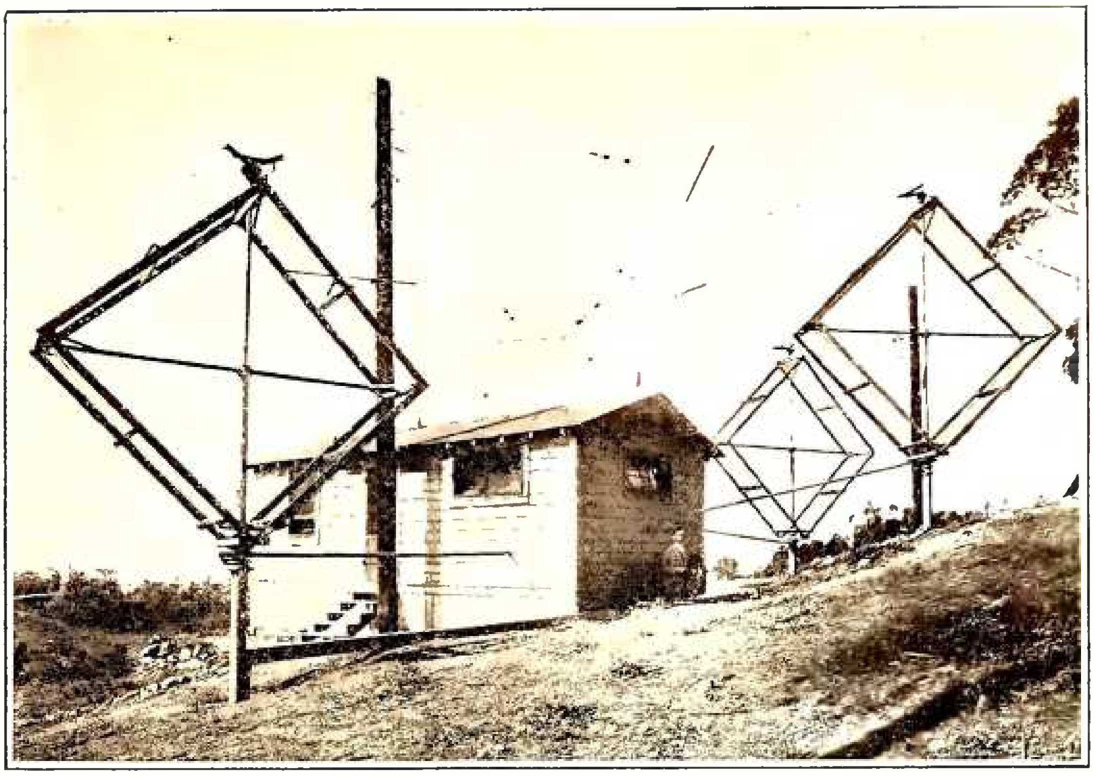
quirements are well known to all radio engineers. We have only 89 wavelengths. For good radio, not over 160 stations of the 500-watt and 5000-watt classes can operate simultaneously on 85 of these wavelengths. On the remaining four wavelengths we can tuck in a couple of hundred 50 or 100-watt transmitters. And there you have the outline of the possibilities in the present state of the art."

No more courageous and clear cut statement has ever emanated from the Federal Radio Commission. It must not, however, be regarded as anything more than the statement of one Commissioner who understands the situation and is in favor of carrying out his duty. It can be fairly charged that the majority of the Commission is totally lacking in ability and courage and has utterly failed to protect the interests of the listener whom it is supposed to serve. So long as the local interests of politicians and the short-sighted demands of individual broadcasters have the ear of the Commission rather than the radio audience at large, the present confusion will persist. Mr. Caldwell's is a voice crying in the wilderness. More power to it!

On May 27, the Federal Radio Commission promulgated its Order No. 32, the first drastic measure to reduce the number of stations on the air. It lists 162 broadcasting stations which must sign off August 1 unless they can show good reason for renewal of their licenses. A careful scrutiny of the list shows that many of the stations have been inactive and that it comprises only stations of a very low order of merit, occupying extremely congested channels. While the number of stations involved is considerable, this is only a first step, which will bring very little noticeable relief. It does not attack congestion of the type to which the Commissioner referred, involving stations rendering important service. The real problems of the Commission will not begin until it disposes of stations of some technical ability which serve no real program purpose. But the measure is a good beginning which, we hope, is only the first of a series of major steps to relieve broadcasting congestion.



WHERE SHORT-WAVE MESSAGES ARE RECEIVED

The barrage antenna and receiving shack are part of the Federal Telegraph Company's station near Los Angeles, California. Coastwise and marine commercial radio traffic is carried on by short waves

AMATEURS IN THE TEN-METER BAND

C. K. ATWATER of Upper Montclair, N. J., has been successful in establishing two-way communication on 10 meters with 6ANN, Long Beach, Cal., 6UF, Los Gatos, Cal., and 8CT, Arachon, France. Commenting on this remarkable achievement, the American Radio Relay League stated that the ten-meter band might yet prove of actual worth in long distance transmission of messages by radio and that experiments by amateurs might ultimately solve many difficulties on this band hitherto considered insuperable by communication engineers.

There is no justification whatever for the statement that engineers consider the difficulties to the utilization of super short waves insuperable. We refer the amateurs to a paper by Marconi, *Proceedings of the Institute of Radio Engineers*, August, 1922, describing experiments conducted over a period of years on wavelengths between 1 and 20 meters. Since that time, continuous research work has been conducted on ultra-high frequencies in many professional laboratories. Several international commercial circuits operate regularly on 11 meters, and no communication engineer who has worked on high frequencies has ever made a statement justifying the A. R. R. L's boast. The amateur is to be commended for his experiments, but the statement that he is pioneering in the ultra-high frequencies, spurned by engineers, is not supported by the facts.

Here and There

A WIRELESS station is being completed at Horta, Azores Islands, by the Portuguese Government for the purpose of radiating detailed weather reports four times daily. It will be of special service to transatlantic aircraft.

THE National Broadcasting Company has formed the National Broadcasting and Concert Bureau, with George Engles, former manager of the New York Symphony Orchestra, as its managing director. The National Broadcasting Company now arranges 5,000 microphone appearances each month.

STATION WGY, on April 30, rebroadcast a program radiated from 2FC, Sydney, Australia, on a 28.5 meter wavelength. H. M. Myers of Birmingham, England, reports an amazing feat of international reception in which 2XAF, WGY's short-wave sister, participated. Tiring of local programs, Mr. Myers tuned to Stuttgart, Germany, then rebroadcasting 2XAF. The Schenectady announcer informed his audience that a program from London was coming in so well that 2XAF would rebroadcast it. The Britisher listened to the London program to the end, setting his watch by Big Ben, after the signal had made two trips across the Atlantic. Distance lends enchantment!

A FLYING description of the parade in honor of the Bremen crew was broadcast by WOR on May 6 with the aid of an announcer aboard a plane. A short-wave transmitter, working on 65.48 meters, utilizing two 210 tubes, served the transmitter.

THE Crosley Radio Corporation, operating WLW, has obtained control of WSAI, U. S. Playing Card Co., of Cincinnati. It hopes, by combining these two stations, both of which have a cleared channel, to secure an exclusive channel for the proposed 50,000 watt WLW transmitter.

STATION WOO, pioneer Philadelphia broadcaster, operated by the John Wanamaker store since 1922, signed off June 1. "Investigations made by special inquiry among radio listeners during the past two years have revealed that broadcasting is not helping the store in general or in an advertising way, hence our decision to discontinue operations indefinitely." Hundreds of stations, making a similar impartial investigation, would come to the same conclusion. Maintaining a broadcasting station is a costly operation, and a single retail organization can no longer justify the expense of running a full time station by the resultant good-will and sales.

PERMALLOY SAVES THE CABLE COMPANIES

IN a paper appearing in the April, 1928, issue of the *Bell System Technical Journal*, entitled "High Speed Ocean Cable Telegraphy," O. E. Buckley discloses the progress made in high speed cable communication, largely attributable to the use of permalloy loaded cable. The first of these cables was laid in September, 1924, between New York and Horta, and there are at present seven high speed permalloy loaded ocean cables, totalling 15,000 miles in length. Their capacity is 2,500 letters per minute. Mr. Buckley's conclusion is that "permalloy loading has so reduced that part of the total cost per word for which the cable itself is responsible that the advantage of radio can never be very great. It has yet to be shown that radio telegraphy can furnish as reliable and satisfactory service as is now provided by the cables. . . . It is evident that only a much higher degree of perfection of radio communication than has yet been attained can permit wresting from the cable the advantage which it has so long maintained."

THE New York Central Railroad has asked the Commission for short-wave telegraph assignments in order that it may equip some 300 small harbor craft with radio telephony of low power. Successful experiments in communication between engineer and conductor of long freight trains will sooner or later require additional channels for the railroads. Inasmuch as

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DX WITH A HOME-MADE LOUD SPEAKER

The improvised loud speaker on top of the radio was made from a camp-fire reflector and an old baking powder can. It helped the members of the Harmon-Freeman Expedition in the Canadian Rockies to get the play-by-play account of the World Series in New York

these services are all of low power, but few channels will be required.

THE Federal Radio Commission was allowed an appropriation of $301,467 by Congress, an amount larger by $149,067 than was allowed by the Budget Bureau. The Chairman of the Commission indicated that it would employ one chief attorney and two assistants, five radio experts and several examiners. Next year, they will ask for an office building, a larger staff and a million dollar appropriation. The Commissioners ought to be hired on a piece-work basis, so much per station eliminated with a bonus for each channel cleared. General Order No. 32 would give it a good start for the year.

GERMAN radio exports during 1927 were valued at 33,426,000 marks, of which about one-tenth was shipped to Belgium, France, Italy, Jugoslavia, Roumania, and Japan as war indemnity. Shipments to the United States were valued at 1,066,000 marks.

THE British Postmaster General has authorized the erection of a new, high-power, twin wavelength station in London, to be erected for the British Broadcasting Company. It will be in service in twelve to fifteen months.

AN ADVISORY Committee to the League of Nations has recommended the construction of a $250,000 wireless telegraph station with an estimated operating cost of $40,000 annually. Its estimated traffic is valued between $20,000 and $30,000.

SENATOR DILL now offers a new substitute for his S. 2783, to the effect that it shall be considered complete defense in an infringement suit to prove that the complainant is a party to an agreement, cross license or understanding with any patent holder which tends to lessen competition or create a monopoly. The proposal is of doubtful constitutionality, but it may help the Senator in his forthcoming campaigning back home. As Heflin hates the Pope, Dill hates the R. C. A. Why not propose to repeal the patent law? It is distinctly in restraint of trade and creates legal monopolies. At least such a proposal would be straightforward and could be fairly judged on its merits.

THREE radio beacons have recently been placed in operation on Long Island Sound by the Lighthouse Service of the Department of Commerce. They are at Execution Rocks Lighthouse near Hell Gate Bridge, at Stratford Shoals Light, and at Little Gull Island.

IN LINE with the policy of conserving frequency space, the number of naval stations has been reduced from 167 in 1921 to 78, and further reductions, to be in effect by June 30, 1929, will bring the number to 72. Traffic continues to grow, the 1927 total being 75,296,500 words, as compared with 55,779,900 in 1927 and 53,102,900 in 1925. During 1927, 40,000,000 words were handled for the Navy, 13,000,000 for other Federal departments and 9,000,000 words of commercial and press traffic.

IN SPEAKING of the newly formed American-Baird Television Corporation, formed by Messrs. Herbert Pokress, Charles Izanstark and Nathan Feldstern, Sir Charles Higham, one of the British stockholders and a well-known advertising man, stated: "In my opinion, television will work a decided advantage in the advertising methods of the new world. The greatest difficulty heretofore encountered by manufacturers has been to give the consumer his first view of the product. People are curious as to the various ways of making things, and rightly so." Mr. Baird's television apparatus is no exception to this rule.

LIONEL BARRYMORE is quoted, in an interview granted in Chicago, as saying that television will scrap the theaters throughout the country. That's what they predicted electricity would do to gas, the telephone to the telegraph, and radio to the movies. Even should television rise to such heights that it has entertainment as well as scientific value, it can never replace mass entertainment presented in person by capable actors.

STATION WRNY will send television images under the supervision of Theodore Nakken. Transmissions will be at the rate of 10 images per second and consequently are restricted to very slow motion. The inventor claims that the station's 10 kilocycle channel will not be exceeded. Observers of WGY's 380-meter television signals report that they trespass far into neighboring channels, although these consist of only 24 lines.

EXPORTS of radio apparatus during March amounted to $858,302, an increase of $199,830 over the same quarter last year Argentina exceeded Canada as our best market for the first time during the month of March.

THE Lektophone Corporation has licensed the United Radio Corp. of Rochester, makers of Peerless speakers, under the Hopkins patents.

AN APPLICATION for a patent on a variable condenser, so shaped as to give a straight-line frequency effect, was denied as lacking "the dignity of an invention" and the decision of the Commissioner of Patents to that effect was sustained by the Supreme Court.

—E. H. F.

RADIO ON TRAINS

SINCE the Delaware, Lackawanna & Western began experiments with radio communication in 1913, considerable progress has been made in the art. Ford installed radio transmitters along the Detroit, Toledo & Ironton, but three years later abandoned radio in favor of a newly completed telegraph and telephone system. The New York Central began its experiments in coöperation with the General Electric Company in 1924, and highly practical apparatus has been developed for conversation between caboose and engine. On Election night in 1924, three eastbound and three westbound sections of the Twentieth Century Limited were equipped with receivers. The Great Northern began its work in 1925, but concluded that its telephone and telegraph equipment was adequate to meet its dispatching needs. The Canadian National Railways has erected ten broadcasting stations and has equipped a number of its de luxe trains with headphone installations. In Germany, several fast trains are equipped for radio telephonic conversation linked with the land line system. It is successful for trains traveling at speeds up to 45 miles an hour. Several English trains are equipped for broadcast reception for the benefit of passengers. Broadcast reception aboard trains is subject to constant intensity variations and, until we have automatic fading compensators, it is not likely to be generally adopted.

STATION WMCA and the stations associated in its chain began a regular schedule of Rayfoto broadcasting on May 23.

THE A. T. & T. has applied for the necessary channels to inaugurate a short-wave, single side band radio telephone service between New York and Buenos Ayres. —E. H. F.

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THE PANEL IS SIMILAR TO THAT OF THE A. C. MODEL

Building the D. C. Lab Receiver

By Keith Henney

Director of the Laboratory

IF THERE is any way we can know exactly what the readers of RADIO BROADCAST *want, we should like to find that way. For months we promised another article on the Lab Circuit receiver. For the June number we got Mr. Hugh Knowles to build us a receiver with all modern improvements, a.c. tubes, etc. Immediately we received complaints that what was wanted was a d.c. Lab Circuit article. Here it is. Almost the same list of parts is used, they are placed in the same postion on the baseboard, and their functions are the same. The differences in operation and dx getting ability are too slight to be noticeable. In favor of the a.c. set is the freedom from battery troubles; in favor of this receiver is the greater freedom from power noise. Battery operation also has in its favor the feeling shared by many radio experimenters that the a.c. tubes may not last as long as their older brothers, the battery operated tubes.*

—THE EDITOR.

THE differences between the R. B. Lab Circuit receiver described by Hugh S. Knowles in the June RADIO BROADCAST (p. 93) and the model described in this article are few; the present receiver uses standard d.c. tubes of the 201A or preferably the 112A type (because of their better detection and amplification characteristics), while the June receiver was designed to use a.c. tubes. The same placement of parts is followed, the parts themselves are the same; the circuit diagram has not changed. The only differences are those incidental to the use of the a.c. type of tubes. Some readers prefer the newer tubes, others prefer battery-operated tubes. It is probably true that thousands of RADIO BROADCAST's readers have d.c. tubes on hand to hundreds who have 226's and 227's, and there are many who still have faith in the old storage-battery-charger outfit—the Staff of RADIO BROADCAST Laboratory among others!

Briefly, the circuit is the R. B. Lab that was first described in June, 1926, and brought up to date in the April and June issues of this year. Readers who are not familiar with its advantages and its theory are urged to get those copies. It is only necessary to state here that it is a four-tube receiver consisting of a stage of neutralized radio-frequency amplification followed by a grid leak and condenser type of detector with capacity feed-back, and a two-stage transformer-coupled amplifier. It is the standard circuit to which all others are compared in the Laboratory. Any other receiver which, regardless of the number of tubes, can get signals of equal strength out of weak distant stations, is considered a good receiver. The chances are that such a receiver is subsequently described for the benefit of our readers.

Fig. 2 is the circuit diagram of this receiver, operating with d.c. tubes. It requires less apparatus than the a.c. receiver, since the C-bias resistors which are used in the a.c. set to give the tubes the required grid voltages are not necessary. Provision is made for an external C battery to perform the same purpose in this model. In Fig. 1 is a top view of the d.c. set. It will be seen that exactly the same placement of parts as was used in the a.c. model is followed. Where the filament transformer of the a.c. set was placed, an output device, such as a condenser-choke or an output transformer may be located and, if desired, a C-bias resistor for the power tube may be placed beside it where the low voltage C-bias apparatus was installed in the a.c. set. Naturally, four-prong tube sockets will be used instead of five-prong or Y type sockets. An on-and-off switch has been included and should be installed on the panel—above the phonograph switch is a good place.

The phonograph switch, Sw_1, makes it possible, as Mr. Knowles has already explained, to throw the audio amplifier of the receiver from the set itself to a phonograph pick-up unit without the usual bother of removing the detector tube from its socket in order to place in it the plug which goes with all modern types of pick-up units. In other words, the plug is permanently installed in the extra socket, V_5, the cabinet is closed, and all bother has been eliminated.

COILS FOR THE LAB CIRCUIT

ALTHOUGH special coils are being manufactured for this receiver, many experimenters prefer to wind their own. The simplest method is as follows. Procure two coil forms 2 inches in diameter. Wind on both forms 75 turns of about No. 24 wire. The insulation and exact size of wire in not important. The coils will then tune over the broadcast band with 0.0005 mfd. condensers. For the antenna coil wind about ten or twenty turns about the exact center of one of the coils which has been tapped at the center turn for the C bias of the r.f. tube. This constitutes the coils, L_1 and L_2, in Fig. 2. The other coil is tapped at about the 25th turn, or if other size winding forms are used with different numbers of turns, tap the coil at about one third of its length. The smaller part of the coil goes in the plate circuit of the r.f. tube; the detector input voltage is that appearing across two thirds of the coil. Experimenters who wish greater selectivity, with somewhat less amplification, can reduce the number of turns in this plate coil, say to 15 in a 75 turn coil, that is, increase the turns ratio to 5 to 1.

NEUTRALIZING THE R.F. AMPLIFIER

THIS amplifier differs from the usual stage of r.f. amplification in being neutralized by the Rice system. When the circuit has been properly wired up, make the detector oscillate by varying the regeneration condenser; tune-in a fairly strong station; then, when the carrier whistle can be easily heard, vary the tuning condenser setting of the r.f. tube. Probably this will force the detector out of oscillation with a thump or a swish or a squeal. Turn the neutralizing condenser until this stoppage of the detector oscillations does not take place. When the amplifier is properly neutralized, changing the amplifier tuning condenser setting will have little or no effect upon the detector circuit. It is not important to worry about this neutralizing business. It may be impossible to neutralize the amplifier exactly so that it has no effect on the detector, due to extraneous couplings between the two circuits—magnetic via the coil fields, resistive via common batteries, or capacitive, through the other elements in the receiver. The important adjustment is that which enables any frequency to be tuned to without the amplifier going into oscillation or preventing the detector from tuning properly. This adjustment is easy to find.

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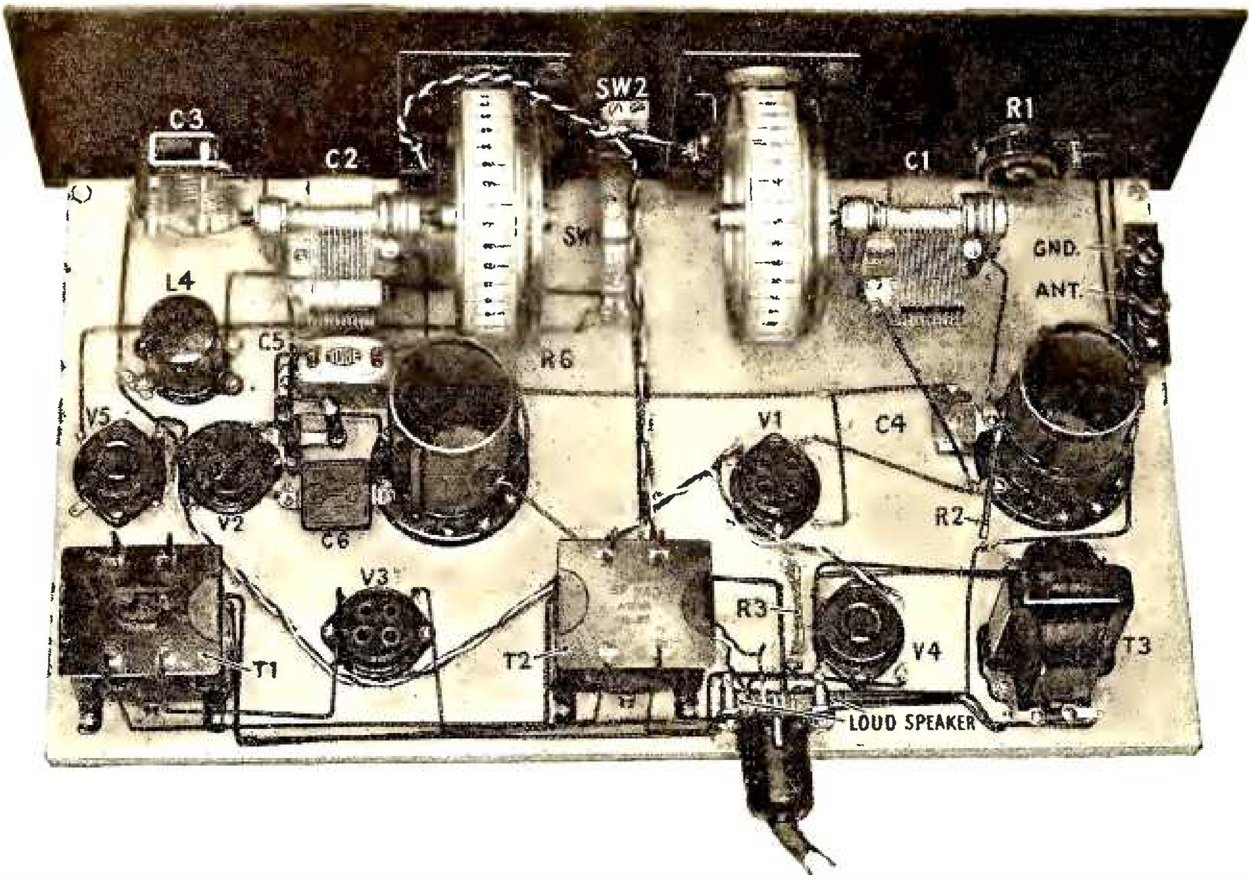

FIG. 1. THE TOP VIEW

Because the Rice amplifier has both the stator and rotor plates of the tuning condenser above ground potential—neither is grounded—some hand capacity may be evidenced. The easiest method of preventing such trouble is to use insulated shafts. Fortunately the Hammarlund condensers used by Mr. Knowles have removable shafts. It is a simple matter to put in a hard rubber (or other insulating material) shaft in place of the metal ones supplied by the manufacturer.

PANEL LAYOUT

A PICTURE wiring diagram and panel layout sheet may be obtained by writing to RADIO BROADCAST, Garden City, N. Y. The parts list on this page gives the apparatus actually used in the receiver. Similar parts may be used, of course. The only special apparatus is the coils, which may be built at home if desired.

WHAT BUILDERS THINK OF THE LAB CIRCUIT

SINCE the first appearance of articles on this circuit in RADIO BROADCAST, many readers have written of their experiences. The first of the letters quoted below is typical. It comes from a man of about forty who sells locomotives—we cannot, we regret, publish his name.

For your personal information, I take the occasion to write you that your last edition of the "Lab Receiver," as shown in April issue, far excells anything I have ever experienced in radio receivers.

I had a set built according to earlier issues, mounted in a handsome console with illuminated dials (Hammarlund), and coupled to a Western Electric 25" cone. Till recently I thought I had perfection.

However, I built a set for a friend as shown in the April RADIO BROADCAST, using Thordarson R-200 transformers and bypassing only the first B lead with a 2 mfd. condenser and audio choke. I used 3 112A's and a 171A. Both sets have the r.f. and detector stages in 6" x 10" copper boxes. This last set was more selective, sensitive, and gave far better tone quality. I put up two grounds and aerials and ran both on the same station, using the 25" and 18" Western cones, switching the cones. If this last set had fit my console I surely wou d have passed the old set on.

I was able to bring in Toronto with no interference from KDKA or WHT—and I am close to WHT. KOA, WSMB,—and others came in strong, clear, and without distortion. Not so on the earlier model. I could not get Toronto. You see I had two complete outfits—speakers, power units, aerials, and grounds. I tried to make a fair and intelligent test of the two sets. With the later set I actually tried to get interference on the lower waves on the locals. It couldn't be done.

The letter below is from Alfred V. Waller who lives in Halifax, Nova Scotia:

Just a line to let you know that I have been an R. B. Lab. Circuit fan since June, 1926, and can say there is no outfit to come near it in performance, or in any way, for that matter. I've tried everything up to 8 tube supers, but the R. B. Lab. tops them all. On the speaker I've had over and over on good nights KFI, KGO, CNRV, CZE and every other 10 kc. from 200 to 545.

LIST OF PARTS

- C1, C2—2 Hammarlund ML-23 condensers
- C3—1 Hammarlund MC-15 midget condenser
- C4—1 Hammarlund equalizer
- C5—1 Tobe 1.0-mfd. bypass condenser
- C6—1 Aerovox 0.00025-mfd. grid condenser
- L2, L3—1 pair Aero coils, type RB 8
- L4—1 Hammarlund choke, RFC-85
- R1—1 Electrad volume control, type P
- R2—1 Electrad grid resistor, 500 ohms
- R3—1 Frost deluxe resistor, 1 ohm
- R6—1 Durham grid leak, 2.0 megohms, with mounting
- SW1—1 Yaxley s.p.d.t. switch No. 30
- SW2—1 Yaxley s.p.s.t. switch No. 10
- T1, T2—2 Silver-Marshall audio transformers, No. 240
- T3—1 General Radio output transformer, type 367
- 1 Westinghouse Micarta panel, 7" x 21" x 1/8"
- 1 Yaxley cable and plug, No. 669
- 5 Eby 4-prong sockets
- 2 Eby binding posts
- 2 National single drum dials
- 2 Coils of Celatsite hook-up wire
- 2 lengths of 1/4" bakelite rod.

The additional parts necessary to make the set operative are three 201A or 112A type tubes and a 171 type for the last audio stage, a loud speaker, and A, B and C batteries or power supply units. The receiver will give best results with an outdoor antenna, 75 or 100 feet long.

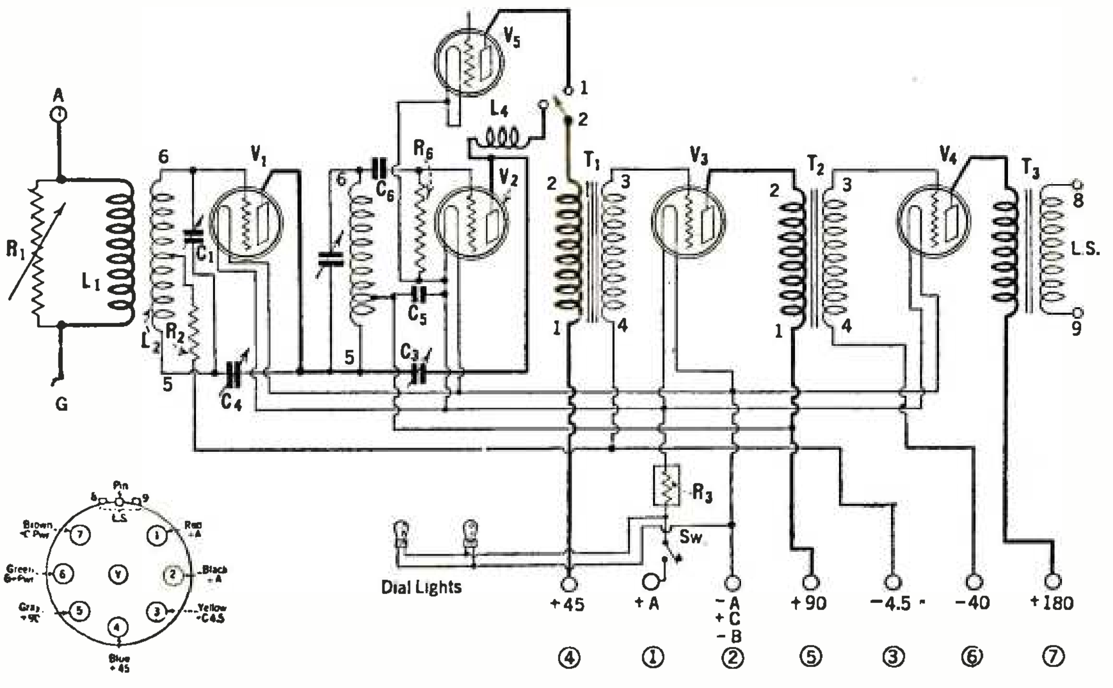

FIG. 2. THE CIRCUIT DIAGRAM

The detail diagram at the lower left shows the proper connections to the cable plug

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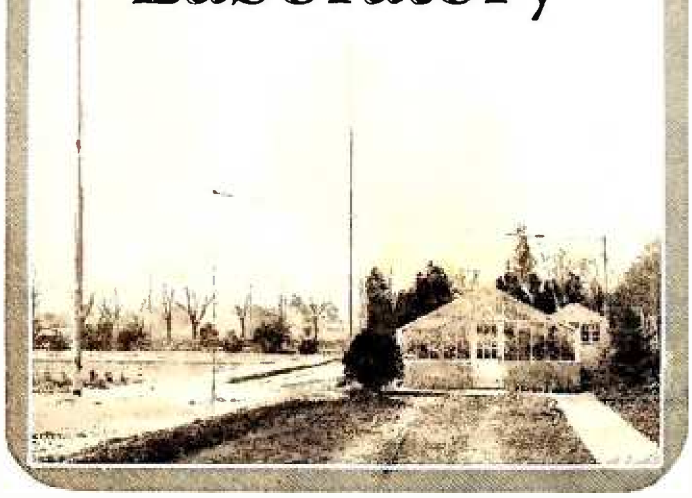
"Strays" from the Laboratory



Keeping r. f. current out of the audio

The presence of radio frequency currents in the input of an audio amplifier is always to be avoided; they tend to make the amplifier overload more easily, promote troublesome hand capacity, and invite a lack of stability. In the February 1st issue of the *Wireless World*, A. L. M. Sowerby discusses this problem and suggests the use of a resistance in the grid circuit of the first a.f. tube, as shown in Fig. 1-A. and the equivalent circuit in Fig. 1-B. Here the resistance, R, is the external series resistance, C is the effective input capacity of the tube, which under operating conditions is much greater than the capacity as measured when the tube is cold.

At radio frequencies, without the external resistance, considerable voltage may be developed across the input capacity. With the resistance, however, this voltage is divided between that lost across the resistor and that appearing across the capacity. It is only the latter that is passed into the amplifier. If the impedance of R is greater than that of C, less voltage will appear across C. The following formula gives the ratio between the applied voltage and what actually gets to the input of the amplifier,

$$\frac{E_0}{E} = \sqrt{1+R^2\omega^2C^2}$$

and the following table gives the result of using an external resistance such that the product of R and C is 10, when R is in megohms and C in mmfd. Such a product reduces audio notes of 5000 cycles only 5 per cent., which is permissible.

Frequency	Per cent. Radio Frequency Remaining
1500 kc.	1.0
1000	1.6
750	2.1
500	3.2
300	5.2
150	10.5
50	30.0

This shows that on the broadcast band, the r.f. currents can be cut down to a permissible figure without greatly decreasing the high audio notes at the same time. But in super-heterodynes operating at 50 kc. such discrimination is not sufficient; 30 per cent. of the r.f. remains and appears across the amplifier. Here a low-pass filter is necessary.

What values of resistance and capacity should be used? Mr. Sowerby states that the effective input capacity of most tubes is about equal in mmfd. to eight times the amplification factor of the tube. This gives the following effective input capacities of American tubes, and using this figure we arrive at the values of resistance given. These resistors need not carry much current; in fact, if the amplifier is properly designed and operated the current that passes will be negligible.

Tube type	Amp. factor	Effective capacity	Resistance ohms
171	3	24 mmfd.	300,000
201-A	8	64	150,000
199	6	36	30,000
112	8	64	150,000
210	8	64	150,000
Hi-mu	30	240	40,000

The Short-Wave Market

Many people seem to wonder at all the excitement about the allocation of frequencies in the short-wave spectrum. This is probably because the uninitiated ones do not know that a license to operate a station below 100 meters is about as unique a franchise as has ever been granted. We often hear that there are no more lands to be developed, that nations must find some way to utilize the Arctic, that the nitrate beds are all doled out, that the oil interests have gobbled up all the available fields—and yet the entire surface and depth of the earth has not been explored, or populated. Other fields of oil or deposits of gold, or beds of gypsum may be discovered. It is not so in the realm of the short waves. All have been discovered—and unless the Radio Commission gets busy, all will be occupied by other nations, who are not at all altruistic about our getting our share.

Once assigned, and with a station operating on a channel, say at 40 meters, the story is told. Any other station of equal power will interfere. Nothing that man has as yet discovered will alleviate the situation. In other words, nothing is so rare as a short wave; it is truly unique. It is like a rare Mauritius postage stamp—we know how many were issued in the year 1847, we know where these stamps are, and nothing can be done about it. No wonder the price is high.

We listen in at infrequent intervals to the short-wave stations, hammering out ultra fast commercial traffic, facsimile transmissions, tele vision signals, shooting shafts of highly concentrated beams of electrical energy at Canada, South Africa, Australia. Nearly every time we listen we discover a new station; one of the blank spots on our dial has been filled. There are only a few left.

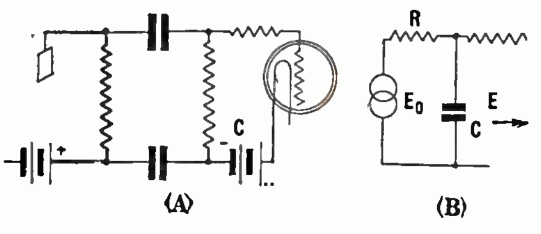


FIG. 1

And yet the Radio Commission bewails the fact that in all the short-wave ether there are only places for 200 stations and they already have applications for 300 from this country alone. What is to be done?

Not long ago we were called on the phone by a brokerage firm operating branch offices in all the larger cities of the South and Southwest. Their bill for wire lines was about $100,000 a year. Wouldn't short waves cut down that cost? They had heard that a short-wave station could be built for $1000; that the upkeep was small. Would we consider a consulting job of equipping this brokerage company with twenty such stations?

The Radio Commission has in its power the issuing of short-wave licenses, the most valuable pieces of paper in modern time. What are they going to do about it?

"Sink or Swim" Tube Testing

It has been our intention for some time to mention the excellent "Laboratory Broadcasts" which appear in the Hartford (Connecticut) *Times*, a column or two of radio ideas, gossip, popular explanations of what happens in your receiver, etc. L. W. Hatry, who has written for Radio Broadcast as well as other radio publications, is the author; he has had occasion to mention the Laboratory, and the writer, for which we thank him. He has recently discussed hard and soft tubes and states that a good test for a soft tube is to give it 100 or more volts—on the plate, we assume—and if it turns blue internally, it is soft. Which reminds us of the way we used to determine whether a small boy could swim or not. We threw him into the creek, and if, after counting up to a hundred, we pulled him off the bottom and found that he was blue in the face, couldn't tell his name, couldn't walk, couldn't even breathe—we assumed he couldn't swim.

Can anyone suggest a better test?—we are now referring to Mr. Hatry's method of testing for soft tubes.

Line Voltage Variations

In a recent release from the Radio Corporation of America, Doctor Alfred N. Goldsmith is quoted as stating that there is no serious line voltage problem. He is speaking of this non-existent problem—according to him—because many a.c. sets have caused no end of trouble due to tube failure, when excessive line voltage variations caused the voltage across the a.c. tubes to average too high a value for long tube life. Doctor Goldsmith's statement was based on a series of tests made in the New York metropolitan district, where the power companies spend much money to maintain their voltages constant at the consumer's home or plant.

So we took an a.c. voltmeter home, plugged it into the socket and made readings at various times during the day and night. The average voltage was 110, the highest recorded was 113, and the lowest 105. Apparently, the people who generate and distribute power to this part of Long Island (Garden City) take as much care to maintain good lines and good voltage regulation as they do in the city.

But we wonder what happens out in the smaller towns, at some distance from cities, say in places with about 35,000 population? How great is the voltage variation there? Is it within

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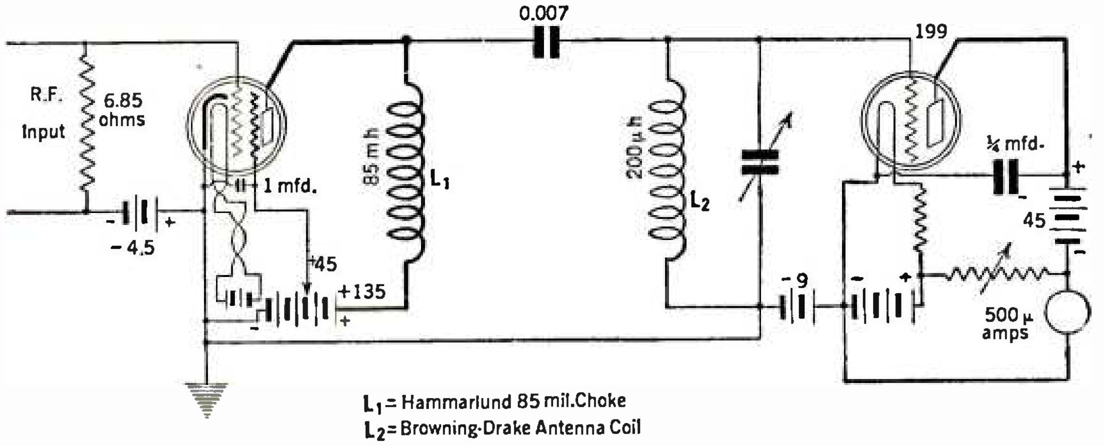

FIG. 2

the 5 per cent. that the R. C. A. engineering and test department found to be true in Manhattan?

A C. Screen-grid tubes

Many experimenters have been hoping for a.c. screen-grid tubes. The following data is the result of some measurements in the Laboratory on several tubes of this type. The filament is the standard 2.5-volt, 1.75 ampere heater type with the accessory plate and grid structure around it as in the d.c. tubes. Under normal conditions of screen and plate voltage, we obtained an impedance of about 375,000 ohms and a mutual conductance of about 500 micromhos.

Realizing that the most experimenters prefer actual gain measurements to those on the tubes' constants, we hooked up the circuit shown in Fig. 2 and secured a voltage gain as shown below.

Frequency	Voltage gain
500	40
580	41
660	48
940	80
1050	120

The coil and condenser unit was standard Browning-Drake apparatus used as the input to an r.f. amplifier tube. The inductance was 200 microhenries and at 500 kc. the combined coil and condenser had a resistance of about 5 ohms. These values of resistance and inductance indicate a theoretical voltage gain at 500 kc. of about 56.

It should be noted that a resistance input was used, and that d.c. was used to heat the heater. The effect of a.c. when this tube is used in an actual circuit has not been determined, although reports indicate that it makes an exceptionally good high-frequency amplifier, the question of selectivity remaining where it was when recently discussed in these pages.

"Strays" from other Laboratories

Last month we quoted some strange business about a loud speaker test that took place in one of our contemporaries' laboratories. During the test the output current from the amplifier ran as high as 49 milliamperes, and from 1200 to 1280 volts appeared somewhere in the circuit without the necessity of calling out the fire department. The following statement appeared recently in another radio publication: "The Raytheon BH rectifier tube is now tipless, increasing rating to 125 MA."

We feel the prize, however, for technically inaccurate statements appeared in still another radio paper a year or so ago. An author was describing a world-beating receiver consisting of one or more r.f. stages coupled to each other by means of transformers. Figuring that the usual voltage gain in a neutrodyne stage, which has 60 turns on the secondary and 6 on the primary of the interstage r.f. transformers, was 10, this writer suggested using only one primary turn, when the voltage step-up would be increased from 10 to 60 per stage!

The field for one's imagination in radio is apparently unlimited.

Making D. C. Sets Comfortable

Several months ago we mentioned the fact that we saw little reason why anyone should throw away a good battery-operated set in favor of an a.c. receiver, when the former only required about eight minutes a week to place the battery on charge. Mr. Beecher Ogden, of Pleasantville, New York, forces us to admit that we have no simple device for doing this work for us, and that we still get down under the table, fuss around with wires, get hands and knees dirty, and get into a generally bad humor—at least once a week. Mr. Ogden's scheme for preserving one's friendliness toward the battery-operated receiver is illustrated in Fig. 3. It consists of a switch which throws one battery on the set and another on charge—or if one has only one battery, a simple d. p. d. t. switch will throw the battery from the receiver to the charger, which may be connected into a base-plug or any other source of a.c. Say Mr. Ogden:

> I am shocked and grieved at the implied admission on page 352 of Radio Broadcast for March, second paragraph, that you still have to disconnect the battery from the set to put it on charge, for I can't figure any other way that could possibly take eight minutes a week. Radio Broadcast has described several switching arrangements that certainly don't need five seconds to put the battery on the charger. However, here is a real one that has been in use for years. Take a four-pole d. t. switch and cross-connect it on the back so that one battery is on charge and another on the set at the same time. A 2-ampere Tungar will give you about 30 a.h. a day, which should be enough.

Loud Speaker Tests

The following letter from a Norfolk, Va., radio enthusiast speaks for itself. It describes the result of two very interesting tests on loud speakers, and calls attention to the dynamic type which has been mentioned more than once in these columns.

> I read with interest your department's comments on recent developments in loud speakers under "Strays from the Laboratory" in the February issue. Your readers appreciate the necessity of protecting your advertisers, but information of that nature based on the results of comparative tests in the Laboratory are of the greatest value to your readers. I hope you will continue to give us the results of your tests.
>
> I have followed the development of loud speakers for a number of years, and have known that the Western Electric has been generally favored for monitoring work in the control rooms of broadcast stations. I have had occasion to compare this speaker with others before an audience composed of people with trained musical ears and technical knowledge. The loud speakers were arranged behind a curtain so that the audience would not be prejudiced by preconceived opinions. Seventy per cent. rated the W. E. first on music, and 90 per cent. rated it first on voice. The same experiment was tried with an audience composed of people none of whom had had a musical education or technical training. Practically everybody in this audience preferred the RCA model 100-A over all other speakers on music, and they were about equally divided between this speaker and the W. E. on voice. These experiments were performed under conditions of ideal local reception, that is, without heterodyne squeals or static. Under conditions of distant reception with heterodyne squeals, background noises, and static present, almost everyone agreed that the RCA model 100-A was to be preferred to the Western Electric. In other words, the high-frequency cut-off filter incorporated in this (RCA) speaker which eliminates the greater part of these interfering noises is certainly desirable under present broadcast conditions even at the slight sacrifice of clearness of speech which it entails.
>
> I have been testing out a Magnavox dynamic power cone under various conditions of baffling, recently, and I am surprised that you did not mention this speaker as being one of the best of the new speakers in your article on this subject. The power handling capacity of this speaker is so far superior to that of other types that it is a little difficult to make comparisons. A 5000-cycle cut-off filter effectively eliminates heterodyne squeals and background noises. On some nights when static noises are so loud on the Western Electric that reception is unsatisfactory, the Magnavox brings the music in clear with a minimum of interfering noises. Of course, this is accomplished at a slight sacrifice in "intelligibility."

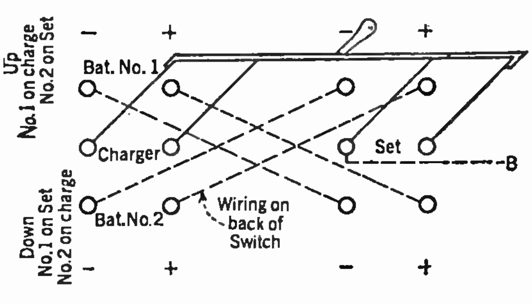

FIG. 3

Recent Articles of Interest

We have read with considerable interest the following articles in various radio and technical publications:

Amplification Behind the Talking Movies, *Bell Laboratories Record*, May.

Loud Speakers of High Efficiency, *Journal of the A. I. E. E.*, April.

Getting Started at 30 Megacycles, *QST*, May

Practical Audio Filters, *QST*, May.

Amplification and High Quality, *Wireless World*, May 2nd.

The Earth as a Magnet, *Scientific American*, May.

Geophysical Prospecting, *Scientific American*, May.

The Inverted Vacuum Tube, *Proceedings of the I. R. E.*, April.

The Development of the 250 type tube, *Proceedings of the I. R. E.* April.

Broadcast Control Operation, *Proceedings of the I. R. E.*, April.

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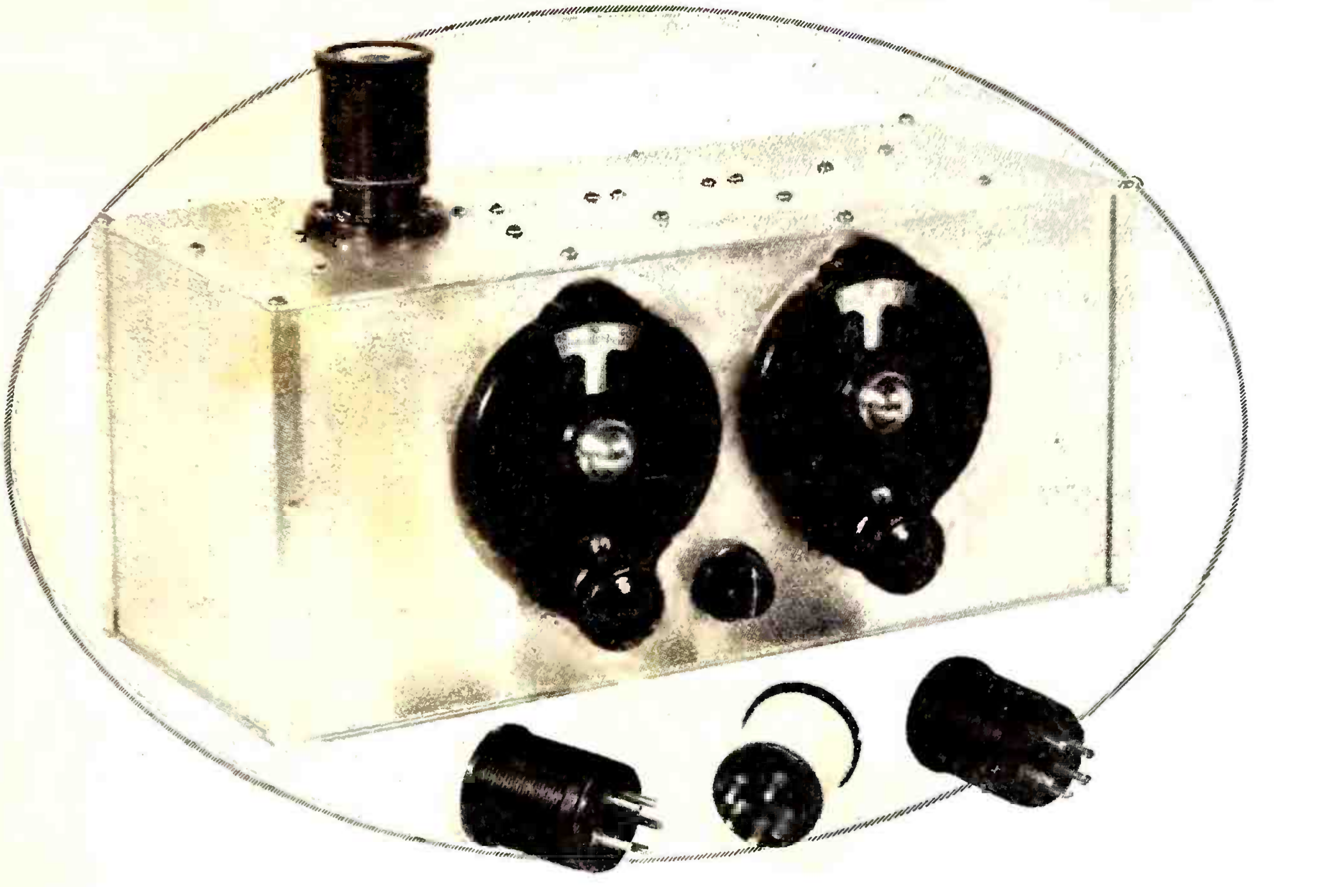

A CABINET MODEL OF THE SHORT-WAVE RECEIVER

The short-wave set shown above uses the same parts and employs the same circuit as the receiver described in this article. It differs only in the aluminum panel and shielding used; these are obtainable through Silver-Marshall, Inc., or may be home constructed

A Screen-Grid Short-Wave Receiver

By Howard Barclay

THE tremendous interest in short-wave reception which has been sweeping the country of late has brought about a great change in the requirements of a good short-wave receiver. The old-style short-wave receiver of the "ham" days, while still as sensitive as ever for c.w. work, has proved inadequate for receiving the modulated signals of telephonic broadcasts with the smoothness and quality of the reception obtainable in the higher broadcast bands. The short-wave receiver described in this article provides this higher degree of performance, plus freedom from radiation, for the oscillating detector is isolated from the antenna by a screen-grid r.f. amplifier tube. This tube does not add a tuning control, its input circuit being untuned, yet it improves the reception of telephone signals, and entirely eliminates "dead spots" at which the set will not oscillate, since it effectively isolates the antenna from the sensitive detector circuit.

An unusual degree of smoothness of regeneration control, freedom from "putting" and "fringe effect" noises as the set goes into oscillation is effected by careful circuit and coil design, notably by using a small coil, which on the lower waves, particularly around 20 meters and below, provides smoother and sweeter control than the two- three- and even four-inch short-wave coils generally used. The coils are actually a refinement of the popular "tube base" or "Scottish" idea which has been found to give such excellent and economical results. These forms are slightly larger and longer than the average tube base, making it possible to design more efficient coils than are possible on the ordinary tube base (often not available except at the expense of breaking good tubes). A winding space $1\frac{1}{2}''$ long and $1\frac{1}{2}''$ in diameter is available, with a tickler slot $\frac{1}{8}''$ deep and $\frac{1}{16}''$ wide at the filament end. On the bottom of the moulded form are five hollow lead pins, properly positioned to fit any five-prong a. c. tube socket. These coil forms are so cheap that any number of experimental coils for different wave bands can be wound at little cost, to be tuned by any size of condenser that may suit the builder's fancy. In this matter of "builder's fancy," however, it is well to remark incidentally that while a code receiver can be thrown together almost any old way and still work, physical placement of parts and wiring details must be most rigidly watched in order to get a good modulated signal receiver. In the set described, the tickler condenser hardly reacts at all on tuning, over 20 degrees at 40 meters being needed to tune a c. w. code signal out of "readable" audibility.

THE short-wave receiver described in this article employs a screen-grid tube as an r. f. amplifier and incorporates an audio system that amplifies high quality signals without distortion. It was designed in the Research Laboratories of Chicago for Silver-Marshall, Inc., and uses a new and ingenious type of coil wound on a form that fits into a five-prong or Y type of tube socket. In the Laboratory the receiver seemed remarkably free from the noises which often ruin short-wave reception, and on the sometimes swinging, sometimes steady signals of 5SW in England we received good dance programs from the Savoy Hotel in London.
—THE EDITOR.

CONSTRUCTION OF THE RECEIVER

THE set illustrated is mounted on an 8 x 18 x $\frac{1}{2}''$ seasoned wood baseboard, with all parts placed in a simple straight line as shown in Fig. 1, instead of being tied up in a knot (as in broadcast band receivers) difficult of assembly and "trouble shooting." In Fig. 1, at the left is the antenna choke coil L_1, next the screen grid r.f. tube socket, then the five-prong coil socket up on 1" studs, next the grid condenser, C_1, and grid leak mounting, detector tube socket, plate r.f. choke, L_3, and the two audio tube sockets, with a pair of flat characteristic 3:1 transformers, T, behind the a.f. tubes. At the rear are the Fahnestock connection clips, and on the front panel are the .00014-mfd. tuning condenser, C_4, the 20-ohm detector filament rheostat, R_2, and the .00035 tickler condenser, C_5. The circuit diagram, giving the proper connections, is shown in Fig. 2.

The matter of a good short-wave variable condenser is an interesting one, for few good broadcast condensers, even of properly reduced capacity, are good at 20 meters and below, where bearing noises develop to an annoying degree. A noisy broadcast type of condenser can often be quieted for short-wave work by insulating its bearings, at increased cost and labor. However, the type of compression bearing found in the General Radio and Silver-Marshal condensers is quiet at 20 meters, and offers all the advantages of a good mechanical bearing of

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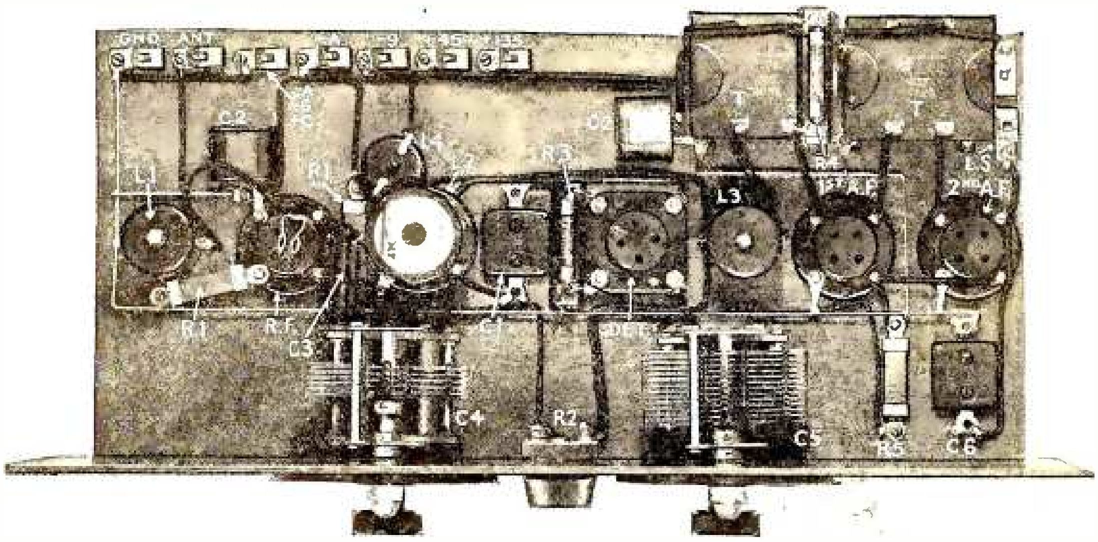

FIG. 1

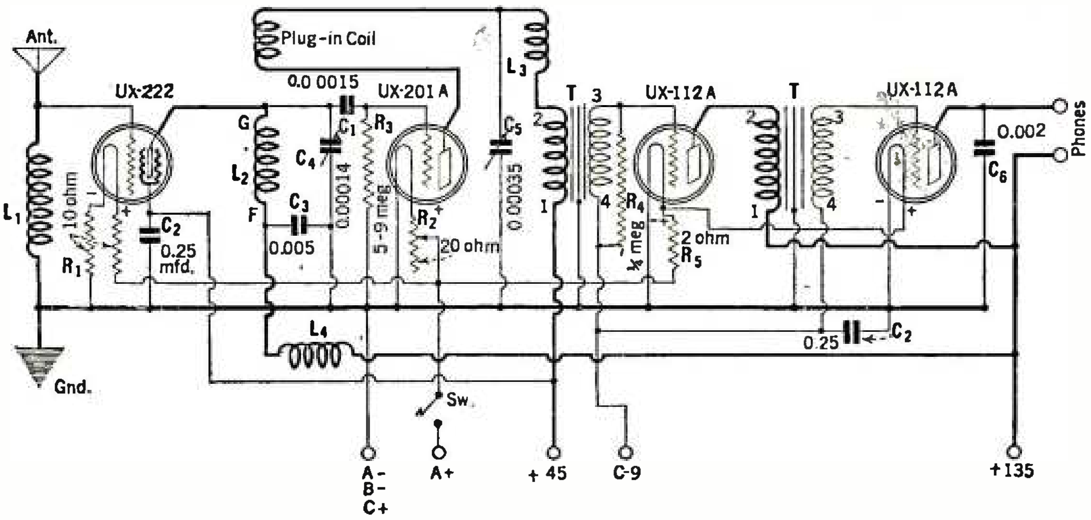

FIG. 2

brass and steel. This feature of quiet bearings may be possessed by other types on the market as well.

In building this type of set, the parts should be placed just about as shown, so that a short direct ground line can be run in from the antenna choke, along the back of the variable condensers and over to the a.f. transformer frames, which must be grounded. All wiring should be short, direct and well soldered, and care should be taken to avoid the possibility of "closed loops" of wiring which would pick up energy and possibly cause irregular regeneration control. The apparently unnecessary bypass condensers, as across the a.f. C battery, C_2, and from the second a.f. tube plate to ground, C_6, should be used; their purpose is to cut stray r.f. currents from the audio amplifier, all in the interest of smooth operation.

The parts used in the model, which was rebuilt several times to make sure that it would go together the same way and with the same results in spite of the minor variations bound to occur in home assembly, are listed at the end of the article. The panel is not a necessity, and can be left off to cut cost, if appearance is not an object. Everything else is quite important to smooth performance, though fixed condensers, sockets, and such parts might be substituted if on hand. Unless you are only interested in code reception, do not substitute for r.f. chokes, coil form size and variable condensers unless willing to "smooth up" your own particular set's operation by the "cut and try" scheme of adding bypass condensers, r.f. chokes, and resistors at needed points.

The coils are all wound on the same type of Silver-Marshall form, with No. 34 d. c. c. wire for the ticklers, and No. 22 enamelled wire for the secondaries (except the 104.0–204.5 meters coil, which used No. 24 d. c. c.) All secondaries have turns so spaced that the windings cover the full 1½" of form space. The windings are so connected that the top or start of the secondary terminates in the G post of a standard 5-prong tube socket and the bottom or end in the right hand F post (the F post nearest the P or plate post). The slotted tickler, wound in the same direction, starts at the "F" post nearest the "C" or cathode post and ends at the "P" post.

The number of turns necessary to cover the four bands from 17 to 240 meters are given below, using a 0.00014-mfd. condenser and a 0.00035 mfd. tickler condenser.

COIL DATA

Type	*Wavelength Range Meters*	*Secondary*	*Tickler*
"T"	17.5—32.1	6½ turns	5½ turns
"U"	30.7—59.0	13½ turns	5½ turns
"V"	57.2—110.0	25½ turns	9½ turns
"W"	104.0—204.5	49½ turns	15½ turns

OPERATION

THE tuning curves for a particular set of four coils are given (Fig. 3) as an aid in finding stations when the set is first operated, and it will be seen that the amateur wave bands fall well away from the ends of the condenser scale, so that with good vernier dials no difficulty is had in tuning amateur code signals.

To duplicate the curves given, it may be necessay to trim coils a bit once they are wound, but this is easily done, or coils simply rewound on the small Bakelite forms. Coils of fewer or greater numbers of turns for other wave bands can be quickly wound for the "tube base four" as the set might well be named.

The operation of the set is simple, almost any antenna from fifteen to fifty feet giving quite good results; even a long broadcast antenna does not seem to destroy the sweet control of the set. Any good storage battery, nine volts of C battery and 135 volts of B battery (or as low as 90 will do) are all that is necessary for operating power.

Socket-power units are generally noisy on short waves and are not to be recommended. If a B-supply unit is used, a 45-volt battery should be supplied for the detector plate voltage. This will cut down the noise appreciably. Two 112A audio tubes, a 201A detector, a 222 screen grid r.f. tube, and phones or loud speaker are also necessary.

LIST OF PARTS

THE coils are the only special parts employed in this receiver, and the data for them is given above. Parts of similar characteristics may be substituted for all the other apparatus mentioned in the list below.

C_1	—1	Condenser, .00015 mfd.
C_2	—2	Condensers, ¼ mfd.
C_3	—1	Sangamo condenser, .005-mfd.
C_4	—1	S-M condenser, .00014 mfd., type 317
C_5	—1	S-M condenser, .00035 mfd., type 316-A
C_6	—1	Condenser, .002 mfd.
L_1, L_3	—2	S-M short-wave chokes, No. 227
L_4	—1	S-M short-wave choke, No. 275
R_1	—2	Yaxley resistors, 10 ohms
R_2	—1	Yaxley midget rheostat with switch, 20 ohms
R_3	—1	Lynch resistor, 5 to 10 megohms
R_4	—1	Lynch resistor, $\frac{1}{10}$ to ¼ megohm
R_5	—1	Yaxley resistor, 2 ohms
T	—2	S-M audio transformers, type 240
	2	National vernier dials
	4	S-M blank coil forms, type 130
	4	S-M tube sockets, type 411
	1	S-M five-prong socket, type 512
	2	Lynch resistor mounts
	9	Fahnestock clips
	1	8" x 17" x ½" wood base
	1	7" x 18" x ⅛" micarta panel
		Screws, nuts, hook-up wire, solder, lugs, etc.

If factory wound coils are preferred instead of winding coils at home, one each of Silver-Marshall 131 T, 131 V, 131 U and 131 W coils may be obtained. The amount of wire needed for a set of home-made coils is given here.

½ lb. No. 22 plain enameled wire
¼ lb. No. 24 double cotton covered wire
¼ lb. No. 34 double cotton covered wire

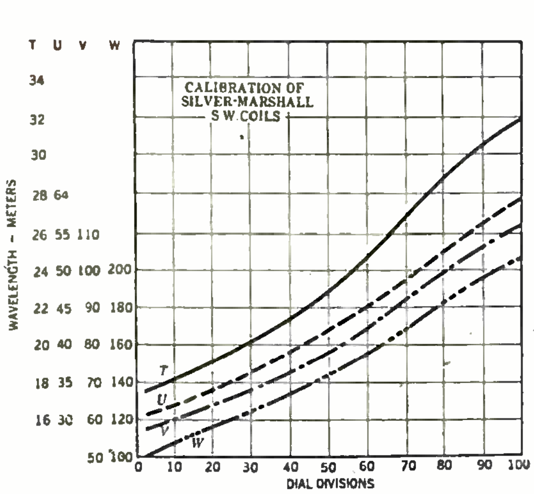

FIG. 3

These tuning curves were obtained with coils mentioned in the lists of parts. Home-made coils can be made which will give similar results

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No. 3 RADIO BROADCAST'S HOME STUDY SHEETS **August, 1928**

Testing Vacuum Tubes

THERE are very few radio receivers nowadays that do not employ one or more vacuum tubes. Many receivers use as many as ten of them; the average in the United States is probably five per receiver. Experiments on such tubes engage part of the time of every serious student of radio because they are the heart of all of our modern circuits and equipment utilizing those circuits. To understand something about the characteristics of such tubes we shall need the following:

LIST OF APPARATUS

1. Source of current, dry cells or storage battery.
2. A rheostat, such as the Frost 20-ohm type 720.
3. A voltmeter, preferably a double range instrument, reading up to 10 volts on its low scale, and up to 100 or more on its second scale. A good one is the Weston Model 506 which reads 7.5 and 150 volts, or the Jewell Pattern 77 which has similar ranges.
4. A milliammeter reading about 10 milliamperes full scale. The one used in the Laboratory to perform this experiment was a Weston Model 301. It lists at $8 and is very useful.
5. A source of plate voltage that is variable in steps of 10 or 20 volts up to about 90 volts.
6. A receiving tube, such as a CX-301A.
7. A baseboard made from 5-ply or ¾-inch stuff and about 6" x 16" in size.
8. Fahnestock clips, wire, such as Celatsite or Belden Colorubber.

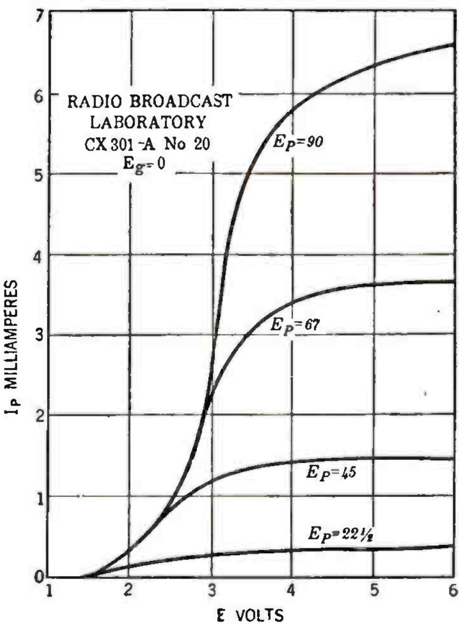

FIG. 1

PROCEDURE

Screw the socket to the baseboard; place the clips in a row along one margin of the board, and mount the rheostat on a small piece of brass strip. If a General Radio or Pacent rheostat is used it can be screwed to the baseboard, and the mounting strip avoided. The connections are shown in Fig. 4, and the experimenter is encouraged to follow out this arrangement of parts since the set-up will be used many times in the laboratory experiments. An hour's time making everything fast and ship-shape according to this layout may save much annoyance later, and possibly prevent a good meter from going back to its manufacturer for repairs. Fig. 3 is a photograph of the set-up used in the laboratory.

Twist a pair of leads, preferably of different colors and about a foot long, and attach one end of the twisted pair to the low voltage voltmeter terminals. Attach the other ends of the pair to the filament terminals on the socket. Make the following connections:

1. Milliammeter between clips 6 and 7.
2. A plus to clip 1.
3. A minus to clip 2.
4. Clip 5 to clip 4.
5. B minus to clip 2.
6. B plus, about 22.5 volts at the start, to clip 8.

A schematic diagram of the above is shown in Fig. 2.

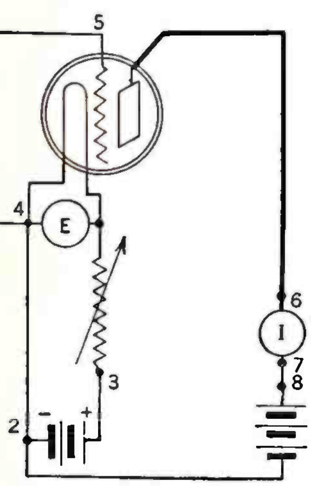

FIG. 2

Turn on the rheostat slowly and watch both filament voltmeter and plate milliammeter. If either reads backwards, reverse the connections to the meter. Note down as in table 1 the plate current as the filament voltage is changed; then turn off the rheostat, increase the plate voltage to approximately 45 and repeat. Repeat for higher values of plate voltage or until the plate milliammeter needle reaches its full deflection. Plot this data as shown in Fig. 1. Remove the voltmeter from the filament terminals and measure the plate voltages applied to the tube in the above experiment by attaching the twisted pair to the high voltage posts of the meter and the other end of the pair of wires to the B minus and the several B plus posts which were used in the experiment.

DISCUSSION

A good description of what happens within the glass wall of the vacuum tube may be found in pages 450 to 470 of the Signal Corps book, *Principles Underlying Radio Communication*. The experimenter is encouraged to read these pages, and to put in his notebook his own digest of the information contained there.

When the filament is heated by the current passing through it, a current begins to flow across the evacuated space between the filament and the positive plate. This current is very small, of the order of thousandths of amperes, or milliamperes. It is carried on the negatively charged electrons emitted from the filament. An ampere is the current carried by 6.28 x 10^{18} electrons per second. The greater the temperature of the filament the greater is the electron stream, and the greater the plate current. Therefore the plate current increases with increase in filament temperature—up to a certain point; then the plate current remains fixed in value regardless of how much the temperature of the filament is increased. This is shown in the curves on Fig. 1. This is known as the saturation effect. The only way to increase the plate current further is to increase the plate voltage, which increases the attraction for the negative electrons and increases the number that arrive per second.

This experiment demonstrates

1. The effect of filament voltage on plate current.
2. The saturation effect at low plate voltages.
3. The fact that under no conditions is there any need or benefit in increasing the filament voltage beyond 5 volts.

The experimenter should explain each of these points in his notebook. These explanations, and the answers to the problems given below, may be sent to the Laboratory, where they will be criticized and returned.

PROBLEMS

1. The d. c. resistance of the tube, that is, the resistance offered to the flow of electrons through the space inside the tube, is the ratio between the plate voltage applied and the plate current (in amperes) flowing; calculate the resistance of the tube for each value of filament and plate voltage applied, and plot against filament voltage.
2. If 6.28 x 10^{18} electrons per second constitute a current flow of one ampere, how many electrons per second make up a current of one milliampere?
3. If power in watts is the product of amperes times volts, calculate the power used up in the plate circuit at each value of plate and filament voltage used, and plot against filament voltage.
4. Where does this power come from? Where does it go?
5. If the average B battery has a life of 5000 milliampere hours, how long should it last furnishing plate current for the tube used in this experiment if the filament voltage is 5 and the plate voltage is 45? If a receiver uses four of these tubes at 90 volts on the plate and one tube at 45 an the plate, all at zero grid bias, how long will the batteries last?

TABLE I

CX 301-A TUBE NO. 20

E_f	E_p = 22	E_p = 42	E_p = 67	E_p = 90
2.0	.15	.2	.2	.2
3.0	.25	1.2	2.25	2.45
4.0	.30	1.4	3.4	
5.0	.32	1.45	3.6	
6.0	.35	1.47	3.65	
		I_p		

E_f = filament volts
E_p = plate volts
I_p = plate current in milliamperes

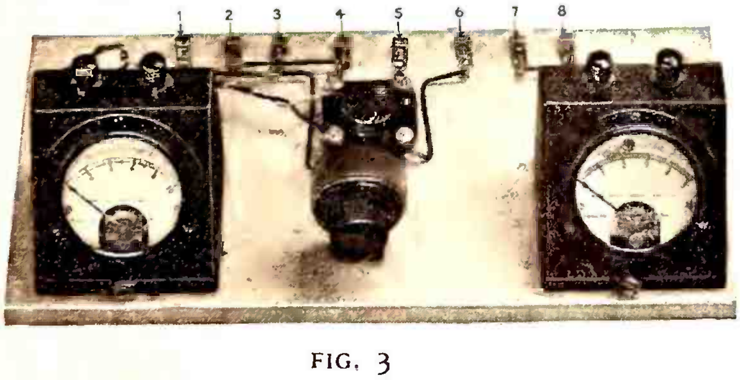

FIG. 3

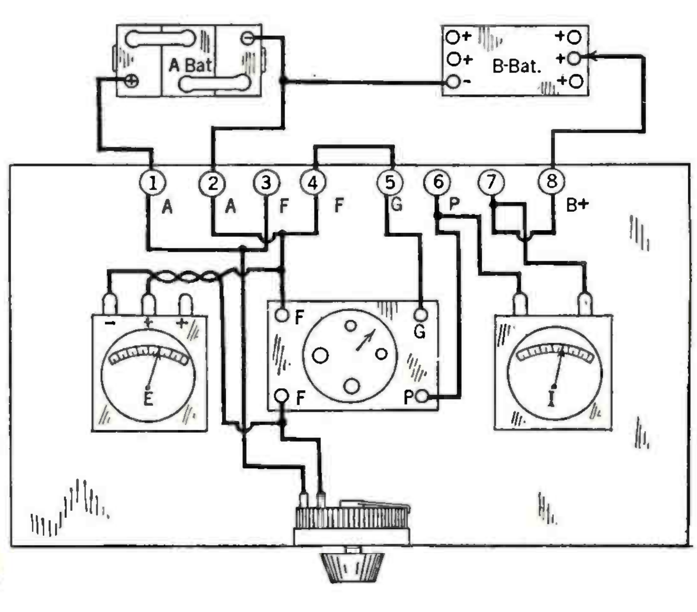

FIG. 4

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No. 4 RADIO BROADCAST'S HOME STUDY SHEETS August, 1928

Ohm's Law

THE most fundamental rule in all electrical work is known as Ohm's Law—from its discoverer, a German experimenter. Previous to its discovery experimenters had only vague notions regarding the amount of current that passed through a circuit under given conditions of voltage and resistance. This law states that in any electrical circuit, the current in amperes equals voltage in volts divided by resistance in ohms.

In electrical language, this means that

I (intensity of current) equals
E (electrical pressure or voltage)
divided by R (resistance)

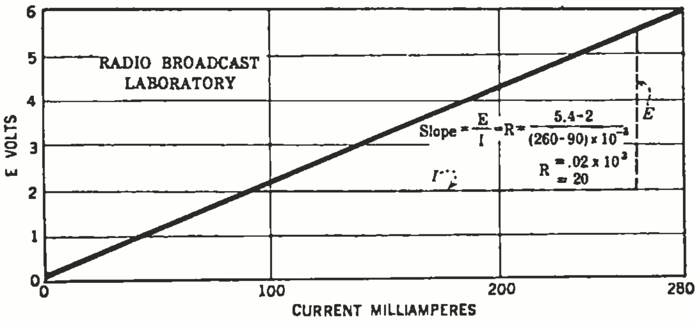

FIG. I

This law may be stated in three ways, viz.,

1. $I = E/R$ 2. $E = I \times R$ 3. $R = E/I$

To get a working knowledge of this fundamental law, we need the following:

LIST OF APPARATUS

1. A source of current, say a storage battery or several dry cells connected in series.
2. Two resistances, about 20 ohms each. One may be a rheostat such as was used in Experiment 2 and the other a similar rheostat or a fixed resistor. The Yaxley 20-ohm De Luxe resistor for example.
3. A voltmeter that will read up to six volts. A Model 301 Weston was used in the Laboratory.
4. A milliammeter reading about 300 milliamperes. The one used in the Laboratory was a Jewell Pattern 54.
5. Hook-up wire.

PROCEDURE

The baseboard set-up described in Experiment 2 may be used for this experiment by connecting the second resistance, i. e. the 20-ohm rheostat or the fixed resistance, R_2, and the voltmeter across the filament terminals of the socket. The connections are shown in Fig. 3, that is, minus A to 3, plus A to the meter and the other meter terminal to 4. The schematic diagram of the set-up is given in Fig. 2.

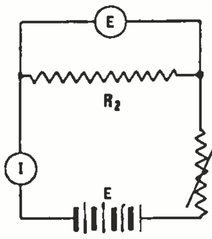

FIG. 2

Turn the rheostat arm *slowly* and note the voltmeter and milliammeter readings. If either reads backwards, reverse the connections to it. Note down as in column 1 and 2 in table 1 the voltage and the current as the rheostat is varied. As a final reading, short circuit the rheostat and allow the full battery voltage to be applied across R_2. Read the current in the circuit. Then remove R_2 but leave the voltmeter across the filament terminals to which R_2 was attached. Read the current flowing now. This is the current taken by the meter.

Using the third way of expressing Ohm's law, viz., that resistance is equal to the voltage divided by the current, calculate the resistance of R_2 and of the voltmeter. Plot on cross section paper as in Fig. 1 the current against the voltage, using the vertical scale for the voltage.

DISCUSSION

The experiment we have just performed is what is known as the voltmeter-ammeter method of measuring a resistance. All that is needed to determine an unknown resistance is to measure the current through it when a known voltage is across it.

The total voltage of the battery has not changed during this experiment, but the voltage across the resistor, R_2, has varied with each setting of the rheostat. What has happened to the remainder of the battery voltage? Clearly it has been cut down by the rheostat, and if we place the voltmeter across this variable resistance as the experiment is repeated, we shall perceive that the total voltage, that is, the voltage lost across resistor R_2 and that across the rheostat, adds up to the terminal voltage of the battery.

Since we know the voltage across the rheostat, that is, the battery voltage minus the voltage measured across resistance R_2, and the current through it (the current in a series circuit such as this is the same in all parts of the circuit) we may use the second method of stating Ohm's law to determine the resistance of the rheostat at each reading in our table and fill in the values.

When the current is plotted against the voltage, a straight line results. The slope of this line, that is, the vertical units divided by the horizontal units, is the resistance of the circuit. If this line did not turn out to be straight, we should have to assume that the resistance of something in the circuit changed with the current through it. This is true of the vacuum tube filament. It has a temperature coefficient, that is, its resistance changes with increase in temperature.

This matter of temperature coefficient is discussed in the Signal Corps' *Principles Underlying Radio Communication* on page 37 in Morecroft's *Principles of Radio Communication* on page 25, in all physics textbooks and in books on electricity.

An "IR drop" is the technical expression for the voltage appearing across a resistance when a current flows through it; it is sometimes merely referred to as a voltage drop. It may be calculated, as may be seen from its name, by multiplying the current by the resistance.

Similarly the value of an unknown voltage may be determined by observing how much current it can force through a known resistance. Thus a meter for measuring voltage, known as a voltmeter, is simply a sensitive current measuring device calibrated in volts rather than in amperes. Throughout an experiment of this kind, and the calculations which go with it, the proper units must be used to make the formula bring the correct answer. The rule uses amperes, volts, and ohms. In this experiment we have used a meter which measures thousandths of amperes, or milliamperes. In order to use the various ways of stating Ohm's Law, we must convert these milliamperes into amperes and then proceed. For example, in the Laboratory the current in the circuit was 94 milliamperes when the voltage across R_2 was 2 volts. In this case one cannot divide 2 by 94 and expect to get an answer in ohms; instead we must realize that 94 milliamperes are 0.094 amperes and divide accordingly.

Thus Ohm's Law, which can be stated in any one of three ways, is useful in determining any one of three fundamental electrical quantities, voltage, current, and resistance.

PROBLEMS

1. Throughout this experiment there have been two "IR" drops in the circuit. Where are they? What should their sums be?
2. Calculate all of the values of current and voltage drops that would exist if R_2 had a resistance of 10, 40, 400 ohms and R_1 were equal to 0, 1, 2 ohms.
3. What current would be taken from the battery if a receiver using five ¼-ampere tubes were operated from it?
4. If the storage battery has a useful life, on one charge, of 100 ampere hours, how long can you operate a five tube (201 A) receiver at three hours per day without recharging the battery?

TABLE 1

E_{R_2}	I	$\frac{E_{R_2}}{I} = R_2$	Eb	E_{R_2}	R_1	Rm
2	94	21.3	4	2		
3	140	21.3	4	1		
4	190	21.0	6	1		
5	236	21.0	6	1		
6	290	20.7	6	0		600

R_2 open, $I = 10 = I_m$ meter current

E_{R_2} = voltage across R_2
I = current in milliamperes
R_2 = resistance of R_2
R_1 = resistance of rheostat = $\frac{I}{E_{R_1}}$
Rm = resistance of meter
E_{R_1} = voltage across rheostat = $E_b - E_{R_2}$
Eb = voltage of battery

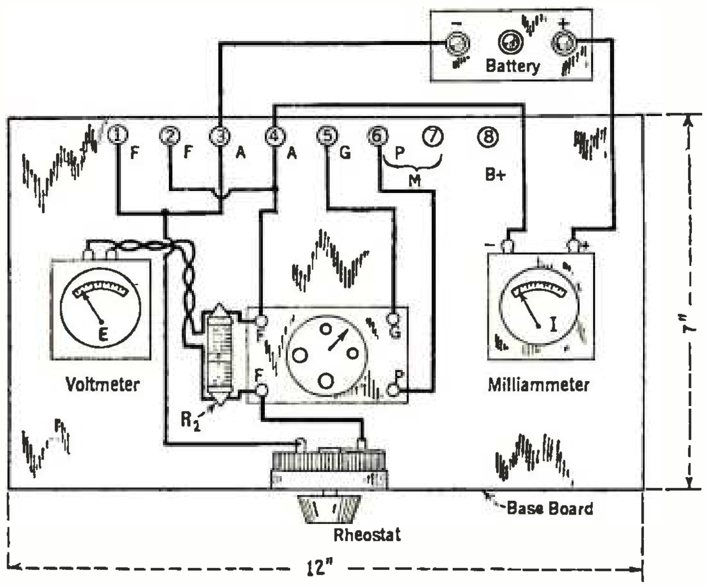

FIG. 3

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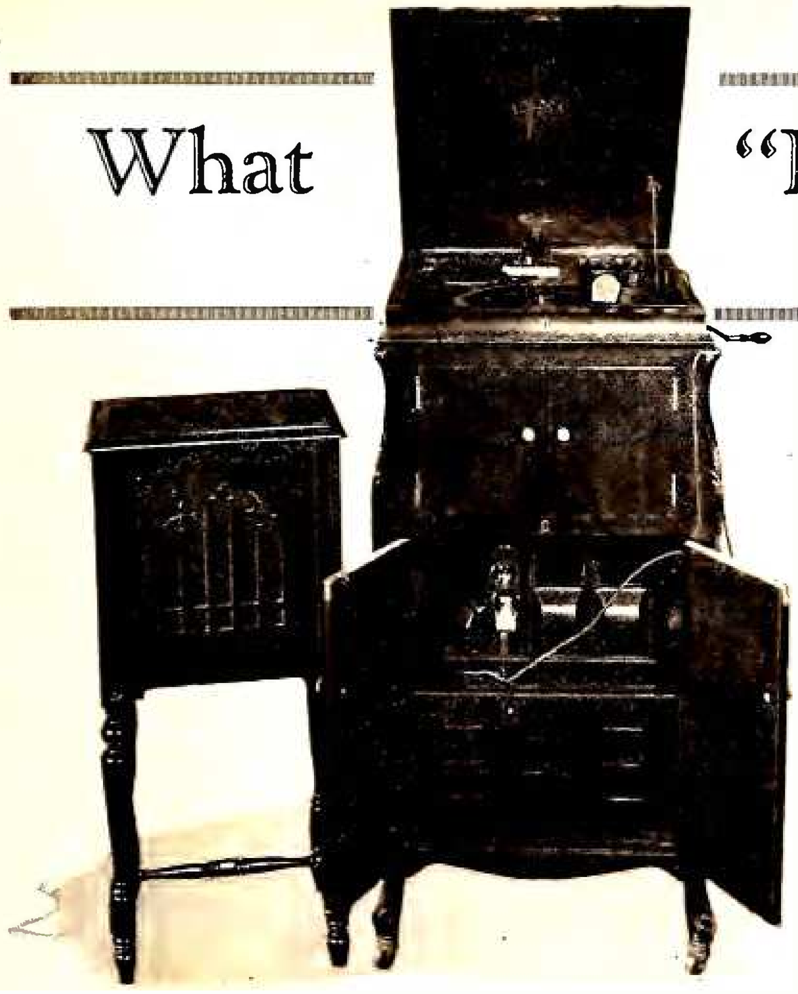
What "Pick-Up" Shall I Buy?

By David Grimes



Here is an unbiased description of the various manufactured pick-up units now available for modernizing the old-style phonographs with the aid of electrical reproduction and amplification. With the data given here you can choose the unit which best suits your own needs, and provide the accessories which have been proved most valuable in electric phonograph reproduction.

—THE EDITOR.

ELECTRICAL pick-up units first started to appear in radio circles early in 1926. Since then several dozen different types have been manufactured and as many articles have appeared covering their operation. Yet at a recent public demonstration of a particular make in one of the large New York stores, nine out of ten people were amazed that such a device was in existance and, of course, knew much less of its workings. For the benefit of the uninitiated, let it be here stated that an electrical pick-up unit is nothing more than an electrical sound box for your phonograph.

The name "pick-up" unit has been given to that particular arrangement suited for connects ing your old type phonograph with your radio receiver. This has required a few circuit kink- which are new, but the fundamental principle employed goes back to the early stage of the telephone and the phonograph. Alexander Graham Bell about 1875 discovered that when a thin piece of magnetic metal was vibrated in front of an electro-magnet, currents were created in the windings of the magnet. These currents were exactly similar in their electrical vibration to the mechanical vibration of the magnetic metal directly in front of the pole pieces of the magnet. Thus, when he talked directly against this thin piece of iron it would vibrate and create currents in the windings of the magnet similar to his voice vibration. This was the first electric telephone.

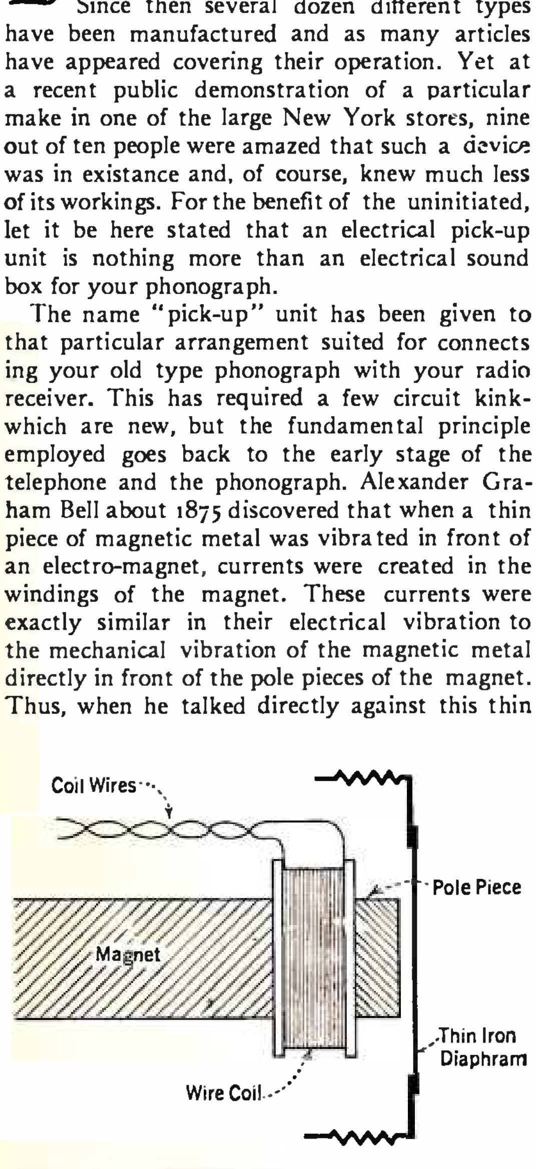


FIG. 1. A CROSS-SECTIONAL VIEW OF AN ORDINARY TELEPHONE RECEIVER

Reference is here made to Fig. 1, which shows a cross-sectional view of the modern telephone receiver with its electrical windings, magnet, and thin metal diaphragm located directly in front of the magnet. But what has a telephone receiver to do with this subject? Bell's first telephone used only one of these receivers at each end. The subscriber talked and listened through the same device, switching it to his ear when he wanted to listen and to his mouth when he wanted to talk. Few people realize that the telephone receiver to-day is practically unchanged from Bell's original conception of the complete electric telephone. As the art developed, other more sensitive principles were used for the telephone transmitter or mouthpiece, but nothing has been found better for the receiver. And even now the receiver, when used as a transmitter, produces better tone quality but less volume than the ordinary telephone transmitter.

We gather from all this that an electro-magnet with a thin piece of iron in front of its poles will act either as a transmitter or as a receiver. You can prove this for yourself at any time by holding your hand over the telephone transmitter and talking to your party at the other end of the line by shouting into the receiver. You will have to talk rather loudly, as the efficiency of this circuit arrangement is quite low, but you will be heard very distinctly at the other end of the line.

Now, Thomas Edison brought out the phonograph a couple of years after Bell's telephone. This was a device which took the minute vibrations of the thin iron disc and, instead of changing them into electrical impulses, recorded them on a wax cylinder which was rotated when recordings were made. This was done by attaching a sharp needle on to the center of the thin disc. This needle cut a waving impression in the wax cylinder as the disc moved to and fro under the influence of the person's voice. Then, when it was desired to hear the record, the thin disc was placed at the end of a horn and the needle was made to travel over the same waving path which it previously had cut. The wax groove forced the needle to and fro, which in turn actuated the diaphragm. Such a device is called a sound-box on the modern phonograph. A diagram of it appears in Fig. 2.

An electrical pick-up unit is merely the combination of these two inventions. A phonograph needle must be attached to the pick-up device. This needle actuates a thin strip of iron mounted directly in front of the pole pieces of an electro-magnet. As the needle is forced back and forth by the waving nature of the grooves of the phonograph record, the thin iron diaphragm is forced to vibrate in unison in front of the electro-magnet. This vibrating magnetic metal induces electrical currents in the windings of the magnet whose vibrations are similar in nature to those of the diaphragm, and in turn to the grooves in the record. See Fig. 4.

Of course, these currents are extremely weak, although very clear and excellent in tone quality. If we should place a pair of headphones across the output of this electric pick-up unit we would hear some very fine music. The only problem

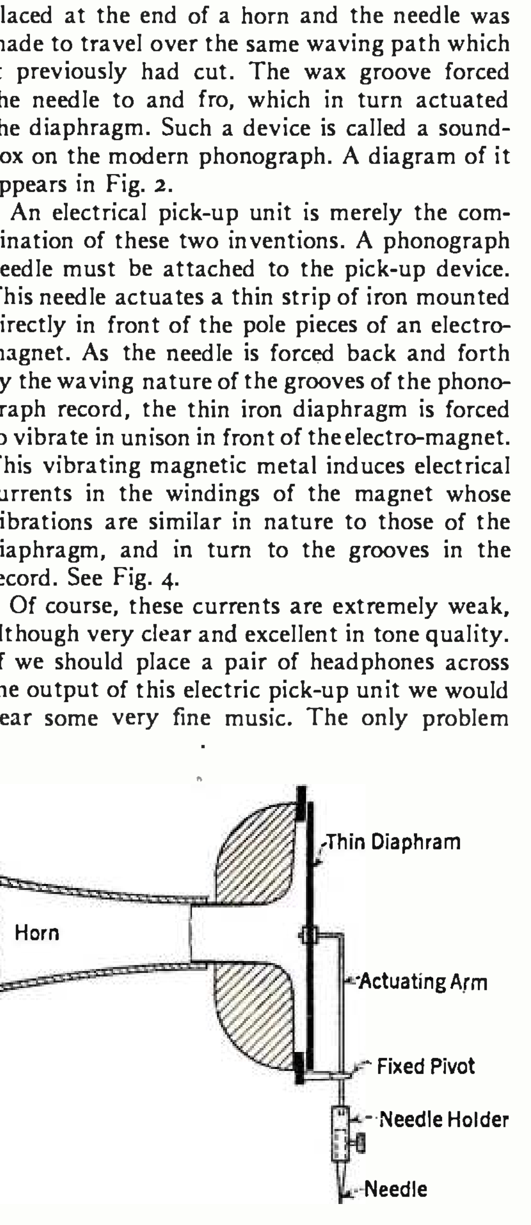


FIG. 2. A CROSS-SECTIONAL VIEW OF A PHONOGRAPH SOUND-BOX

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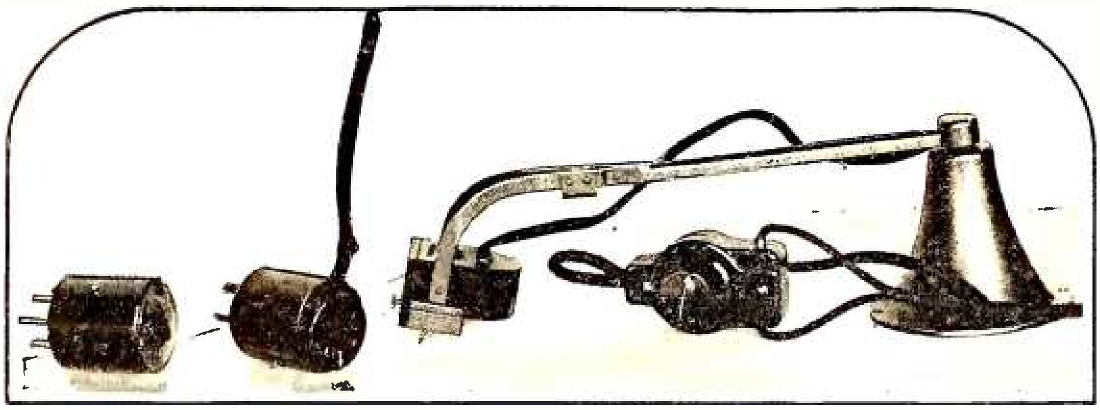

FIG. 3. THE AMPLION REVELAPHONE

that now remains is to amplify this sufficiently to be heard well from the modern loud speaker. Here is where the radio receiver comes into the picture. So far, we have only used the turn-table, motor, and record of the old photograph. The electrical pick-up unit has taken the vibrations off the record and has transformed them into

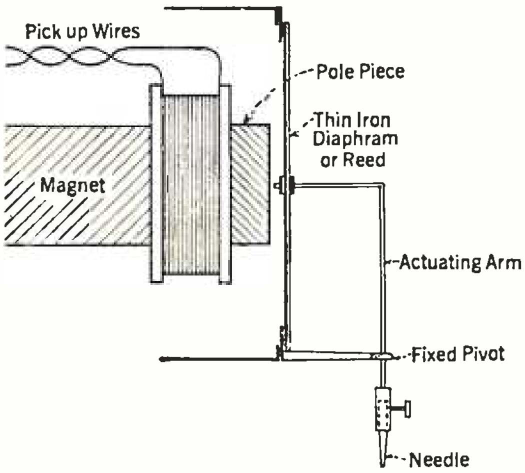

FIG. 4. A CROSS-SECTIONAL VIEW OF AN ELECTRIC PICK-UP UNIT

electrical currents; now they are to be amplified by the radio set.

ONLY THE AUDIO IS USED

THESE currents are not radio currents at all. They are merely the amplified music and voice from the record. Hence, only the audio amplifying end of the radio set is utilized, and the pick-up unit must be so designed as to be readily attached to this audio amplifying section of the radio receiver. The currents are then amplified through the audio amplifier and are reproduced through the loud speaker, just as the radio programs are amplified and reproduced after they are detected by the detector tube. One would guess from this that the pick-up units are attached in some way to the detector tube, at the beginning of the audio amplifier. All of the electrical pick-up units tested in my laboratory operated on this principle. Most of them were arranged to operate in the plate circuit of the detector, although one was arranged to work into the grid of the detector tube and thus gain the amplification of the detector tube.

A careful study of the constructional details of quite a number of different designs shows the necessity of some sort of damping on the vibrating piece of thin iron. Naturally, everything has a natural or inherent period of vibration. Just as a tightly stretched piano string will vibrate at a certain pitch when plucked with the finger, so will the thin iron reed in front of the pole pieces of the magnet tend to vibrate at some particular pitch whenever it is set in motion. If this were not damped or stopped in some way the unit would rattle on certain notes and blast and distort the music. This damping is accomplished by mounting pieces of soft rubber tightly between the iron reed or diaphragm and the pole pieces. The photograph in Fig. 5 shows how this is done in the pick-up unit made by the Stromberg-Carlson Company. In the Amplion Revelaphone the entire vibrating iron reed is pivoted in sponge rubber. The reed is thus left free to vibrate between the pole pieces, but is damped by the rubber mounting at its pivot. The Bosch Recreator also operates on the damping principle of a rubber pivot rather than rubber between the pole pieces. The Baldwin Needlephone has a rubber damped pivot as well as damping rubber between the pole pieces.

MOUNTING AND VOLUME CONTROL

THERE are two main methods of mounting these electrical pick-up units on the phonograph turn-table. Most of them are built with their own mounting arm which holds the magnet and the needle on the record. The mounting arm is swiveled on a supporting base which screws on to the top board of the phonograph, adjacent to the revolving table. This is shown in Fig. 3, a picture of the Amplion Revelaphone. The Bosch arm is swiveled on a leaded base which is heavy enough to hold the arm in the correct position without screwing the base down to your phonograph. The Stromberg-Carlson unit has a leaded or weighted base, but has provision for screwing it down also, if desired. The second principle of holding the electrical magnet and needle on the record is that employed by the Baldwin Needlephone and the Pacent Phonovox. Both of these units are arranged for attachment on the present phonograph arm which holds the regular sound-box.

The regulation of volume of tone has brought forth almost as many ideas as there are different electrical pick-up units. In general, these volume control boxes are variable resistances which shunt out some of the electrical currents generated in the pick-up unit. An adjustable knob enables the volume to be reduced to an almost inaudible whisper. In the Pacent Phonovox and the Amplion Revelaphone these volume regulators are quite small and look more or less like an electric switch such as is often used in lamp cords. The Stromberg-Carlson control box is medium and is arranged for screwing on the baseboard of the phonograph, if desired. The control box for the Bosch is the largest of all, it being the largest piece of apparatus in the pick-up ensemble. Then, again, we have the other extreme in the Baldwin Needlephone, which has no volume control at all, but relies on the volume control in the radio receiver.

The question of weight on a record is indeed a serious problem. Records as well as needles wear out, and we are quite familiar with the fact that needles should be changed rather frequently.

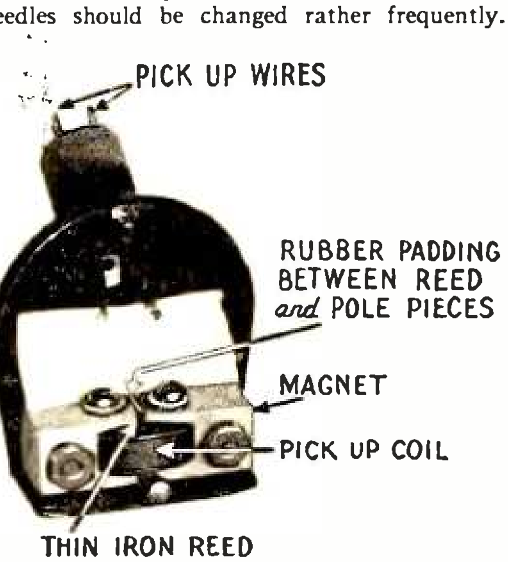

FIG. 5. THE COMPONENTS OF A TYPICAL PICK-UP UNIT

However, one is not accustomed to think in terms of "record wearing." Nevertheless, this is quite an important factor, if the electrical pick-up unit is made at all heavy. It is this factor that has controlled the size of the magnet in the pick-up unit and accounts for the fact that all of them are extremely small. Of course, it would be possible to build a pick-up unit which would deliver considerable volume without amplification, but, the weight of the magnets would soon ruin any phonograph record. In this connection, it is

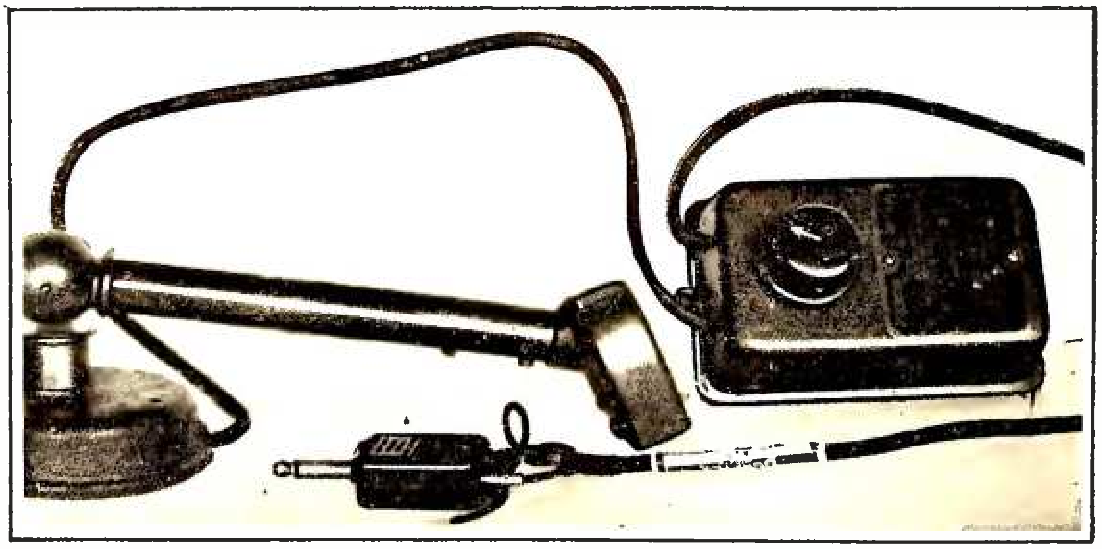

FIG. 5. THE STROMBERG-CARLSON PICK-UP UNIT

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worth while noting the Stromberg-Carlson system. A stiff rugged spring is mounted at the point of support for the pick-up arm and its mounting base. This spring tends to lift the arm and unit off the record. Of course, the weight of the unit overcomes the spring action, but the spring takes a great deal of the weight of the electrical pick-up unit off the record. The Amplion Revelaphone has a slightly different system. By making the unit arm pivot near the unit itself, only the weight of the unit rests on the record while the rest of the supporting arm is rigidly swiveled on the base, which is screwed to the top of the phonograph.

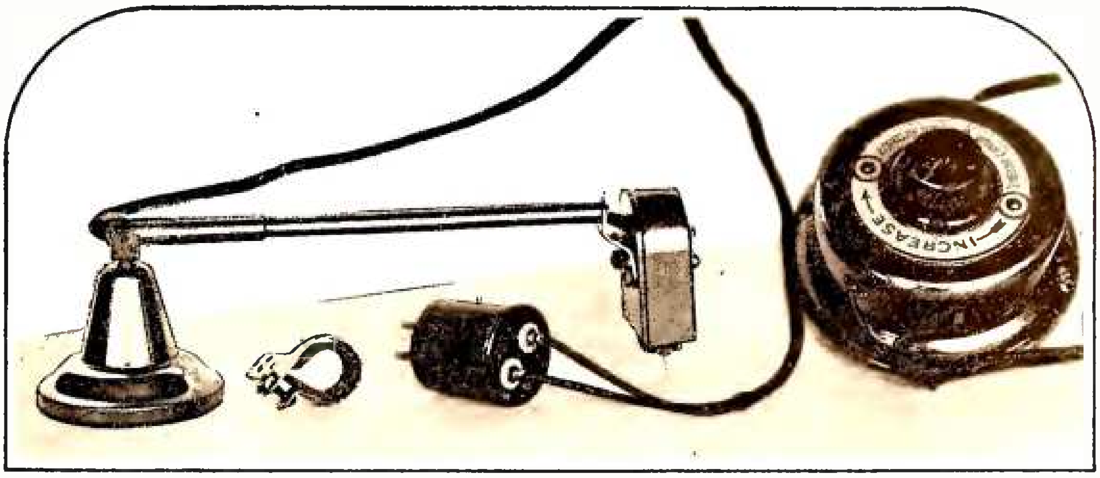

FIG. 6. THE BOSCH RECREATOR

HOW THE UNITS ARE CONNECTED

THE methods of connecting the pick-up unit to the detector tube vary considerably in each case. The Bosch Recreator is attached by means of a special plug which fits into the detector socket in place of the detector tube. At the top of the plug are two tip jacks into which the cord tips are inserted. The Amplion Revelaphone is built with a combination plug and socket. The detector tube is removed, the plug inserted in the detector socket, and the detector tube replaced in the special socket at the top of the plug. The Stromberg-Carlson electrical pick-up unit is built with a standard plug which is made specially to fit into the proper jack for the purpose in their various models of radio receivers. The Pacent Phonovox Unit is designed with a very unique method of attachment which utilizes the amplification of the detector tube and so permits the tube to be reinserted in its socket. A thin bakelite strip with the proper holes is pushed on the pins at the base of the tube. The tube is then inserted into the socket. By means of eyelets in two of the holes (the grid and filament) contacts are made with two pin jacks at the outside edge of the bakelite strip. The electrical pick-up unit is connected by cord tips in these two pin jacks.

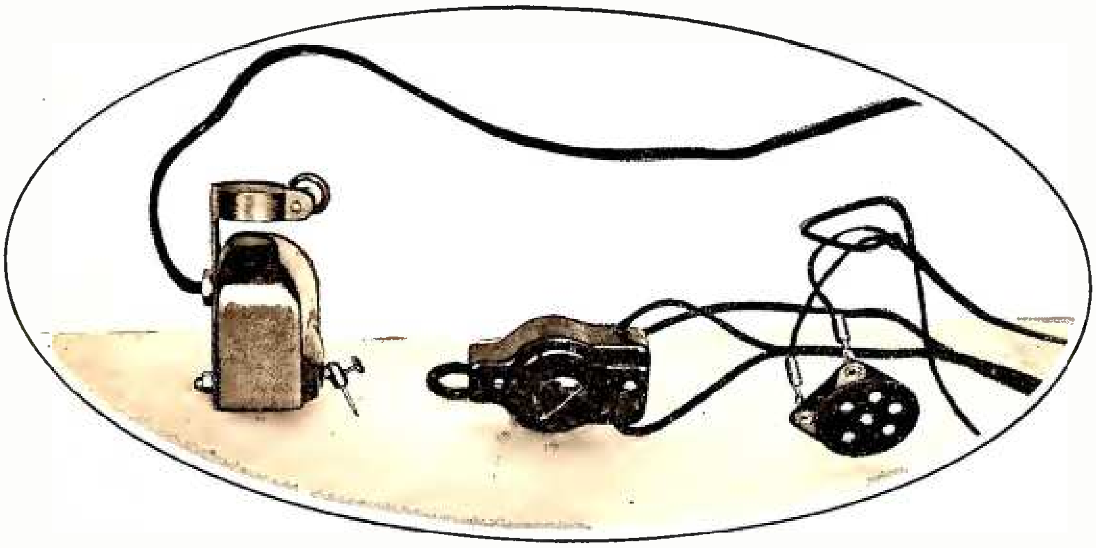

FIG. 7. THE PACENT PHONOVOX

The electrical coils wound on the pick-up magnet must be very small, mainly because of the smallness of the pick-up magnets themselves. As previously discussed, the magnets must be as small and as light as is consistent with good results, in order to reduce the wear on the phonograph records. In order to make a compact, small, electrical coil, it is necessary to use very small wire. This wire is hardly larger than a hair, being in the neighborhood of No. 40 B & S gauge. Obviously, such a coil would quickly burn out if any battery currents were allowed to flow through it. Of course, any unit which is attached to the grid of the detector tube does not have to have any special precautions for eliminating the battery currents from the electric winding, as no battery current exists in this part of the circuit.

All of the pick-up units that are designed to operate on the plate circuit of the detector or the primary of the first audio transformer, must be arranged with a fairly large condenser in series. This condenser prevents the flow of the detector battery currents through the pick-up unit, but allows the audio current generated in the unit to pass through into the primary of the first audio transformer. This circuit arrangement is shown in Fig. 9. The Stromberg-Carlson receivers are equipped with a pick-up jack wired according to Fig. 8. This places the pick-up unit directly across the primary of the first audio transformer when the pick-up plug is inserted in the jack. A stopping condenser, under these circumstances, is not necessary.

HOW TO GET BEST RESULTS

ALL of the electrical pick-up devices which we have tried operated very satisfactorily. Some were particularly low pitched while others covered the higher ranges. It would be entirely a matter of taste which would be considered the best from the point of view of tone quality. In this connection several important things should be mentioned in order to do justice to all types of electrical pick-up units. In the first place, it is most desirable to use the latest type of electrically recorded phonograph records. On the Victor records this can be easily ascertained by the letters "VE" at the top of the name-plate at the center of the record. This means "Victor Electric." Electrically cut records of other makes are also plainly marked on the signature of the disc. The old-fashioned records were not made with the bass notes because there was no way of reproducing these bass notes. You will not obtain the best tone quality on any electric pick-up with an old record.

In the second place, it is essential, for best results, to employ a power tube in the last audio stage of your radio set. Such a tube should be operated on at least 135 volts and should preferably be of the 171 type. This has more effect on the reproduction of the base notes than the audio transformers of your receiver. I have heard of a case where a man went to all the trouble of replacing his audio transformers in his radio set to give him the bass notes and then did not employ a power tube in the last audio stage.

In the third place, a good cone speaker, an exponential horn or a dynamic speaker should be used on the set. The use of the old type horns or small cone speakers will take away much of the excellent tone quality which is noticeable in the modern Orthophonic and Panatrope phonographs.

The most important of these suggestions is that you should have a power tube and good speaker if you are seriously interested in good quality. The reason for the excellent tone quality on the latest phonographs is not solely the electric sound-box. A loud speaker and a good power tube, such as is used in the Panatrope, are equally essential. The picture at the beginning of this article shows an excellent arrangement for phonograph reproduction. A Stromberg-Carlson pick-up, a Samson PAM power amplifier, and a Jenson dynamic speaker are used.

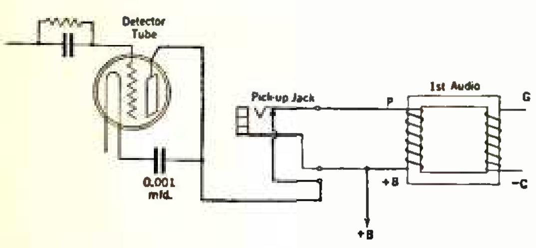

FIG. 8.

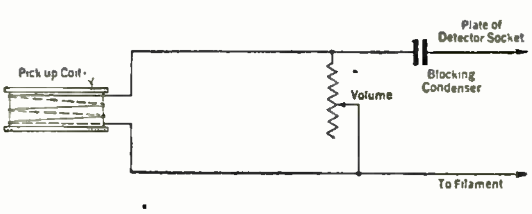

FIG. 9.

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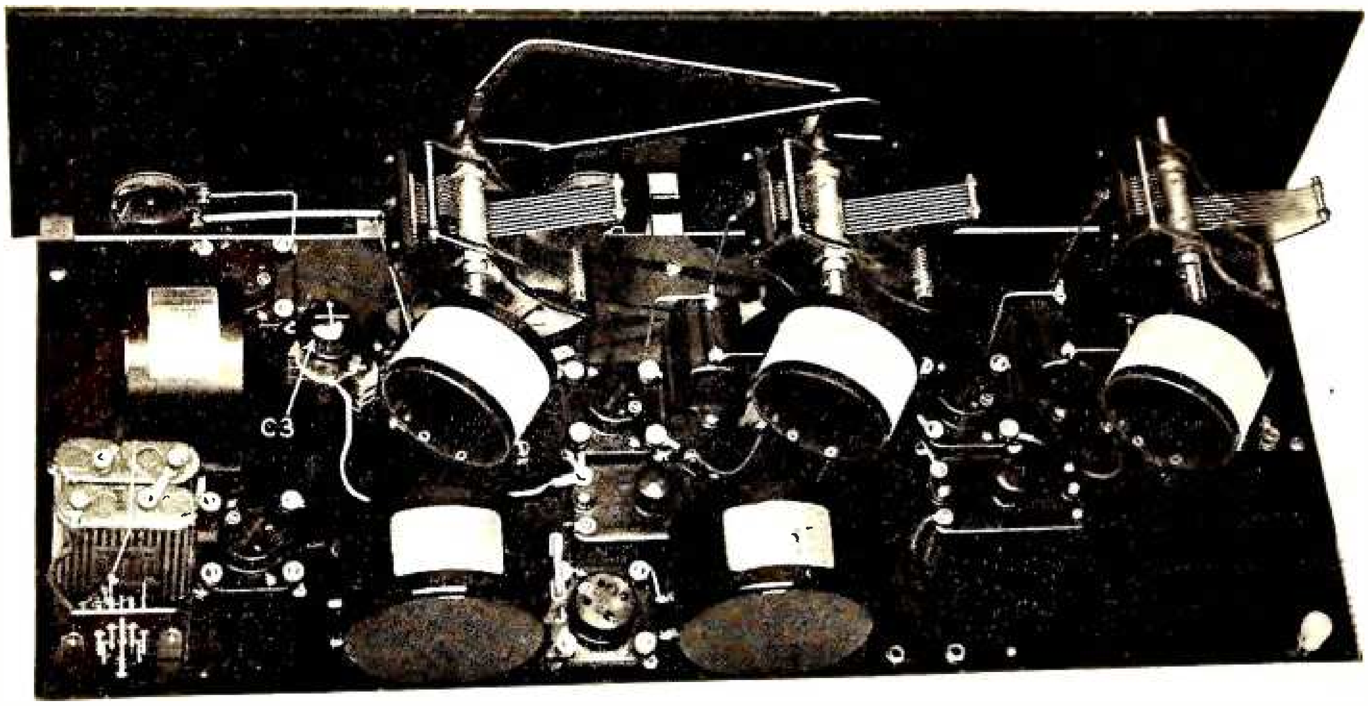

THE EQUAMATIC REVAMPED FOR REGENERATION

The Equamatic system is well known to all radio experimenters and home constructors. The addition of one small condenser, C_3, makes a lot of difference in the sensitivity of this circuit—as well as that of any neutrodyne or t. r. f. set

Adding Regeneration to Any Set

By Herbert Grove

> ### *Making Regeneration Simple*
>
> *MANY radio writers have a habit of making very simple things seem most complex. In this article, the originator of the Equamatic circuit, which was first described in this magazine, does the opposite. He tells how in a very simple fashion the seemingly complex trick of adding regeneration may be played upon the Equamatic, any t. r. f. set, or any neutrodyne. Such a trick should double the stations one can hear on a good night—at least, it did so in the Laboratory.*
>
> *Mr. King's trick consists in adding regeneration to the detector of the circuit by means of the primary of the r. f. transformer which connects the previous tube to the detector. The only additional instrument necessary is a small variable condenser. In some cases a r. f. choke may also be necessary.*
>
> —THE EDITOR

ONE of the commonest ways of finding out whether or not a radio scheme works is the "cut and try" method. This is usually the longest way around an often simple problem, but radio has not yet advanced to the point where one can do all his labor at his desk or drawing board. Some work must be done with a screw driver, soldering iron, and pliers. A little judicious work with pencil and paper, however, will often save hours of labor and promise either ultimate disappointment or success.

For example, if you knew that adding a little regeneration to the detector of a neutrodyne, or t.r.f. set, or an Equamatic receiver, would give it sufficient pep to enable it to get that elusive dx, how would you perform this minor operation?

Before presenting a system for which we are indebted to Mr. Louis G. King, known to RADIO BROADCAST's readers as the originator of the Equamatic system, let us look at a few simple diagrams. In Fig. 1 we have the conventional detector circuit of a receiver—let us say a neutrodyne—in which an r.f. stage precedes the detector. This is the fundamental detector circuit used in such receivers as the Atwater Kent, the Crosley, t.r.f. sets, etc.

Following Professor Hazeltine's patent papers, No. 1,648,808, the primary P, will have about 8 turns, the secondary, S. about 60, and there will probably be a bypass condenser; C_1, from the plus 90 lead to one side of the filament circuit, as well as one across the audio input, C_2. Condenser, C_1 will be about 1 mfd., effectively conducting r.f. currents through the primary coil back to the filament of the last r.f. amplifier tube and keeping them from running all over the plate in the B-battery leads. Condenser C_2 is usually about .001 mfd. and is placed across the audio amplifier input so that r.f. currents in the plate circuit of the detector are given an easy path across the amplifier. A better way to connect C_2 is from the plate to the filament of this tube so that these r.f. currents need not go through the B battery or plate supply. Of course, there will be a tuning condenser and some other apparatus, but since we shall not need to discuss them further we shall dismiss them from the argument at once.

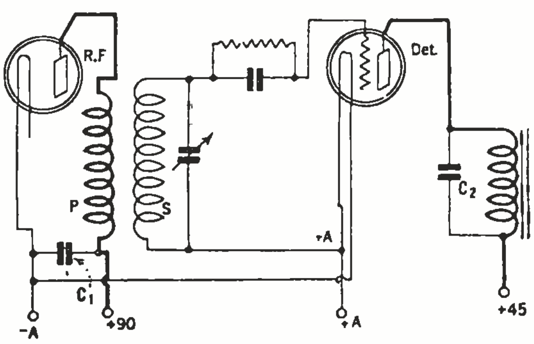

FIG. 1

The conventional detector circuit preceded by the primary of a transformer which couples this detector to a preceding radio-frequency amplifier

Let us revamp this diagram so that it looks like Fig. 2, which from the viewpoint of radio-frequency currents differs not at all from Fig. 1. Condenser C_1 connects the lower ends of both primary and secondary coils, and C_2 goes from plate to filament. Now let us look at Fig. 3, which is a simple regenerative detector. We have added coil T in series with the audio amplifier and the plate of the tube. All radio-frequency currents in the plate circuit of the detector must go through this coil before returning to the filament of the tube.

These changes are small, but the difference such a slight circuit change makes to weak signals is remarkable. Regeneration in a detector

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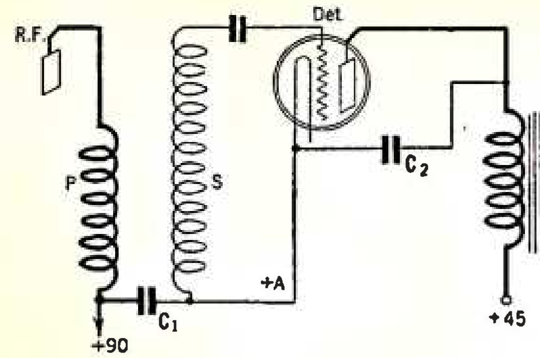

FIG. 2

The same detector circuit as shown in Fig. 1, but drawn differently. The bypass condenser, C_1, connects directly from the bottom of the primary to the filament and hence to the bottom of the secondary winding. Radio frequency currents are bypassed from the plate to the filament directly

is often as good for weak signals as two or more stages of radio-frequency amplification. How can we make our neutrodyne detector, Fig. 1, look like Fig. 3? Add a tickler coil? No, says Mr. King, there is a simpler way. Let us look at Fig. 4. This is exactly the same as Fig. 3 but drawn differently—the tickler coil is at the bottom of S instead of on top of it. It works just the same.

The next step, shown in Fig. 5, is more complicated. Here is where the trick begins.

In Fig. 5 we have added a radio-frequency choke and regeneration condenser, C_3, and placed the audio system as a shunt path, instead of a series arrangement, to the regeneration circuit composed of T, C_2 and C_3. The choke keeps the r.f. currents out of the audio system; C_3, which is about 0.0001 mfd. keeps the audio currents out of the tickler circuit. We have provided an effective filter system, keeping the two frequencies in their respective channels. The tickler coil, T, is now fixed in place and regeneration secured by varying C_3.

THE R. F. PRIMARY AS A TICKLER

HERE is where Mr. King steps in. He notices that the primary coil, P, is attached to the secondary by C_1, just as tickler T is, and says why not use P as the tickler coil as well as the primary of the r. f. transformer which connects the r. f. amplifier to the detector? The result is Fig. 6.

If applied to a neutrodyne or t. r. f. set of the conventional type it will be necessary to adjust the regeneration condenser at each frequency, since more regeneration is needed at the longer waves. But if applied to an Equamatic, and Mr. King had this receiver in mind when he worked out the trick, C_3 can be placed inside the cabinet, adjusted, and let alone. The photograph at that head of the article gives a good view of the installation. It can be fixed so that the detector oscillates all the time, or nearly oscillates, or so that the additional pep is just enough to give one the dx required. This simplicity is due to the variable coupling between P and S, which is the heart of the Equamatic system and which automatically increases the coupling between T and S at the longer waves where more coupling and more regeneration are needed.

Sometimes if the impedance of the audio frequency channel is sufficient at radio frequencies to keep r.f. currents from flowing through the winding and to force them through the shunt circuit, the choke may be omitted. It will be necessary to remove the condenser across the audio input, and if the regeneration condenser, which may be 0.0001 mfd. as a starter, is not sufficient to cause oscillations at the longest wavelength to be received, the choke may be added.

Suppose, then, we have an old-style neutrodyne. We get into the box, attach our regeneration condenser from the plate of the detector to the plate of the previous r.f. tube, and listen-in. If nothing happens we look for the bypass condenser across the audio transformer primary and remove it. The detector should now oscillate at the shorter wavelengths and with about 0.0001 mfd. regeneration capacity. If the detector does not oscillate, the primary of the transformer, which is also being used as a tickler coil, must be reversed. If the detector oscillates on the longer waves as well as on the short, all well and good. The next step depends upon the type of set to which this trick is being applied. If it is an Equamatic receiver, in which the primary automatically moves as the tuning condenser capacity changes, nothing need be done but to determine the best setting for the regeneration condenser. This is the point at which regneration occurs at all wavelengths, but actual oscillations do not occur at any. Some receivers have decided bumps and hollows in the gain-frequency curve, so that a setting of the regeneration condenser which does not cause the detector to break into oscillation at one frequency will cause decided oscillations at another. The trick is to find the position of this condenser which causes oscillation at no setting of the tuning dials.

If the receiver has fixed primaries, as in the neutrodyne or the t.r.f. sets, the regeneration condenser had better be on the panel so that the amount of regeneration is under control at all times. With such an additional control it is always possible to make the detector circuit oscillate, and to tune in stations by the familiar "squeal" method. If oscillations do not occur in the longer wavelengths, the choke will be necessary.

In the latest Equamatic, in which a stabilizing condenser is used as shown in the photograph at the head of the article, the procedure is as follows. Open up the stabilizing condensers until the receiver oscillates. Then screw them down slowly until the set is under control at all frequencies. Then add the regeneration condenser, and choke, if necessary, and ascertain the combination of stabilizing capacity and regeneration capacity that is best—it must be determined by experiment alone.

The result of such a procedure is to make the receiver, be it an old-style t.r.f. set that has little or no amplification at the lower radio frequencies, or a modern high-gain set, more sensitive and naturally more selective.

The parts necessary for these changes are but two, the 0.0001 mfd. variable condenser and the r.f. choke—which may not be necessary.

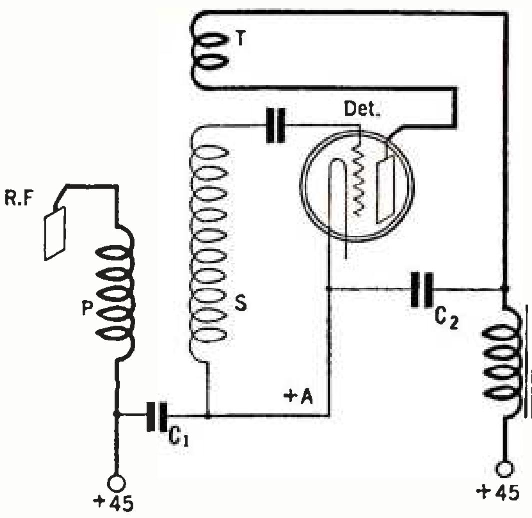

FIG. 3

A rengerative detector. The additional coil marked T is the tickler. There is no more sensitive or efficient single circuit than this

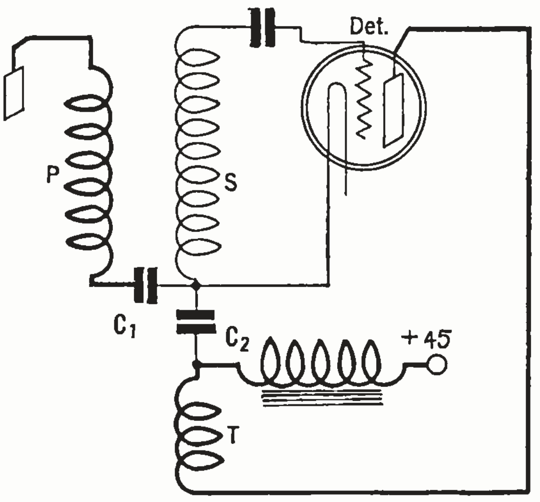

FIG. 4

The same regenerative detector drawn differently. The tickler coil is at the filament end of the secondary instead of near the grid end It works equally well in the two cases

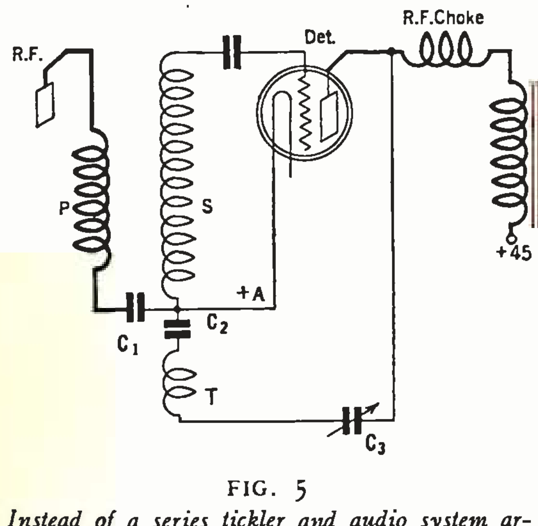

FIG. 5

Instead of a series tickler and audio system arrangement, we can use this arrangement, which shunts the audio input across the regenerative apparatus. Variable regeneration is obtained by the condenser, C_3

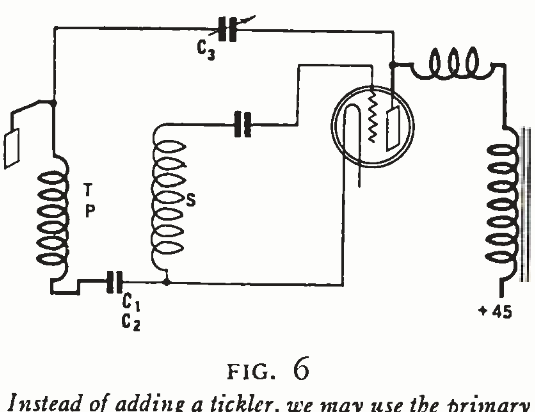

FIG. 6

Instead of adding a tickler, we may use the primary of the interstage transformer, not only as a primary, but as a tickler as well. The r. f. choke may not be necessary, provided the condenser across the audio primary is removed. Condenser C_3 provides the variable regeneration necessary to cover all frequencies

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THE PANEL OF THE 5-METER RECEIVER
A top view of this receiver is shown in Fig 1. At the left is the tuning condenser, of the vernier driven type. The knob in the center of the panel is the regeneration control. At the right is the filament rheostat

What About the 5-Meter Band?

By R. S. Kruse

MANY years ago, when there was no radio but telegraphic radio, we used to talk to station 9LQ, at Lawrence Kansas. Not so many years ago we met the operator of this station, who was then at Cruft Laboratory working with John Hays Hammond on the various secret radio transmission systems in which the inventor was interested. Together we listened with considerable awe to lectures on tubes, etc., from Professors Pierce and Chaffee. Since then, we have known Kruse intimately through his breezy articles in QST.

Now, we are glad to say that Mr. Kruse will be a regular contributor to Radio Broadcast. *He will speak about short-wave receivers, transmitters, antenna systems, laws, problems—and all that goes with them. An article to follow this one will give the constructional data on the 5-meter receivers and transmitters described in this article. If there is any reader of* Radio Broadcast *who does not know Kruse already, he is hereby introduced!*

—The Editor.

THERE has been too much sorrowing for the Ishmaelites, those chaps who fell out with the community and took to the hills where there were better chances of running away—and more things to run from. I suspect that in the course of hunting and being hunted they fell across more interesting things per month than their orderly relatives down in the towns saw during a lifetime.

This is of course an argument for crime and disorder, which is quite fitting, since we are about to tell a story of some wholly irregular proceedings that resulted in driving a surprising lot of interesting radio rabbits out of the electric brush.

HOW IT BEGAN

OF COURSE there isn't anything novel about the 5-meter wave except by reason of its having so long lain in mothballs with all the other short waves that the early radio men from Hertz to Marconi investigated. The spark apparatus then available not being very suitable for short-wave work, not a great deal was learned, and the styles turned toward long waves with antennas large enough to cover a Texas county.

When the vacuum tube had become thoroughly practical as a transmitting device we were treated to the singular show of a world full of radio folks stoutly insisting that a vacuum tube was useless on all waves below 400 meters— but that it was of small moment, since the waves below 350 were worthless anyway.

At this statement a number of us went off the reservation just as the Indians used to and after some bushwhacking around we discovered that the short waves were not worthless but looked astonishingly as if they might be improvements on the longer waves. Furthermore, we found that the vacuum tube oscillated nimbly at 60 meters, whereas our spark sets refused to get down to 150 at all. This was duly denounced as rank heresy by the orthodox, who took no part whatever in such practices, i.e., making circuits that would oscillate at 60 meters.

So it went, even as late as 1921. Sprinklings of stations below 200 there were, but at least one of us (which was I) was hauled before the radio club and accused of communicating with an imaginary station because I and the station I was working were both on 160 meters, and the accuser, being nearby, could hear my part of the proceedings but not the other fellow. Of the commercial folks our good friend Grebe first showed faith by building a tuned r.f. amplifier that went down to 150 meters!

Grebe shows his continued faith in short waves by continuing to build receivers for the very high frequencies.

By 1923 we had become fed up with this sort of thing, and through the machinations of Boyd Phelps and myself, some amateur stations staged an "Exploring 100 Meters" Party, moving our transmitters down by steps and demonstrating that signals would really come through at such wavelengths as 60 meters. There was loud derision at first—and puzzled silence afterward—for the signals had of course come through like the well-known ton of bricks just as several years of tinkering had assured us they would. The tinkering was, by the way, started by Phelps at least as early as 1919 with a low-power 33-meter spark set. After that many names appear that all amateurs know—Reinartz, Dunmore, Conrad, Ramsay. Presently, there was a short-wave "CQ Party" and many stations were heard over great distances. However, the great congregation remained at the old waves—mainly a little above 200 meters. It is very singular that all the wavemeter errors were upward!

Presently, the Washington Radio club produced some active 100-meter stations, those of Browne, Darne, Basim and Hastings in particular. Soon we managed to blast out of the authors some articles on short-wave tuners. These tuned all the way down to 90 meters and Schnell's went to 60 even.

Things now became active—there were investigations between the Naval Research Laboratory and other stations, under the leadership of Dr. A. H. Taylor and L. C. Young. Then a coöperative arrangement with Leon Deloy of Nice, France, put our own Schnell's 100-meter signal across the Atlantic and then Deloy's came back. A few hours later Reinartz talked to Deloy and then many others did it. Presently, in 1924, the Department of Commerce gave back again to the amateurs some of the territory below 150 meters, which resulted in the present system of amateur wavebands and the pages of *QST* bristling with articles on using them. The population, however, howled murder and refused utterly to use the low waves until there was much more demonstration by Schnell and others that the 40- and 80-meter bands were good ones. At that the 20-meter band lay idle until the Experimenter's Section of the American Radio Relay League made 20-meter tests resulting in daylight transcontinental contact between Reinartz on the East Coast and Willis on the Pacific.

SETTLING UP

BY THIS time the 80-meter band was settled territory and presently the 40-meter band became the same. Nowadays, the 20-meter band is thickly populated. Long ago, however, the ones who discovered the 20, 40, and 80-meter bands have moved on down to 5 meters and have run assorted tests with uniform results—oh, very uniform! Without exception there have been no signals but those of Uncle Henry's model T ignition systems. From this it is clear that there is nothing to this 5-meter business, especially since the latest and most up-to-date transmission theory points out clearly that wavelengths of the order of 5 meters will never come

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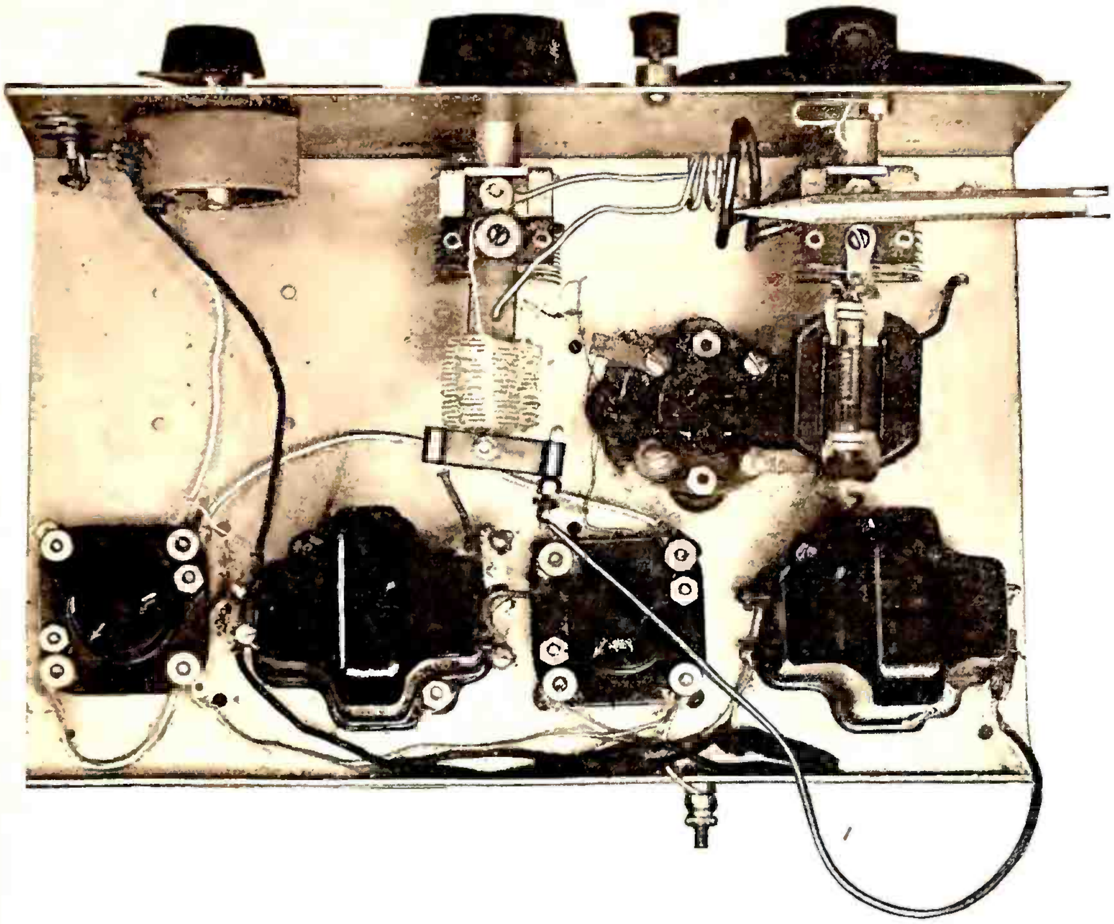

FIG. 1. A RECEIVER THAT GETS 5 METERS

An ancient 5-meter receiver—still good. This set was used to make 1200 field observations on transmissions from 2EB *at Jamaica and* 1OA *at Hartford and Glastonbury. The circuit is perfectly normal, being of the general type of the circuit shown in Fig. 2 plus a second audio stage. With so simple equipment the signals from a* UX-852 *have been copied in a moving car through ignition noises at 5 miles, and at 60 miles with the car stationary and a 20-foot antenna hung on a tree. The pencil points toward the tuning inductance*

down at all on this earth, except, mayhap, in the antipodes.

However, the wanderlust drives on the same group that originally departed from the 200-meter reservation. With the group consisting of Ducati of Italian, 'ACD,' Douglas out in Kansas, Phelps and Kruse on the east coast, it became necessary to make some more detailed study in place of mere "blind" transmissions.

EXPLORING 5 METERS

AT THIS point there entered the radio flivver, financed by Phelps and known as *Conny* because of its Connecticut and New York licenses. The flivver wandered restlessly about Jamaica and Hartford, gradually determining what one may expect 5-meter waves to do. The results were surprisingly normal and unalarming. The signals do not die off in the rapid manner that we had been warned against, nor do they do anything especially freakish.

Some 14 months prior to the days of *Conny* a few signals from an ancient 5-watt UV-202 transmitter of Phelps, at Staten Island, had managed to put signals at 5.2 meters into Glastonbury, Connecticut, where an amazing "haywire" receiver of mine received them. We hoped to repeat this and make it more consistent. We did repeat it, but not before many trials were made, more power used, the apparatus repeatedly improved, and an appalling number of tests run. Our difficulty was with a tremendous "noise level," far worse than at longer waves. This having finally been greatly reduced by means of a double detection receiver, we again hoped for communication, but failed.

Phelps then built a huge automatic key that ground out his call and a test signal by the week, and after some listening this was heard in Kansas by Douglas and in Seattle by another listener. My own signals struggled as far as Kansas, and I heard Ducati's signals. Ducati's transmitter was located at Bologna, Italy, and used about 400 watts. This began to look more hopeful but the contacts were always brief. Phelps then organized a two-way contact with E. S. Strout, 2NZ, of Newark, N. J., and several conversations were held at 25 mile distance. However, the "lure of distance" was again at work.

MORE DISTANT RECEPTION

IN THE fall of 1927 a trip to the West Coast seemed to offer a good opportunity. A 5-meter double-detection receiver was rather hastily discarded in favor of a new detector-audio receiver which I took to Lawrence, Kansas. However, it proved to be not sensitive enough and was replaced by another and better double-

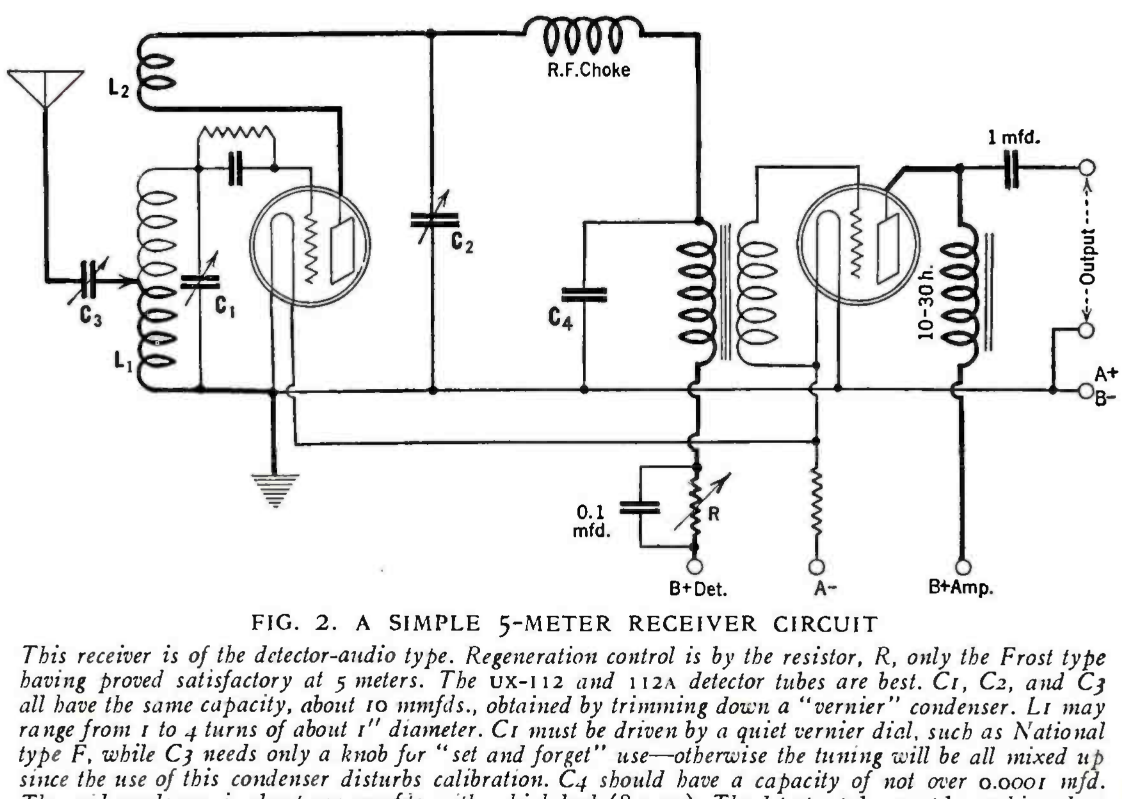

FIG. 2. A SIMPLE 5-METER RECEIVER CIRCUIT

This receiver is of the detector-audio type. Regeneration control is by the resistor, R, only the Frost type having proved satisfactory at 5 meters. The UX-112 *and* 112A *detector tubes are best.* C_1, C_2, *and* C_3 *all have the same capacity, about 10 mmfds., obtained by trimming down a "vernier" condenser.* L_1 *may range from 1 to 4 turns of about 1" diameter.* C_1 *must be driven by a quiet vernier dial, such as National type F, while* C_3 *needs only a knob for "set and forget" use—otherwise the tuning will be all mixed up since the use of this condenser disturbs calibration.* C_4 *should have a capacity of not over 0.0001 mfd. The grid condenser is about 100 mmfds. with a high leak (8 megs). The detector tube must be cushioned on sponge rubber and all leads to it made flexible.*

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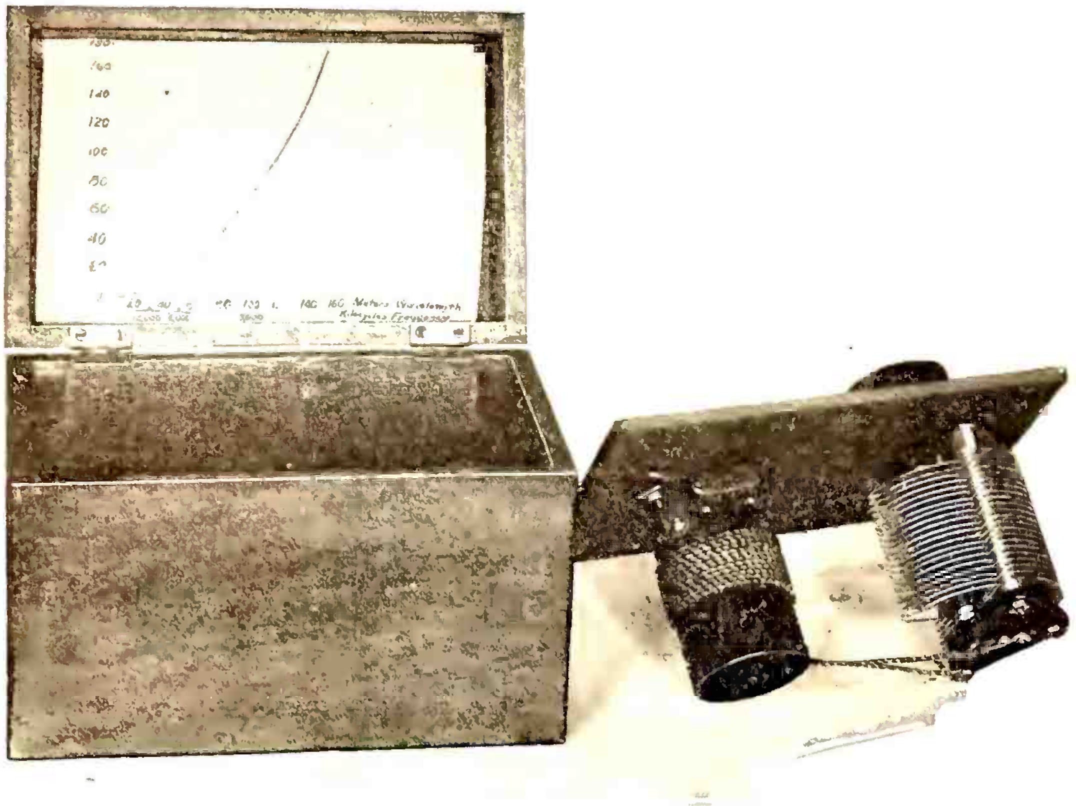


A WAVEMETER—OLD STYLE

A bit of history. This old time wavemeter was used by Phelps at 9ZT in Minneapolis in the fall of 1921. The range is from 10 to 150 meters, (a range of 28,000 kc.) and the condenser has a capacity of 1000 mmfds.

detection set built before breakfast in some miraculous way by Douglas. With this nothing was heard at Newton—180 miles west—at night, which was expected. At Grand Canyon, Arizona, both Norwell Douglas (Kansas) and Phelps (New York) were very weak. At San Diego, neither were the signals thrillingly loud nor were they amazingly steady, but they were *there!* At San Antonio, in the midst of perfect receiving conditions, there was an equally perfect silence. As nearly as can be established, the reflector at 9EHT (the Kansas station) was not aimed right, and the schedule at 2EB (the New York station) was either not sent or else sent at another time than it was listened for. At New Orleans the set stubbornly refused to function and after finally being persuaded into unstable oscillation, grudgingly turned out a rather weak and barely readable signal from Kansas.

All this looked highly encouraging, especially when viewed in the light of the reception of Italian 1ER (Santangeli)—a distance of about 1000 miles—at Tripolitania by Captain Filipini, and the rather consistent 24 mile reception by C. H. West (2CSM) of his own very low-powered automatic signals at distances within 24 miles of Stapleton, New York, and finally the very nice work of C. H. Turner with a crystal-controlled 5-meter transmitter in the Vermont mountains at distances above 100 miles.

The thing was especially interesting because the results did not "gee" very well. Turner's conclusions were that the wave was a daylight one (on which we seem to agree) and that it was useful only for straight-line work, whereas we have numerous cases wherein the signals were very healthy indeed behind hills of good size, for instance, on the opposite side of Avon "mountain" (Connecticut for hill) from my own Hartford station. Again the alleged daylight wave has at certain times shown a strange disposition toward abnormally strong signals on very foggy days, though this applies seemingly to the "local" (60 miles or less) signal only. In the main, the distance reception has been best and steadiest with clear skies, the California "high fog" (West Coast for generally cloudy) being a good barrier in the few cases where it was possible to observe while it parted.

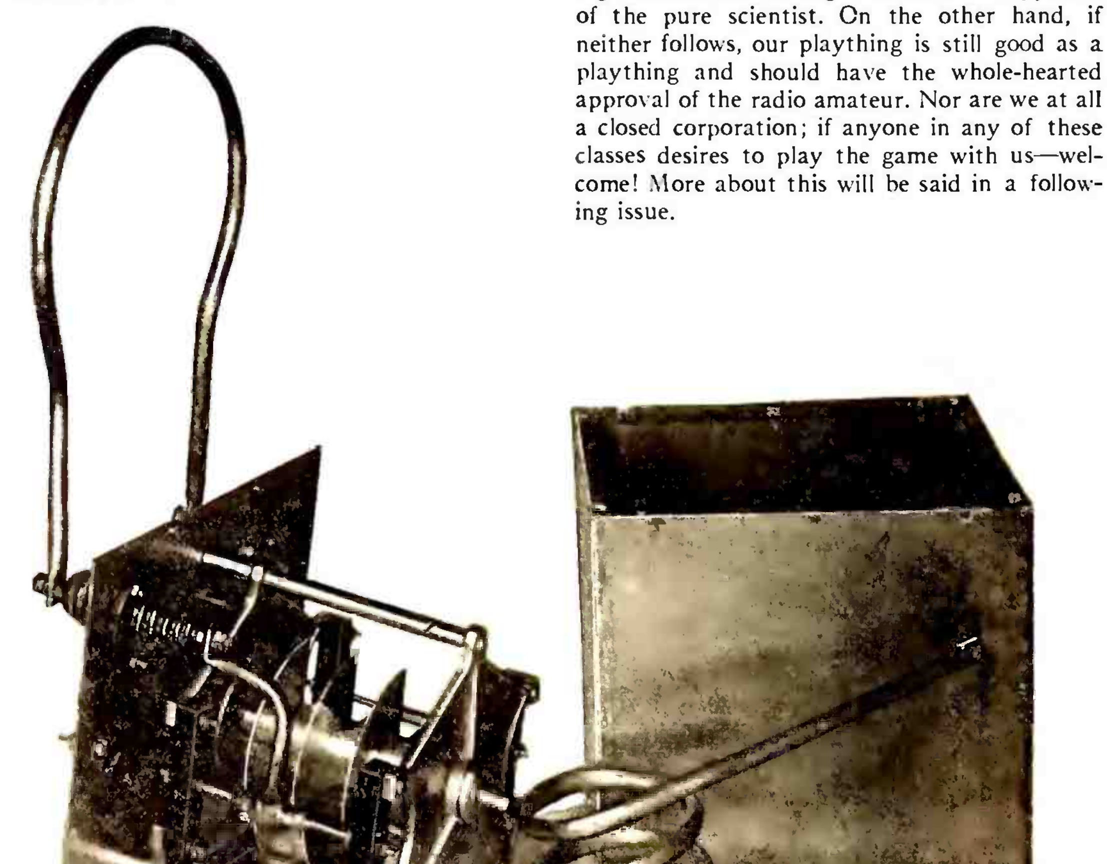
Again, the attenuation (i.e., the dying off of the signal as one goes from the station) does not seem to follow theory. The thing seems to fall off no worse than some other wavelengths which are, theoretically speaking, better.

THE ABSENT ANTIPODES

IT IS, perhaps, especially interesting that the Australian observers, who seem to be better than average, have never heard the signals. They are the ones with the best mathematical right to hear signals—which again leaves matters open for speculation.

For that matter there is no end of room for speculation in the whole thing. A few of the puzzling things we hope to answer. Douglas has a pair of reflectors, horizontal and vertical, with which to aim signals at suspected points, and Langreth of Wesleyan University, at Middletown, Connecticut, is building a crystal-controlled 5-meter transmitter to wash out some of the other uncertainties. To fit into this picture there is being made a receiver with CX-322 intermediate-frequency amplification, a long-wave heterodyne and an autodyne first detector, all of which is hoped to be an improvement on present equipment. Perhaps there will be something more to report of communication results.

Meanwhile, the reader, if still following this story, has begun to do a bit of speculating of his own, asking of what conceivable use all this may be. As to that—why is that so serious? If we make a "useful" wave of 5 meters then the utilitarians will say the thing has been good all along. And if by any rare chance an interesting scientific fact emerges we have the approval of the pure scientist. On the other hand, if neither follows, our plaything is still good as a plaything and should have the whole-hearted approval of the radio amateur. Nor are we at all a closed corporation; if anyone in any of these classes desires to play the game with us—welcome! More about this will be said in a following issue.



A WAVEMETER—NEW STYLE

A later chapter in the story. The new short-wave meter at 2EB, Phelps' present station. The condenser capacity is 33 mmfds. there are 5 plates instead of 43, and the tuning range is from 9.9 to 10.8 meters (30,303 kc. to 27,778 kc., or 2525 kc.) for the full scale of the short-wave coil. This gives a precision, aside from the mechanical improvement, of approximately 14 times that of the old wavemeter! The one-turn coil is for 5-meter work

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"Our Readers Suggest—"

Increasing the Output Voltage of B-power Units

IN PAST numbers of this department suggestions have been offered by readers for the modernization of power supply devices designed before the advent of high-voltage rectifying tubes and power tubes. These suggestions have generally considered the possibilities of improved voltage divider systems, the addition of C-supply resistors and the slight gain effected by the use of new rectifying tubes. Two readers of this department, William C. Millar of Long Island City, N. Y., and Wallace Allen of Denver, Colorado, have simultaneously contributed details of a simple device that, connected exterior to the power supply unit, increases the output voltage of the transformer, making it possible to take full advantage of the new tubes and voltage distribution system. Both contributors have suggested the same arrangement, but, as they individually cover slightly different phases of its possibilities, the editor has combined their two contributions into a single article, rather than accepting only one of them.

The device recommended has two principal advantages. It permits the use of C bias resistors in the negative plate current return without reducing the applied plate voltage below the potentials secured without the bias resistors and the booster. Also, it raises the output of power-packs designed for the original Raytheon and similar tubes to voltages suitable for the efficient operation of modern power tubes.

The arrangement, fundamentally, is a transformer booster, raising the line voltage from approximately 115 volts to 130 volts before applying it to the input of the power supply transformer. The output of the power supply source is increased in proportion. The filter systems of present-day line power devices built by reputable manufacturers have a factor of safety permitting this overload. This is not generally true of units designed several years ago and there is a possibility that filter condensers will break down if this method of increasing the output voltage is applied to some older B-power units.

The only additional part required is a small toy or bell ringing transformer having a secondary output of about fifteen volts. This is connected between the line and the power supply unit in accordance with the diagram, Fig. 1.

The secondary of the step down transformer is connected in series with the primary or line voltage, giving an additive effect when connected properly. (If the output voltage of the power unit is less when the booster is used, the connections to the secondary should be reversed.) So connected, the device is, in effect and actually, an auto-transformer.

A new BH Raytheon tube (or similarly perfected rectifying tube) should be substituted for the type employed with the lower voltage in order to take full advantage of the increase.

Mr. Millar suggests that this arrangement might well be employed even with modern power supply units to compensate poor line regulation in suburban districts. In this case a tapped boosting transformer such as the Ives type 204 and the Thordarson TY121 will provide the desired regulation.

OUR Readers Suggest" is a clearing house for short radio articles. There are many interesting ideas germane to the science of radio transmission and reception that can be made clear in a concise exposition, and it is to these abbreviated notes that this department is dedicated. While many of these contributions are from the pens of professional writers and engineers, we particularly solicit short manuscripts from the average reader describing the various "kinks," radio short cuts, and economies that he necessarily runs across from time to time. A glance over this "Our Readers Suggest" will indicate the material that is acceptable.

Possible ways of improving commercial apparatus is of interest to all readers. The application of the baffle board to cone loud speakers, is a good example of this sort of article. Economy "kinks," such as the spark-plug lightning arrester, are most acceptable. And the Editor will always be glad to receive material designed to interest the experimental fan.

Photographs are especially desirable and will be paid for. Material accepted will be paid for on publication at our usual rates with extra consideration for particularly meritorious ideas.

—THE EDITOR.

Cleaning Corroded Battery Terminals

ASIDE from being unsightly and causing general corrosion of A-battery leads, dirty terminals on a storage battery are responsible for much of the so-called "static" experienced in many receivers. Dirty terminals are easily cleaned by washing with a saturated solution of baking (bicarbonate) or washing soda. The terminals should be swabbed with this solution until there is no more effervescence. The terminals and battery top may then be wiped perfectly clean with a rag.

In addition to cleaning the battery, the soda wash effectively puts a stop to the corrosive action by neutralizing the acid—an effect that cannot be secured by ordinary cleaning.

A. J. PETERS, San Francisco, Cal.

New Use for a Block Filter Condenser

THE more popular models of dynamic cone loud speakers, such as the Jensen or Magnavox, require a six volt source of magnetization current. I find that this can be adequately supplied by many of the popular trickle chargers with a Tobe A Block connected across its output to eliminate hum. This combination is altogether satisfactory, not a trace of a.c. being perceptible in the speaker, which functions at full efficiency.

ALBERT E. CHASE, Quebec, Canada.

Simplified Plate Rectification

THE advantage of plate rectification—the lessened possibility of introducing distortion through overload of the detector tube—has been described on various occasions in "Our Readers Suggest" columns. In some cases this advantage fails to justify the loss in detecting efficiency. It would be well to determine, before permanently changing the wiring in the receiver, whether or not satisfactory signal strength will be obtained on the desired stations when using plate rectification. This can be found out in a half minute by substituting a C battery for the grid leak in the average receiver. The C battery is connected across the grid leak mounting. It is not necessary to remove the grid leak. The negative side of the C battery is connected to the grid side of the leak. The potential should be varied between 1.5 and 9.0 volts, the plate voltage being changed from 22.5 to 60.0 volts for each C battery adjustment, in an endeavor to determine a combination giving the greatest signal response.

HENRY WHITEHALL, Camden, N.J.

Parallel Plate Feed

THE use of a parallel feed, i.e., a separation of the direct current and alternating current paths in the plate circuit of a vacuum tube, certainly has no claim to novelty. This system of connection has not, however, achieved the popularity to which its merit would seem to entitle it. So far the set builder is familiar with the circuit only as associated with the loud speaker, where the use of the so-called "speaker filter" has become general. The parallel plate circuit applies the principle of the speaker filter to the audio amplifier. The circuit is illustrated in the diagram in Fig. 2.

Inductance L should have a high value of about 100 henries. It must be of such construction as to maintain its inductance at currents of several milliamperes. Capacitor C is a condenser of sufficiently large capacity to offer a low impedance at low frequencies—from 2 to 4

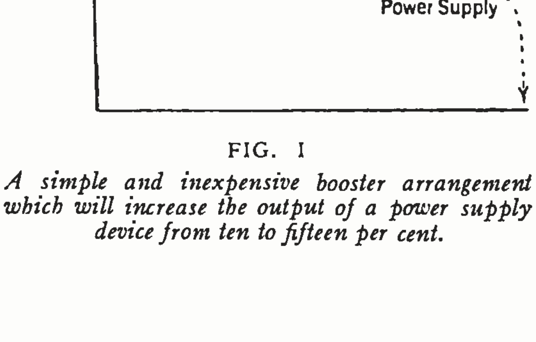

FIG. 1

A simple and inexpensive booster arrangement which will increase the output of a power supply device from ten to fifteen per cent.

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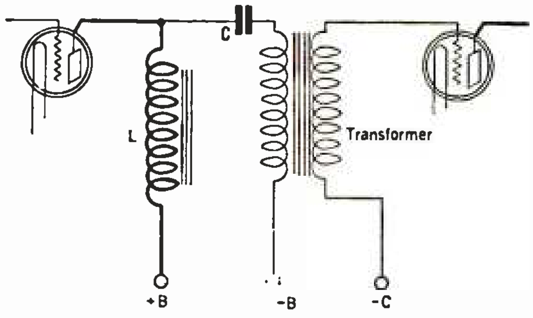

FIG. 2

The principle of parallel feed, familiar in output devices, applied to the conventional transformer-coupled amplifier.

microfarads. The direct plate current flows through the choke, L, which has a low impedance to direct current, while the condenser offers an effectual bar to the flow of direct current through the primary of the transformer. Alternating current is prevented from flowing through the choke, L, in appreciable amount because of its high impedance, while the condenser and transformer primary offer a path of low impedance as compared with that offered by the choke. In this way the two components of current existing in the plate circuit of the tube, i.e., the space current (constant and undirectional), and the audio frequency signal current are directed into different circuits.

The separation of the direct and alternating components of the plate current of a vacuum tube is desirable for a number of reasons. Direct current flowing through the primary of a transformer sets up a field in the core which may cause magnetic saturation in the core. Saturation is a condition under which changes in magnetizing current do not produce corresponding changes in flux. Since the operation of the transformer is dependent on changes in flux, the instrument is naturally affected. The better the transformer, the more likely is this to happen. If the transformer's core is of silicon steel, saturation is not likely to occur with tubes of the 201A or 199 type, but if a 112 or 227 tube is used, saturation may occur. Cores of nickel steel such as are coming to be used to an increasing extent are much more subject to this difficulty than are silicon cores.

Many experimental receivers employ semi-power tubes, such as the 112, in the first stage. In such cases, the following transformer should always be parallel fed.

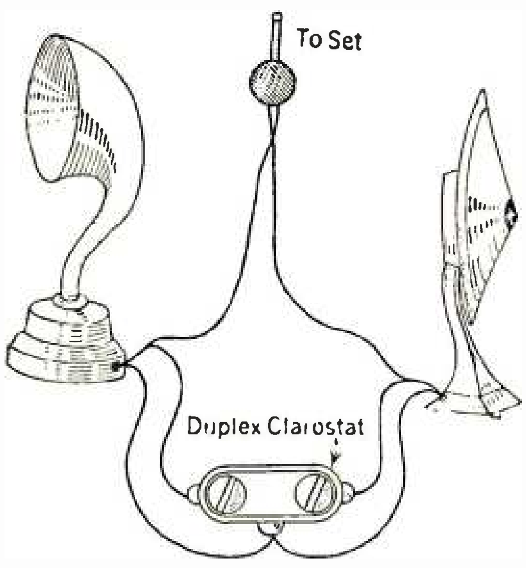

FIG. 4

This balancing arrangement for adjusting cone and horn speakers connected in series is useful where one unit favors the high frequencies and the other low frequencies.

Currents of more than a few milliamperes will seriously affect the behavior of the nickel steel transformer, and the instrument may easily be permanently injured by the application of too large a direct current magnetizing force. The effect of saturation of the iron is to reduce the input impedance of the instrument, resulting in a loss of amplification which is particularly marked at low frequencies. When using cores of some of the nickel alloys, the gain due to the special core material may be completely sacrificed as a result of too much direct current in the primary.

The elimination of oscillation and motor-boating in the amplifier is another advantage gained by the use of parallel feed. It has been noted that the signal current does not flow through the direct current circuit, i.e., no signal or audio-frequency current flows through the plate supply unit. Since no signal current from any stage flows through the plate supply, no audio-frequency voltages are set up, and no coupling between the stages results from the common impedance in the plate supply device. The result is an increase in the stability of the amplifier, and elimination of regeneration and "motor-boating."

C. T. Burke, Cambridge, Mass.

Some More on Balanced Speakers

"OUR Readers Suggest" has devoted considerable space to the interesting possibilities of operating speakers of opposing characteristics, such as a cone and a horn, in series in order to obtain adequate reproduction of both high and low notes. Different resistor devices have been suggested to determine the correct balance. I find that the simple arrangement, employing a Duplex Clarostat, as shown in Fig. 4, altogether satisfactory and less complicated than the systems heretofore suggested. I am using an R.C.A. horn with a Western Electric 24-inch cone. When the right hand screw is tightened, the cone is cut out of the circuit and the high notes emphasized. When the left hand adjusting screw is tightened (and the right hand screw loosened if necessary) reversed conditions prevail, and the low notes are accentuated. Once the correct balance is obtained, the resistors should never be touched, and the screw driver adjustment is well adapted to this semi-permanence.

R. Mackey, Schoharie, N.Y.

A Milliampere Meter Protector and Multiplier

A FEW days ago the representative of a well-known manufacturer gave me a startling figure on the number of milliammeters repaired daily at his factory. After one of mine had been laid up for repairs, I adopted the protective device shown in Fig. 5.

The milliammeter is shunted with a 30-ohm General Radio filament rheostat. When the ammeter is inserted in the circuit, the resistance is adjusted so that the resistance is practically cut out. In this position, a very slight deflection of the meter is noticeable, which serves to show if the polarity connection is correct. The resistance of the rheostat may then be gradually increased and the meter reading noted. If the current in the circuit is above the meter capacity, it will be noted before any damage is done. Providing all is well, the rheostat may be turned to the "off" position, which gives normal full deflection on the meter. If the meter has a scale of fifty or more milliamperes, the rheostat may be used as a multiplier with sufficient accuracy for all ordinary purposes.

While on the subject of protection, I might add that I find the 199 Amperites a very effective fuse in the B and C battery circuits, and 1- and 3-ampere fuses useful in the A circuit.

Edward T. Werden, Mt. Vernon, N. Y.

STAFF COMMENT

THE rheostat can be used as a multiplier regardless of the range of the meter as far as the requirements of the average experimenter are concerned. The rheostat should be set so that the indication of the meter is some easily multiplied fraction of the actual current. For instance, with the rheostat open, the current through the meter should be noted (any desired current can be secured by connecting the meter in series with a high range Clarostat and a dry cell). The rheostat is then cut in until the current through the meter drops to one half or one third or one tenth of the original reading. This fraction will then hold for all readings. For example, if the rheostat is set for a one quarter deflection, three milliamperes on the meter indicate an actual current of twelve milliamperes.

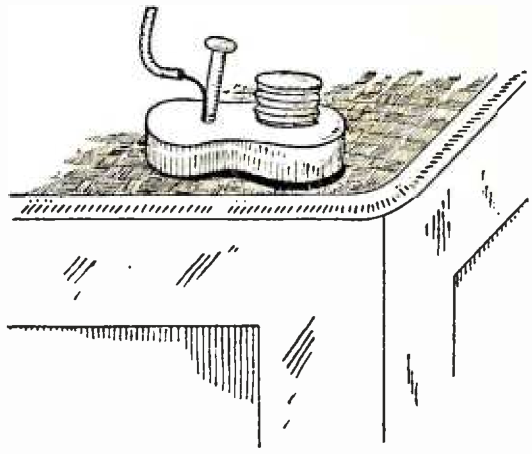

FIG. 3

An emergency storage battery connector that is quite independent of the elusive binding-post cap.

Tinning Wires

WHEN using an untinned wire for the internal connections of a receiver difficulty is often experienced in tinning the ends before making a joint. The process of tinning these wires may be carried out much more effectively if a groove is filed in one of the surfaces of the soldering iron. This groove will readily fill up with solder, and then by sliding the wire to be tinned into the groove, it will be tinned on all sides simultaneously.

J. B. Bayley, Jersey City, N. J.

Emergency Battery Connections

IN THE absence of the usual battery clip a good emergency connection may be made with an ordinary one inch finishing nail, or even a flat head if it is of small diameter. First drive the nail into the lead end post about a quarter to three eighths of an inch. This may seem difficult, but is really very easily accomplished. Then remove the nail and insert the wire from the receiver or charger and drive the nail in again. Fig. 3 shows how it is done. This will make a good solid contact equal to the carrying capacity of the wire used.

J. B. Bayley, Jersey City, N.J.

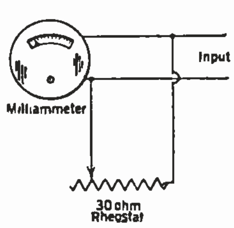

FIG. 5

An inexpensive milliammeter protector and multiplier that will save its fifty cent cost many times over.

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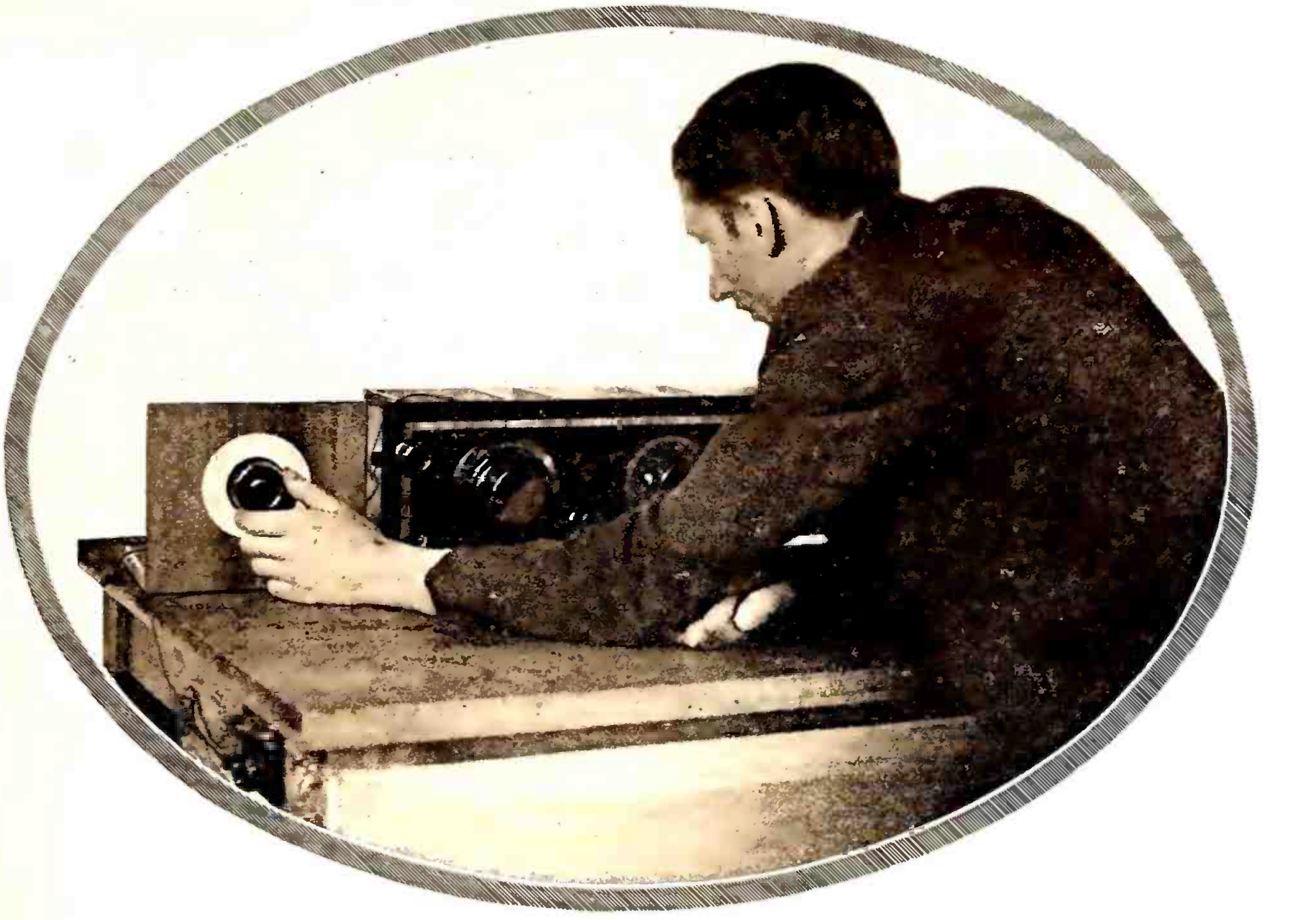

A NEW WAY TO RECLAIM OLD SETS

The use of the screen-grid tube in an external amplifier unit constitutes one of the simplest and most efficient ways of giving new life to receivers that are in need of a little more r. f. amplification. High gain, easy operation, and the elimination of the necessity for neutralization are among the features of this unit

An Extra R. F. Stage for Any Receiver

By The Laboratory Staff

THERE is hardly any receiver that cannot profitably utilize a little more radio-frequency amplification to enable its owner to reach out for those stations which ordinarily are just beyond the set's range. If, at the same time, selectivity can be added—and all this very cheaply—it is small wonder if many thousands of the one-stage screen-grid tube radio-frequency amplifiers described here are not built. It may be added in front of practically any receiver, and with those which are none too selective or sensitive now, the difference made on weak signals after they have passed through this amplifier is extraordinary.

Such an amplifier as is illustrated in Fig. 1 is quite simple to build. It adds a stage of radio, adds selectivity, adds dx-getting ability, and with simple sets like the one tubers, the crystal receivers, or the reflex receivers, makes all the difference between a local or one-station receiver and a high gain modern receiver.

The apparatus is as follows: a screen-grid tube, a coil and a condenser with a dial, a socket, an r. f. choke and a coupling condenser. The tube requires 3.3 volts at 0.132 amperes for the filament, 45 volts for the screen grid and from 90 to 135 for the plate. The bias on the control or signal grid is obtained by taking the drop across a resistance in the negative filament lead of the tube. The circuit diagram is given in Fig. 2, and any one can put the apparatus together in about an hour with the certainty that it will work. If desired a box can be built around it, or the whole outfit can be placed in an aluminum or copper can or—as was done in the Laboratory—it can be built in the simple manner shown in Fig. 1.

When this amplifier is used with a receiver which is not shielded, and which may already have considerable r. f. gain in it, it may be an advantage to shield the external amplifier, either by putting it into one of the Alcoa or similar box shields, or by placing a metal box around the coil. Under some conditions the amplifier may cause the receiver to oscillate, or the amplifier itself may oscillate. In the Laboratory no trouble was had at all, even when the external amplifier was used with receivers which had considerable gain.

MANY owners of radio receivers desire to add a stage of radio-frequency amplification in front of their set. Such an amplifier with a tube of the 201A type has a tendency to oscillate and create trouble if it has any r.f. voltage amplification in it. The answer is to use a screen-grid tube, which does not oscillate so easily. Such an amplifier is described here. In the Laboratory it has been possible to hear stations with its use that were inaudible without it.

When the unit is used with the crystal receiver described in June Radio Broadcast, *the receiver changes from a one-station set to one which will not only separate* WJZ *from* WEAF *under the very severe receiving conditions mentioned in the article, but will bring in all the other New York stations as well.*

No receiver has been found in the Laboratory which could not be used with this additional amplifier—it seems to be a universal unit.

—The Editor.

In the Laboratory the amplifier was used with the crystal receiver described in the June Radio Broadcast, making it possible to receive WJZ, which is about thirty miles away, without getting WEAF, which operates within 50 kc. of WJZ and is only five miles away. Ordinarily WJZ could not be distinguished through WEAF on this crystal set. It was also possible to hear good signals from the other New York and New Jersey stations when the amplifier-crystal detector receiver was operated, although they could not be heard at all without the amplifier. In view of the extremely strong field in the vicinity of the Laboratory from WEAF, the gain in selectivity evidenced by this additional tuning circuit and its amplifying tube is considerable.

HOW THE UNIT IS OPERATED

THE operation of such an amplifier is simple. The antenna is removed from the receiver and attached to the amplifier. Then the output wire from the amplifier is attached to one of three places on the receiver. On most sets it is merely necessary to attach the output wire to the antenna binding post. On some sets which have an additional tube with an untuned antenna-ground circuit ahead of the r. f. amplifier itself, better signals will be received if the output wire is attached to the grid terminal of the first or second tube socket, or to the rotor or stator plates of the first tuning condenser. The best

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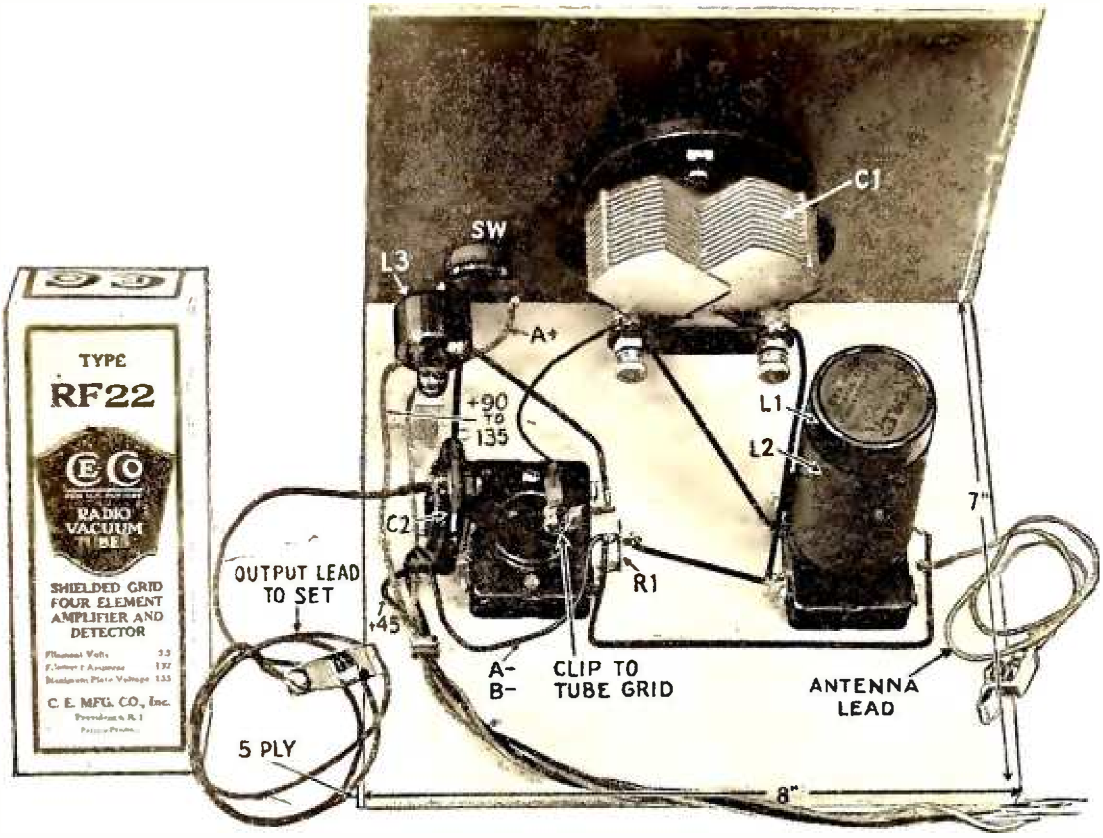

FIG. 1

Simplicity is the key note of this additional stage of r. f. amplification which can be added to your present receiver. It adds amplification and selectivity—and costs but little

place to connect the output wire is a matter to be determined by test only. There is no danger attached to such an experiment; nothing can happen if the wrong connection is made.

The receiver is then tuned as usual or to the dial setting where signals are to be expected, and the amplifier dial turned until the signals are heard. Under some conditions a slight readjustment of the receiver dial or dials may be necessary. In general, however, the external amplifier will have no effect on the receiver tuning with the exception of the first tuning condenser of the receiver's r. f. amplifier. Since the antenna is removed from the first tube of the receiver's r. f. amplifier, the tuning of this circuit may be a degree or two different from usual. The volume control remains on the receiver itself.

Power for the amplifier may be obtained from the receiver power supply unit. Several long leads may be cabled together and attached to plus and minus A, plus 45 and plus 90 to 135. These voltages are not critical. If the receiver's A-voltage supply is used, minus B will be already attached to the A supply; if an additional A battery is employed for the amplifier, minus B must be attached to it. Whether it is connected to minus or plus A makes little difference. If dry cells are used, six of them arranged in a series-parallel connection (Fig. 4) will be economical to operate. A rheostat should be used under these conditions to cut down the voltage from 4.5 to 3.3, and the C bias for the grid obtained as shown in Fig. 3. If an external battery is used, the amplifier should be grounded. If the set's battery is used, it is probably already grounded, automatically grounding the amplifier.

COIL DATA

THE coil used in this amplifier is the Remler plug-in type 550 coil, designed to cover the broadcast band with a 0.00035 mfd. condenser. If the constructor desires to build his own coil, about 90 turns of No. 24 wire on a 2-inch form with about ten turns for the antenna-ground coil will do nicely. With a .0005 mfd. condenser about 75 turns will be correct. The kind of insulation on the wire is not important.

A stage of r. f. amplification similar to the unit described here was described in the June RADIO BROADCAST (A Screen-Grid Booster) by Glenn Browning, and may be purchased complete from the Browning-Drake Corporation or the parts may be assembled at home. A similar unit is manufactured by the Sterling Manufacturing Company. Up to the present time, this unit has not been tested in the Laboratory.

The parts used in the unit described in this article are as listed below. Other similar parts may be used, of course.

LIST OF PARTS

C_1	1	Remler condenser, 0.00035 mfd., type 638
C_2	1	Sangamo fixed condenser, 0.001 mfd.
L_1, L_2	1	Remler inductance, type 550
L_3	1	Remler r. f. choke, No. 35
R_1	1	Frost De Luxe resistor, 20 ohms
	1	Remler dial, type 637
	1	Carter Imp on-and-off switch
	2	Remler sockets
	1	Baseboard, 7 x 8 inches, 5 ply
	1	Panel, 7 x 8 inches, $\frac{1}{8}$-inch walnut
		25 feet Celatsite Hook-up wire

To place the amplifier in operation the following apparatus will be necessary:

- 1 Screen-grid tube, UX-222 type
- 1 A Battery supplying not less than 4 volts
- 1 45-volt screen-grid voltage source
- 1 90–135-volt plate voltage source

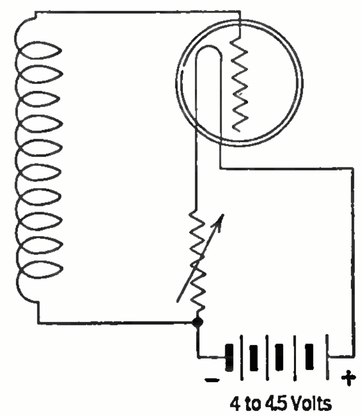

FIG. 3

If dry cells are used a variable resistor should be used to lower the battery voltage to that required by the tube. This diagram shows how to connect it in the circuit

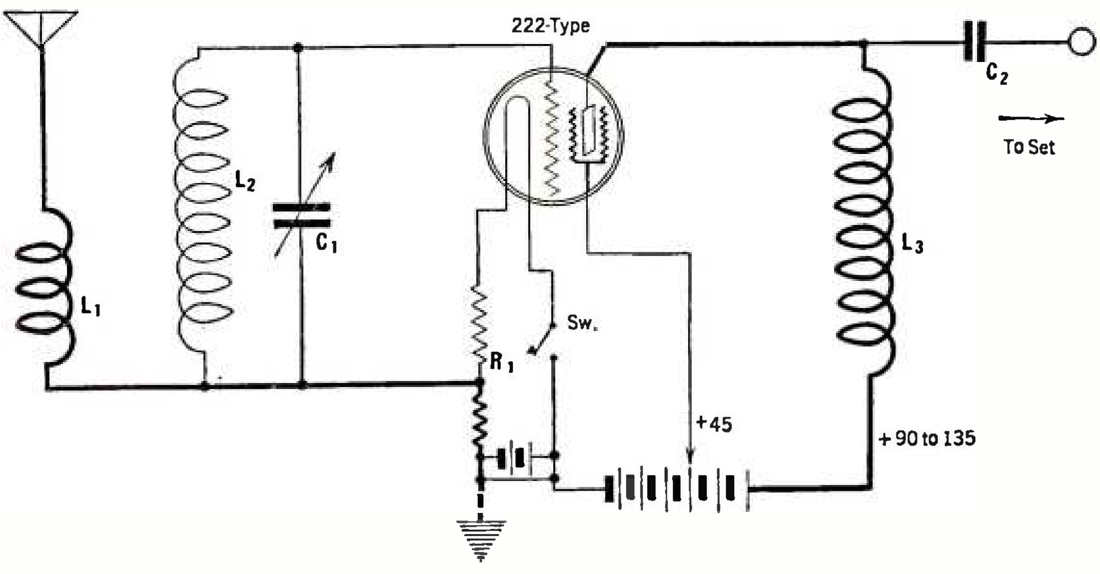

FIG. 2

The circuit diagram of the amplifier if a six-volt storage battery is used. The fixed resistor R_1 drops the battery voltage to 3.3–3.4 required by the tube and supplies a constant grid bias of about 1.3 volts

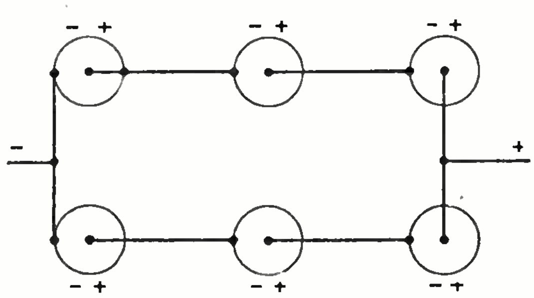

FIG. 4

Six dry cells in this series-parallel connection will supply 4.5 volts and when used to light the filament of a screen grid tube taking 132 milliamperes should last a long time

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AS THE BROADCASTER SEES IT

BY CARL DREHER

Broadcast Frequency Characteristics

A QUESTION of importance is brought up by Mr. F. H. Akers of Chicago in the following communication:

> There is, I think, a growing tendency among the broadcasting stations, at least around Chicago, against which I should like to raise a "squawk." I have been noticing for some time an increasing tendency for articulation to become poor and a general inability to hear spoken words distinctly. At first I looked in the set for the trouble but was not able to find it, and, checking up with other sets and with a friend working at a broadcasting station, I found that they are favoring the low audio frequencies so that their station will sound better on sets with poorer audio equipment. This seems to be a growing practice which, of course, is nice for the fellow with a poor audio amplifier, but leaves the quality not so good for the listener with fine equipment. Perhaps others are having the same trouble and are mystified at not being able to find the cause. In the long run I do not believe such practices will be good for broadcasting, because they discourage buying good receiving equipment. I do not know to what extent this is being done, as the better and larger stations do not do it, and I may be wrong in my conclusion.

I have not run across cases of intentional frequency discrimination at broadcast stations, such as Mr. Akers complains of, and doubt their prevalence in the Chicago district or elsewhere. Of course, there are numerous instances of failure to transmit essential frequencies in the audio band, but these are seldom purposeful, and may as a rule be ascribed to poorly designed or badly operated equipment. The case reported in this department about a year ago, where a station operator connected a half-microfarad condenser across an amplifer to get rid of microphone hiss, and incidentally cut out most of the tones above 2000 cycles a second, is a flagrant instance, but quite extraordinary. In this case the owner of the station liked the absence of high frequencies; it made the music "mellow," he said. He should have a dozen cheap violins smashed over his head before being handed over to the constabulary. Violins are rich in high-frequency partials. A few years ago, also, a New York station broadcast from a sea resort about eighty miles distant over an unequalized wire line. The result was about the same as in the station which eliminated carbon "rush" by the inspired-expedient aforementioned. Many stations, of course, transmit only the three middle octaves of music, and the Federal Radio Commission lets them stay in business. But these are all effects of ignorance or inadequate technical facilities. The stunt which Mr. Akers describes is a different kind of offense.

If anyone has actually thought of such a device, I agree with our correspondent that the inventor had best put the idea in his cold file and forget it. Compensation in one link of an electro-acoustic chain for the defects of another section is of course no novel idea, and in some cases it is a justified, although always somewhat dubious, design resource. Something may be said in its favor when it happens to be economical and when the defects to be ironed out are quantitatively known, so that a precise compensation is possible. But receiving sets may have so many different defects that any attempt at correction of the audio characteristic at the transmitter is bound to injure as many listeners as are benefited for the time being. If the lows are allowed to predominate at the broadcast station, what is going to become of the people who have drummy receiving sets, not to mention those who have already attained a reasonable flatness in acoustic design? There is as much logic in making the station output tinny in order to help people whose receivers are down at the high end. If the stations went in for this sort of thing the audio-frequency spectrum would become as disorderly as the radio, which heaven forfend. Let the manufacturers of receivers, amateur and professional, strive for audio characteristics flat between 100 and 6000 cycles, and let those of the broadcasters who have not yet attained this reasonable ideal bend their efforts in the same direction. Plenty of the broadcasters are already ahead of this standard. I offer in evidence Fig. 1, a curve of the frequency response of the National Broadcasting Company's WEAF transmitter at Bellmore, Long Island. The station was built by the Radio Corporation and the transmitter supplied by the General Electric Company (Advertisement). The observations for the curve were made by Mr. Raymond Guy, and I will vouch for them as authentic. That is a pretty curve, and for practical purposes it would be no better if it were a horizontal line drawn with a ruler between 30 and 10,000 cycles, because the irregularities in the characteristic are too small for the most sensitive human ear to detect. Alas, not all of this lovely curve is utilized by the stuff which gets out over the wire line. I reproduce it, however, so that Mr. Akers may feel assured that some broadcasters strive to let the efforts of the artists go out to the world without any acoustic infidelites. Those who do not at least make that effort are, I believe, in a very small minority.

Low Voltages are Dangerous

WE HAVE certainly stressed the danger of coming into contact with high-tension conductors in broadcast stations frequently enough in this department. Perhaps not enough has been said about the menace of relatively low-voltage circuits. The following account of a most unfortunate accident, through which a well-known telephone and radio research engineer lost his life, may give pause to those who think nothing can happen to them on 110 or 220 volts. The clipping is taken from the New York *Times* of April 13, 1928.

> Deal, N. J., April 12.—H. R. Knettles, 31 years old, a member of the technical staff of the local Bell Telephone laboratory, was killed early to-day when he came into contact with a low-voltage power circuit. His body was found on the floor by other members of the staff.
>
> He had entered an enclosure in which the only electric power was a 240-volt alternating current supply, and was probably killed, it was said, when moisture in the air caused a short circuit with his body. Pulmotor efforts at resuscitation failed.

The seriousness of an electric shock is dependent, of course, on the power dissipated in the victim's body, rather than on the voltage impressed. The "medical" induction coils which were popular ten years ago used to generate several thousand volts, but the available power limited the current to a few milliamperes, so that no damage to tissue could result. When the power is not so limited, and the resistance presented by the body happens to be low, moderate voltages may cause death. Every year a sizable number of persons are killed in bathtubs on 110-volt circuits. Standing in water, and with wet hands, they touch a defective electric light fixture. Under these conditions the resistance of the body is reduced to a few hundred ohms. The resulting current may be of the order of an ampere. Any considerable fraction of an ampere, especially when it passes through vital organs or nerve ganglia, is likely to cause grave injury or to kill outright. In handling high-power, high-voltage circuits, in general, contact means certain death. In the case of high-power, low-voltage circuits one gambles with the electrical resistance of one's body. If it happens to be low a few hundred volts will send a man to eternal sleep just as surely as a few thousand.

The story about moisture in the air, in the case of Mr. Knettles, is, of course, a reporter's misconception. Apparently the engineer came into contact with the conductor through his head, which may have been moist. Anyone who has ever made a good contact with a 220- or 240-

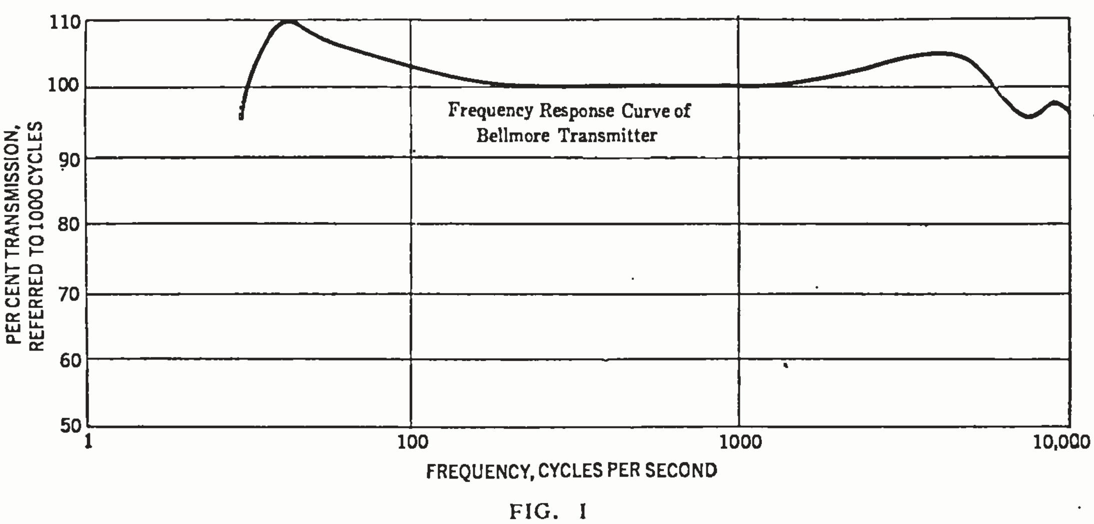

FIG. 1

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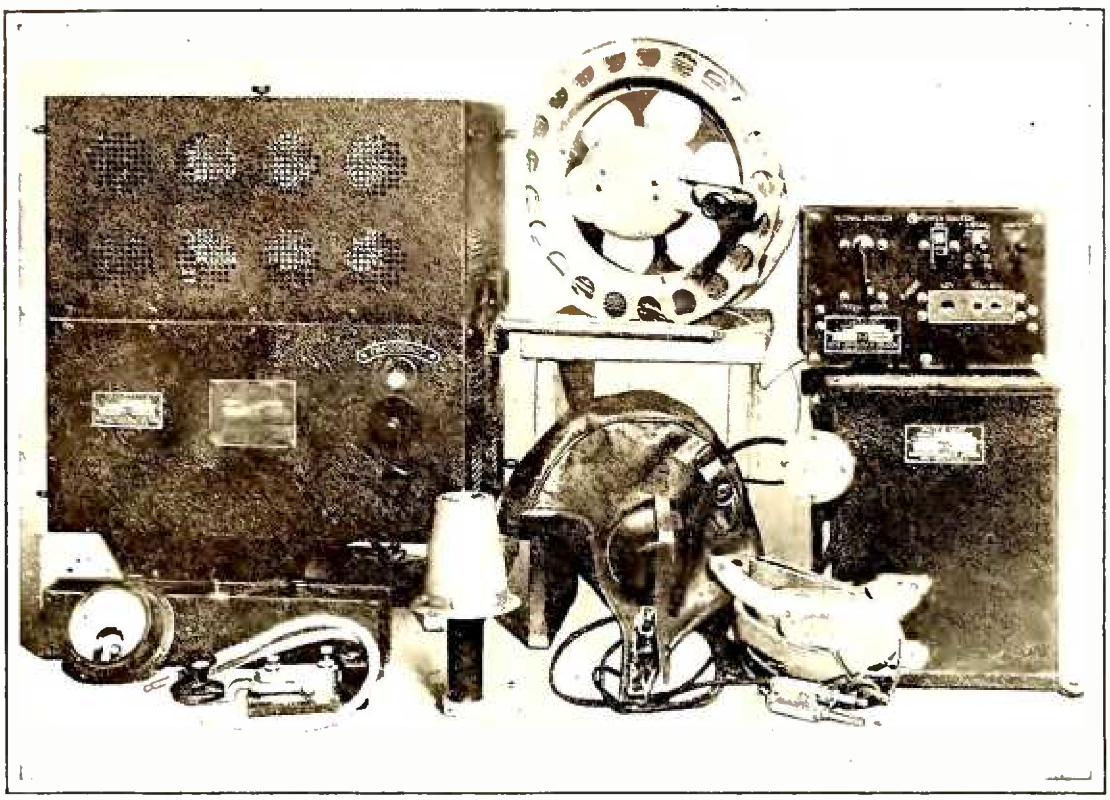

THE R. C. A. 300-WATT AIRPLANE SET

volt circuit knows what a terrible shock can be sustained on such potentials.

Broadcast technicians, used to handling potentials of the order of thousands of volts, become contemptuous of lower voltages. They are making a mistake. As one gets older in this business one becomes more and more reluctant to fool with electricity on any voltage at all, when power is known to be behind the terminals. As a young man, just out of college, I used to test for a live circuit on 110 and 220 volts without hesitation, using my fingers. On one occasion I actually touched my thumb and forefinger to a 440-volt line feeding a telegraph quadruplex to see what it would feel like. I did it in such a way that the movement would disengage me, and there were spectators present, but it was a pretty idiotic stunt. Nowadays, I won't touch the metal of a 110-volt circuit if I can help it. There are plenty of test-lamps to be had for twenty cents. And, incidentally, these warnings hold for receiving set rectifiers as much as for broadcast transmitter apparatus. One of these days some enterprising broadcast experimenter is going to be burned up on the 500 volts from his power rectifier, when he forgets to turn off the electricity before putting his hands into the case. A few electrocutions are imminent. All I can do is to point out the fact and wait for the newspaper reports.

Commercial Radio Publications

RADIO CORPORATION OF AMERICA:
"Aircraft Radio Equipment"

THIS is a beautifully printed pamphlet of specifications and illustrations of three types of airplane radio stations marketed by R.C.A. It is issued by the Sales Department of this company, at 233 Broadway, New York City, which will supply quotations on request. The three types of transmitters and receivers available for planes of different sizes are described as follows:

ET-3652—Weight: 86½ pounds. A light weight transmitting and receiving equipment for installation on the smaller types of "single seater" airplanes. Rated at 10 watts, it will, under favorable conditions, transmit via radiotelephony a distance of approximately 25 miles, or by radiotelegraphy (c.w.) a distance of approximately 75 miles.

ET-3653—Weight: 132¾ pounds. A medium weight transmitting and receiving equipment for installation on practically any type of airplane. Rated at 100 watts, it will, under favorable conditions, transmit via radiotelephony a distance of approximately 75 miles, or by radiotelegraphy (c.w.) a distance of approximately 300 miles.

ET-3654—Weight: 202 pounds. This transmitting and receiving equipment is designed for use on large aircraft where long distance communication to ground stations and other aircraft is desired. Rated at 300 watts, it will, under favorable conditions, transmit via radiotelephony a distance of approximately 200 miles, or by radiotelegraphy (c.w.) a distance of approximately 500 miles.

The above ranges are stated by the manufactures to be approximate, yet conservative, so that at times a considerable increase in range may be secured.

The following major units are included in the 10-watt Model ET-3652 equipment: 1 transmitter, including 3 UX-210 radiotrons; 1 control unit; 1 terminal box; 1 receiver; 1 filter unit; 1 antenna with wire (300 ft.); 2 antenna weights; 1 fairlead (an insulating tube in which the antenna lead is carried out through the fuselage of the plane); 1 aircraft anti-noise microphone; 1 wind-driven double-current generator; 1 Deslauriers air propeller; 1 antenna ammeter; 1 flame-proof key; 1 helmet and phones, cord and plug; 1 set inter-connecting cable.

The rating of these airplane transmitters is based on power in the antenna, so that the Model ET-3652 will deliver 10 watts of r. f. power to an antenna of the trailing type, 80-130 feet long. The frequency range available is 2250-2750 kilocycles (133-109 meters). Three UX-210 tubes are used, one as a master oscillator, one as a radio power amplifier, the remaining one as a modulator. With voice input a 50-60 percentage modulation is reached, the Heising system of modulation being used. The quality of reproduction is stated to be very good, but no figures as to the actual audio-frequency range are given.

The receiver is a simple and compact 5-tube affair, with two stages of neutralized radio-frequency amplification, a regenerative detector, and two stages of transformer-coupled amplification. The receiver derives its power supply from the same generator which feeds the transmitter, suitable filters being interposed.

The larger transmitters (100 and 300 watts in the antenna for telegraphy) carry substantially the same parts as the 10-watt outfit, with the addition of spares, owing to the greater weight permissible, and, of course, in proportionately larger sizes where the power requirements are greater. The 100-watt (ET-3653)model uses a UX-210 tube in a Hartley master oscillator circuit, followed by a neutralized power amplifier in the form of a UV-211 tube. This power amplifier is modulated for telephony by the Heising system.

The receiver for this set covers a 3750-2200 kilocycle (79.95-136.3 meter) range. It is slightly heavier than the receiver provided with the 10-watt outfit. The antenna wire, carried on an insulated reel, is copper-clad steel. Ten antenna weights are provided. In the case of this transmitter and receiver the wind-driven generator supplies voltages of 1000 for the plates and 10 for the filaments. The 10-volt winding also feeds an inter-communicating telephone system between the pilot and operator. The maximum total output of the generator is 800 watts. Normally it provides 450 milliamperes at 1000 volts for the plates and 9 amperes at 11 volts for the filaments and excitation circuits. The housing is of stream-line design. As long as the plane is in the air the generator maintains a speed of 4000 r.p.m., regardless of wind speed or load, the regulation being automatic through a centrifugal governor which changes the pitch of the propeller blade to compensate changes in speed.

The 300-watt (ET-3654) outfit utilizes 1 UV-211 tube as a master oscillator, 3 UV-211's as power amplifiers, 1 UV-211 as a speech amplifier, and 3 UV-211's as modulators. Presumably the object of employing such a large tube as a 211 as a microphone amplifier was to confine the set to one kind of transmitting tube. The master oscillator is a modified Colpitts circuit, with its tank circuit exciting the power amplifier, which in turn feeds the antenna through a coupling transformer. Part of the d.c. voltage across the power amplifier grid leak is used to bias the speech amplifier and modulators.

One novel design feature of this set is the inclusion, in the microphone transformer, of a side-tone winding which is connected across the headphones of the operator and pilot and across the receiver output. The headphones are thus used for interphone communication, monitoring radio telephone transmission from the plane, and for reception of incoming signals, whether telegraph or telephone. Operation is possible from either the pilot's or radio operator's seats in the plane, a magnetically controlled send-receive relay being provided. The general features of the 300-watt equipment do not differ, except in size, from those of the 100-watt model.

In all airplane installations adequate electrostatic shielding of the aircraft engine is essential if any kind of reception is to be expected. Another precaution which cannot safely be neglected is the bonding of all metal parts of the plane by means of electrical conductors, to eliminate the danger of sparking between surfaces.

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RADIO BROADCAST'S Service Data Sheets on Manufactured Receivers

The Fada 480-B

RADIO receivers designed for a.c. operation fall into three general classes, i.e., those using a.c. tubes, those using standard battery type tubes with the filaments connected in series, and those using standard type tubes with the filaments connected in parallel and energized from an A-power unit. This latter type of receiver may be operated from batteries when one desires or may be made completely light-socket operated by the use of A- and B-power units. Such a receiver is the Fada 480-B, a circuit diagram and photograph of which is given in this data sheet.

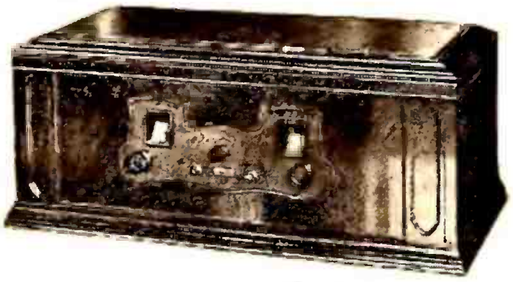
The Fada 480-B receiver is a dual control set, the right-hand drum dial (in the diagram) tuning the antenna stage and the left hand drum dial controlling all the other tuning condensers in the set. Small trimming condensers are placed across each main tuning condenser so that the several tuned circuits may be accurately aligned. The tuning condensers are substantially made with heavy plates and large bearings so that they will operate smoothly and hold their calibration over a very long period of time. The receiver may be operated from either a loop or an antenna, either indoor or outdoor.

This eight-tube receiver consists of four stages of tuned radio-frequency amplification, a detector and either two or three stages of transformer-coupled low-frequency amplification, depending upon the position of the toggle switch indicated at the top of the diagram. All of the r.f. stages are shielded, the plate leads are all bypassed with 0.5 mfd. condensers and each stage is neutralized by means of center-tapped primaries on the r.f. transformers—a type of neutralization familiar to many as the so-called "Roberts" method. An r.f. choke coil, L_1, is placed in the positive filament lead of each of the r.f. tubes to keep any a.c. currents out of the plate supply, where it might produce common coupling and cause oscillations.

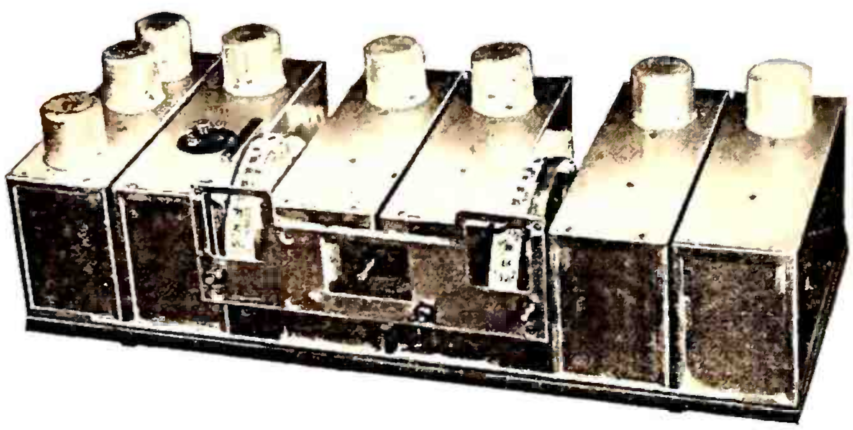
A separate shielded compartment contains the audio-frequency amplifier. This compartment is at the right in the circuit diagram and contains the sockets, three audio transformers, the output choke, output condenser, and bypass condensers. By means of the toggle switch on the panel either two or three audio stages may be used; with the switch thrown to the No. 8 position all three stages are used, while in the No. 7 position only two stages are used. Tubes of the 201A type are used in the audio amplifier as well as in the detector and r.f. tube sockets. A power tube of the 171A type is recommended for use in the output of the amplifier. The power circuit contains in its output a choke-condenser combination to protect the loud speaker from the d.c. plate current. The choke is marked L_2 in the diagram and the output condenser, C_1. The condenser has a capacity of 1.0 mfd.

An A-B-C power unit is made by the same company to be used with their receiver; The B and C unit uses a type 280 full-wave rectifier to supply the necessary plate and grid bias voltages to the set. The A-power unit consists of a rectifier-filter system designed to supply approximately six volts and currents up to 2½ amperes. This supply is used for the operation of the filaments of the tubes in the receivers and the output is sufficiently well filtered to give quiet operation. The alternating line current is converted to pulsating direct current by means of a dry type rectifier manufactured by the Elkon Works, which is supplied with the correct amount of voltage from the secondary winding of the transformer. The pulsating current is then filtered by means of high-capacity dry A type condensers and properly designed choke coils. There are two adjustments provided; one is for various line voltages between 90 and 130 volts, and the other is used to adjust the output of the device for the operation of six, seven, or eight tube receivers.

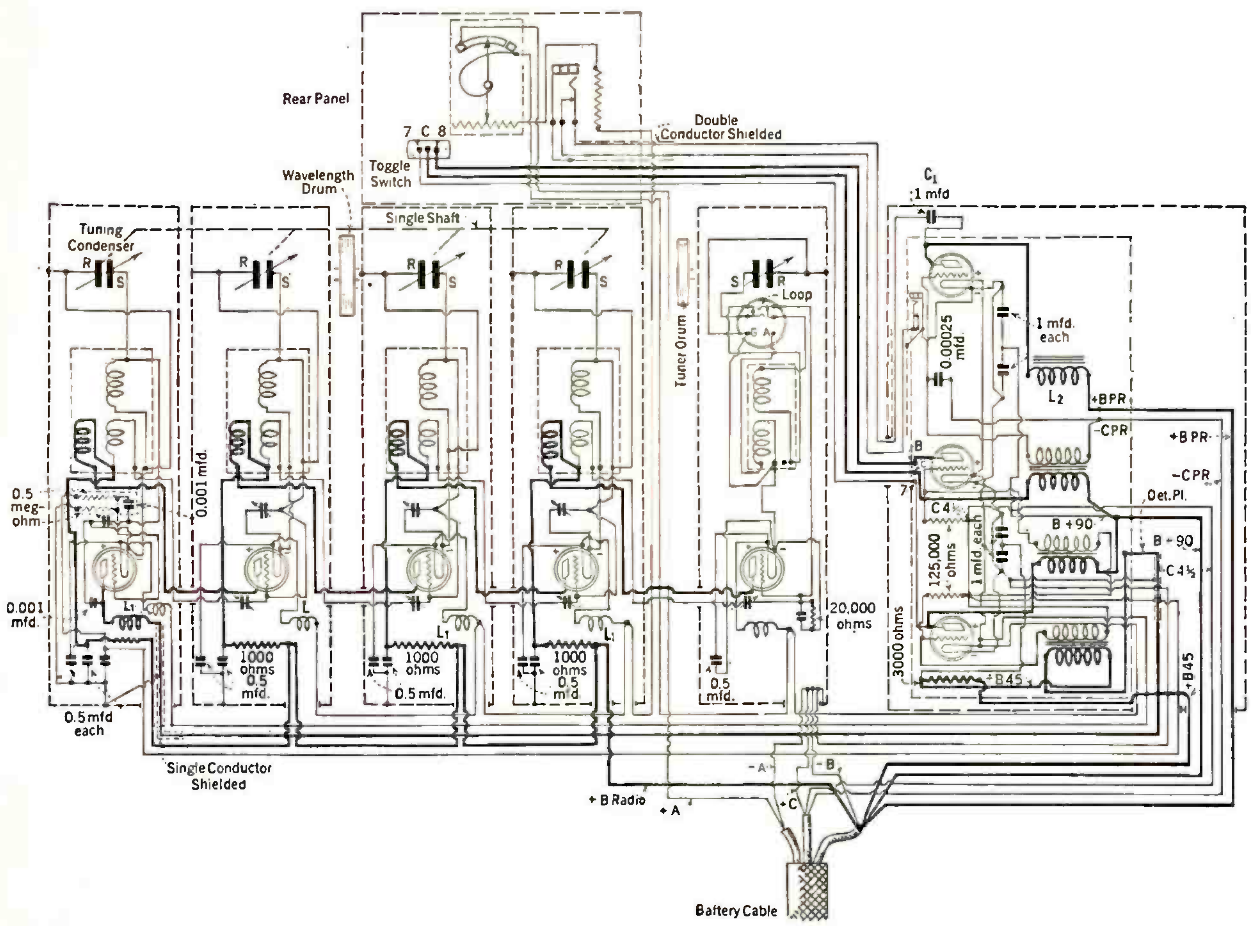
These 6-volt A-power units are furnished in two types: one for the operation of six-and seven-tube receivers and another for the operation of six-, seven-, or eight-tube receivers. Both of these types are supplied in two models: one for operation on either 50- or 60-cycle alternating current and one for operation on from 25 to 50 cycles.



A VIEW OF THE CABINET



THE SHIELDING ARRANGEMENT



THE CIRCUIT OF THE FADA 480-B

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No. 6. **August, 1928.**

RADIO BROADCAST'S Service Data Sheets on Manufactured Receivers

The Federal Ortho-sonic Seven-Tube Receiver

THIS set is a good example of a receiver designed for a.c. operation using standard 201A type tubes in a series filament arrangement and supplied with filament current from a rectifier filter system employing a Raytheon type BA high-current rectifier.

The seven tubes in the receiver are arranged as follows: four of them are used as radio-frequency amplifiers, one is used as the detector and the other two are used as audio amplifiers. A 171A type tube is used as the power tube. The order of tubes in the series filament arrangement is: First r.f., second r.f., third r.f., fourth r.f., first a.f., detector, and second a.f.

In an efficient four-stage radio-frequency amplifier careful design is essential if the receiver is to be stable over the entire broadcast band. To promote stability in this receiver all the r.f. stages are completely shielded, radio-frequency choke coils are placed in each leg of the filament of each of the tubes used in the r.f. amplifier, each plate supply lead to the r.f. tubes is filtered by the use of resistances, and bypass condensers, and finally each stage is carefully neutralized, the small inductance coils, L, in the filament circuits forming part of the neutralizing system. The five variable tuning condensers are ganged to a single drum dial control, a small vernier condenser being used to obtain fine adjustment of the tuning system.

The audio amplifier is of standard design. It is interesting to note that the first audio-frequency tube has about 70 volts applied to its plate and that a 5-volt negative bias for the grid is obtained by connecting the grid return from the transformer to the detector tube filament, so that the 5-volt drop in the filament of this latter tube is impressed on the grid of the first audio tube. Bias for the second audio tube is obtained from the voltage drop across resistance R_5, in the power unit. The cores of the two audio transformers are grounded to prevent any possibility of audio-frequency oscillations due to extraneous coupling between the two transformers. Bypass condensers are also connected at various points in the audio amplifier to prevent common coupling in the power supply. The detector and audio amplifier apparatus is housed in a single compartment, entirely separate from the radio-frequency amplifier.

THE RECEIVER IN ITS CONSOLE

Only two values of plate voltage are supplied to the receiver from the power unit, 180 volts and 70 volts. The latter is reduced to 45 volts for the operation of the detector by means of a 160,000-ohm resistance connected in series with the detector plate circuit. Volume control is accomplished by varying the potentiometer, P, which controls the amount of voltage applied to the plates of the r.f. tubes.

A grid leak condenser type of detector is used. The grid leak has a value of one megohm and the grid condenser has a value of 0.0002 mfd. Because the input capacity of a tube when used as a detector is somewhat less than when it is used as an amplifier, it is necessary to connect a small midget condenser, across the detector input so that the last tuning condenser will gang properly with the other tuning condensers. The output of the detector contains a fixed resistance in series with the plate circuit to keep the r.f. currents out of the audio amplifier. In addition, a bypass condenser is connected between the plate of the detector tube and the negative side of the detector tube filament.

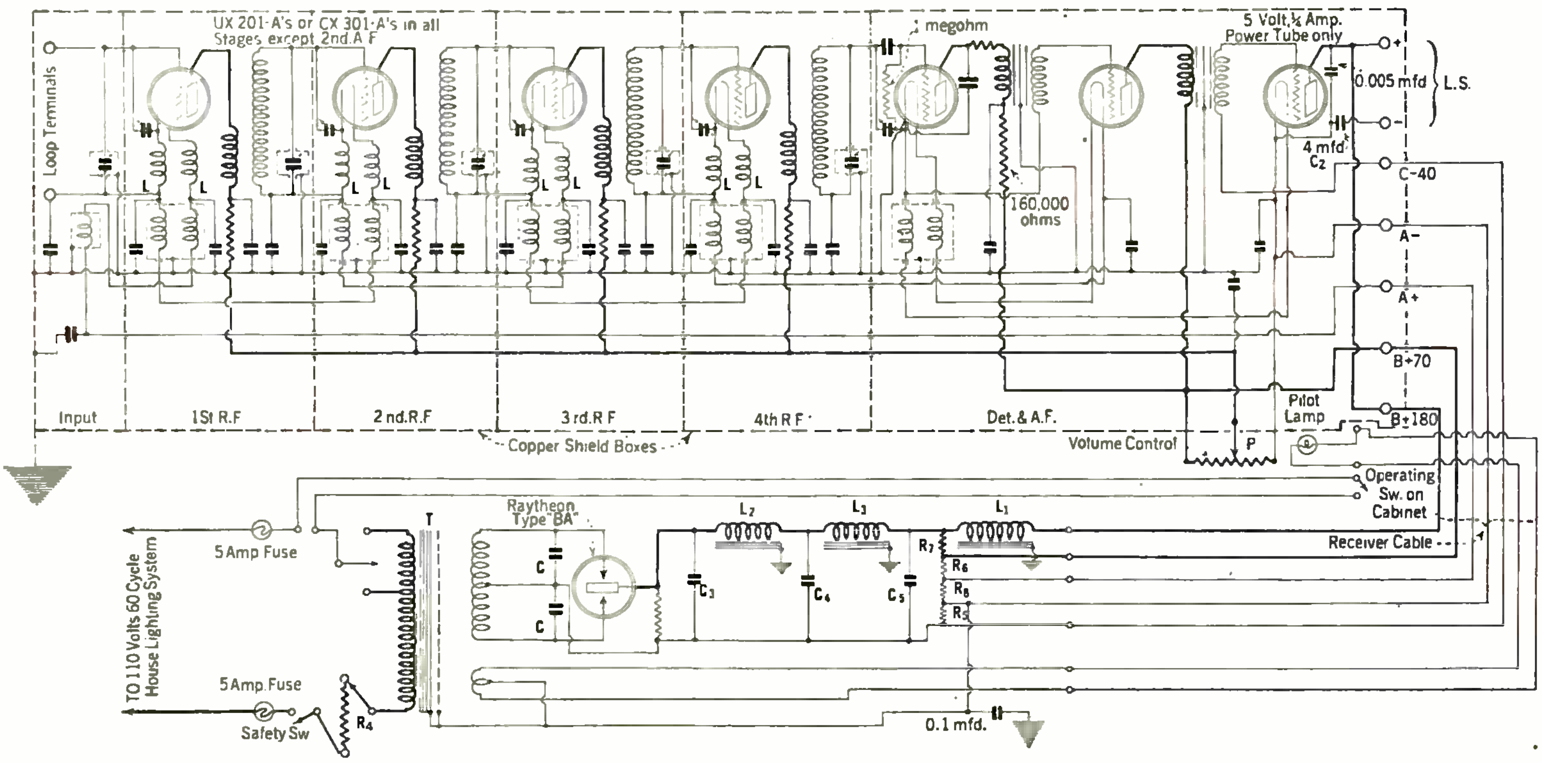
The loud speaker is insulated from the direct current in the plate circuit of the 171A type power tube by means of a choke-condenser combination. The condenser, C_2, has a capacity of 4 mfds. The output choke, L_1, is located in the power unit.

The power unit supplies all the A, B, and C voltages required for the operation of the receiver. The power transformer, T, is arranged with three taps on the primary so that the installation may be adjusted for low, medium, or high line voltages. The high-voltage secondary of the transformer supplies the Raytheon BA rectifier. The output of the rectifier feeds into the filter system which consists of the usual two filter choke coils, L_2 and L_3, and three main filter condensers, C_3, C_4, and C_5. The output of the filter goes to the resistance bank from which taps are taken for the A, B, and C voltages required for the operation of the receiver. Bypass condensers are not necessary across these resistances, as all the necessary bypassing is placed in the receiver itself.

An additional 5-volt winding is placed on the transformer and is used in this model to supply current to the pilot lamp located on the panel of the receiver.

An adjustable resistance, R_4, is connected in the primary side of the power transformer so that small variations in line voltage may be compensated. The equipment is also protected by the inclusion of two 5-ampere fuses in the primary circuit.

This receiver is designed for operation on a loop type antenna. The advantages of loop operation, i.e., convenience, directional properties, better signal-to-static ratio, are well known. In the model illustrated in the photograph the loop is located on one of the doors of the cabinet.



THE CIRCUIT OF THE FEDERAL ORTHO-SONIC RECEIVER

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Is the Highbrow Entitled to a Program of His Own?

By John Wallace

WE ARE in receipt of several letters, as a result of our remarks in the May number, condemning us for an alleged desire to see radio go highbrow. We are reminded by the writers that "radio is for the butcher, the baker, and the candle stick maker." Further, they bring to our attention the highly original point that "Radio can't please everybody. The great mass of people can't be neglected. Would you deprive them of their entertainment to please a dubious minority of highbrows?" All this because we had set forth an appeal that a little brains be applied to the devising of continuity programs so that they might cease being an insult to the intelligence.

In reply to such unmeditated protests we wonder: if instead of an article on radio we had inscribed a lengthy plea that larger areas in Chicago be devoted to playgrounds, would not these same correspondents have written in protesting, "Would you have our great office buildings, hotels, and theaters leveled to the ground to provide space for a lot of silly pastures which probably wouldn't be used anyway?"

The absurdity of such reasoning lies in its assumption that there isn't room for both. Because we, and others of the "highbrow" contingent, clamor in print, and otherwise, for more highbrow stuff, does not mean that we would have the air filled with it to the exclusion of all else. If we ask for a loaf, persistently and again, it is not because we expect even half a loaf, but because we hope thereby to gain a few crumbs of the general broadcast fare.

There is not the slightest danger that the masses will ever be neglected by the radio entertainment purveyors. They present far too large a potential market for cleansing powders, tires, tooth paste, hair tonic, and linoleum for anything like that ever to happen. They will continue to get the popular stuff they want without lifting a finger. But if the high-school-graduated minority wants to keep some little attention directed toward itself it will have to continue to beg for it, to write to its congressman, and to stand on its head as means of gaining notice.

This is doubtless as it should be. Radio, by rights, belongs to the unlettered. They are entitled to make demands upon it. The lofty-domed minority can, with justice, do no more than make *requests* of it. The fairness of this arrangement should be evident in view of this fact: radio is the only agent of dissemination that has made its appearance since printing was introduced several centuries ago. Through all those centuries printing has been the rightful possession of the lettered. You may point to the vast stacks of popular periodicals that ornament the news stands as evidence to the contrary, but that demon, Statistics, will show this to be but a drop in the bucket. If all the books and pamphlets and periodicals that have been printed since Mr. Gutenberg invented movable type back in 1456 were placed end to end they would stretch from New York to San Francisco and then some.

And if they were placed in the order of their brow elevation, with *Weird Stories* and *Liberty* at the beginning of the stack and the *Novum Organum* or Mr. Einstein's book at the finish, it would be found that the lowbrow section would peter out somewhere around Elizabeth, N. J., while literature and scientific writings, philosophy, and other weighty tomes would stand in solid ranks for many thousands more of miles.

In other words the printing press operators haven't really given much of a whoop for the masses over their 472 years of production. So if now this new contraption, radio, decides to put in its major effort in behalf of *hoi polloi* there can be no great cause for complaint.

We trust we have by now made it quite clear that we have neither any desire to deprive the candle stick makers of their rightful enjoyment of any old kind of radio program piffle they may want, nor any slightest suspicion that any words of ours, or of any one else's, could succeed in having them deprived of it.

But since the printing press operator not infrequently takes off his silk hat and his kid gloves and runs off an edition of the *Police Gazette*, it seems to us that it might be in some way contrived that the radio lords dish up a little program for the highbrows without, at the same time, keeping one eye on the lowbrow and both thumbs on his pulse. In short, we think it is high time that some one, somewhere, put on a program with a little touch of sophistication to it.

Once before we published in this department a list of the findings we made by starting in at the top of the dial and recording everything that was available from the top to the bottom. We offered this list, a record of forty-one stations, as a cross section of what was on the air, and a rather lugubrious cross section it was. After its publication we received complaints to the effect that the general mediocrity of the listed turns was due to the fact that the listening was done in Chicago instead of New York. This objection is not valid, for of the seven or so first rate stations in New York, three are available in Chicago by chain. The three or four we might have missed couldn't have done much to boost the average of the forty-one stations examined.

The following list, made from 8:30 to 9:30 of a summer's eve, is, on account of the late sunset, confined almost exclusively to Chicago stations. Its general tone would doubtless have been slightly elevated had such Eastern stations as WGY and WBAL been available but, after all, we don't all live on the East Coast, so we herewith present our last night's list as a reasonably representative cross section of what's on the air:

1. Dance orchestra
2. Hawaiian guitar
3. Dance orchestra
4. Soprano singing ballad
5. Hymns
6. Tenor solo, popular songs
7. Orchestra, popular
8. Mixed quartet, American Indian song cycle
9. Solo trombone
10. Piano and violin, popular music
11. United Synagogue broadcast
12. Popular duet
13. Dance orchestra
14. Baritone solo, semi-classical
15. Dance orchestra
16. Dance orchestra
17. Male quartet
18. Orchestral program with continuity
19. Mixed chorus, light opera
20. Concert ensemble, popular music
21. Orchestral program with continuity
22. Popular singing
23. Banjo solo
24. Operatic selections

We propose neither to praise or berate this listing. We present it simply as a record of the facts. If it meets with your approval you can take it to be an endorsement of your opinion that all's well with radio. If it meets with your displeasure you can cite it as proving the contrary. However, we might be allowed to call attention to this: of the twenty-four programs encountered on the one hour trip across the dial, twenty-one were popular in make-up. The only exceptions were numbers eight, nineteen, and twenty-four. Two of these were "light" and only one could by any stretch of the imagination be labeled highbrow. That, the last named, happened to be WJZ's excellent organization, the Continentals.

Thus it seems apparent that radio programs are directed, by an overwhelming majority, at the lowbrow. This does not mean that the highbrow may not also enjoy some of them, but it does mean, just exactly as it says, that precious few programs are leveled

HE SUPERVISES WBAL'S ORCHESTRA

Michael Weiner brought a love for music when he immigrated to this country from Russia as a boy. Now he supervises the orchestral programs for which WBAL is famous

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ONCE A WEEK AT WOC

The Voss Vagabonds, orchestra and mixed quartet, is one of the most popular features broadcast from the Davenport, Iowa, station

at the highbrow. He is simply tolerated, and privileged only to gather what crumbs he may from his numerous brothers' table.

There is probably some very good reason which we have stupidly overlooked—but why, oh why, doesn't some program sponsor get up a program that is aimed directly at the individual of mildly sophisticated taste? Evidently a manufacturer of paper picnic plates or overall buttons wouldn't want to sponsor such a program, but there must be somewhere in this country a manufacturer whose product coincides with the needs of a medium-highbrow audience.

To arrange a sophisticated program would not be difficult, hardly a bit more difficult than arranging a banal one. It would require only two things, first, that an individual of some sophistication get up the program and, second, that he be allowed to "let himself go."

The sponsor of a such-like program would have heavy sledding at first, for the reason that he hasn't a potential audience at the present time. Individuals who make some cerebral demands on their entertainment do not listen to the radio. This is not, as is popularly supposed, because of some silly prejudice against radio itself, but simply because their various attempts at listening have convinced them that radio programs are not, at present at least, intended for the likes of them.

We do argue, though, that such an audience could be worked up. If a genuinely witty and sophisticated program made its début, its appearance would excite all the attention that any rarity does. Mr. Tallbrow would remark to Mr. Highdome on the morning train, "I almost died laughing at the Rolls Royce Hour last night." And Mr. Highdome, knowing Mr. Tallbrow's swell taste, would immediately rush out and buy himself a receiving set.

That no such program now exists is apparent to anyone who has tried looking for it. There are highbrow musical programs, and excellent ones, but they are always tempered with popular selections to widen their appeal. That is all right, too. But there ought to be at least one program that would make no concession to popular taste and which would make it snootily apparent that it didn't give a tinker's dam for the man in the street.

Pat Barnes——

Chicago's Gift to the Radio World

is just the right sort of a heading to put on a brief paragraph about said person, its wording being quite in character with Mr. Barnes' style of presentation. But, quite seriously, Mr. Barnes is probably the most individual thing Chicago has to offer. If you have never sought out one of his programs through WHT you should without delay.

Mr. Barnes is an announcer-impresario-artist of the "heart-to-heart" type—the type which was so prevalent in the first years of radio, and which has now largely disappeared. Comparisons are odious, and so forth, but we cannot refrain from comparing him to Roxy. Barnes' delivery is of the same general style as Roxy's—personality-plus stuff. But where Roxy generally gives this particular listener somewhat of a pain, Pat Barnes pleases him enormously. This, we grant, is simply a matter of personal reaction, for Pat Barnes seems to us convincing, whereas we always have a feeling that Mr. Rothafel is simply acting a rôle. Of course, analytically, we realize that Barnes is acting, too. No one with the intelligence he displays in concocting his programs could be as witlessly maudlin as he makes himself sound—but he does it so infernally well. After all, no matter how unmomentous a thing a man picks out to do, if he does it surpassingly well it is worth attending to.

The bit of Mr. Barnes' program which we heard to-night included the reading of a perfectly banal poem with a moral. But the reading of it, the enunciation, the phrasing, the nuances of expression were simply perfect, and infinitely better *in toto* than a selection from Shakespeare poorly delivered. Then he sang "Chloe"—he has a good voice—and interpolated a recitative passage of heart-rending cries of anguish for "Chloe, where art thou?" which was the veriest melodrama and consisted in tearing passion to tatters. But who cares? It was convincing anguish and genuine passion. And then the elegant little choke in his voice when he bids his audience "Good night" . . . but try him out yourself some time.

Identification Marks of European Stations

IT MUST be a pleasanter, because more varied, existence to be a radio reviewer in England. If things on the Island get too dull he has but to fish around for Continental stations and get a nice assortment of languages and varying ideas about broadcast fare. This from the reviewing department of Jay Coote in *World-Radio:*

During my nightly trips around the ether I have particularly noticed that many Continental stations have either made some alterations in their interval signals, or adopted new methods to identify themselves to distant listeners. The adoption by numerous studios of the ubiquitous metronome, to say the least of it, was becoming monotonous. Rome, instead of using two bells, has now added a further one, and between items you may now hear the notes A, C, F in pure crystal tones. By this means a very pleasant series of sounds is obtained. Munich appears to have dropped its Morse call, and in its stead opens its transmissions with a long-drawn-out deep note resembling that of an organ, although I feel sure it is produced by some electrical gadget. Again, PTT, Paris, which for a short time had adopted the call of the cuckoo to its young, at the request of its admirers, has withdrawn the signal and is, I understand, seeking some other noise more befitting its broadcasts. Radio Toulouse still possesses its alarm clock; it can be nothing else, and its spasmodic *tock-tock* preceding each item is at times peculiarly irritating. To the credit of its announcer, however, it must be said that the call *Radio Toulouse,* clearly enunciated, is never omitted between items in the programme. It is particularly galling to hang on for some minutes in the hope of identifying a station, and to find oneself rewarded by *Allo! Allo!* followed by an almost incomprehensible mumble accompanied by spark or atmospherics. Why do so many announcers persist in dropping their voice at the moment the name of the city is broadcast?

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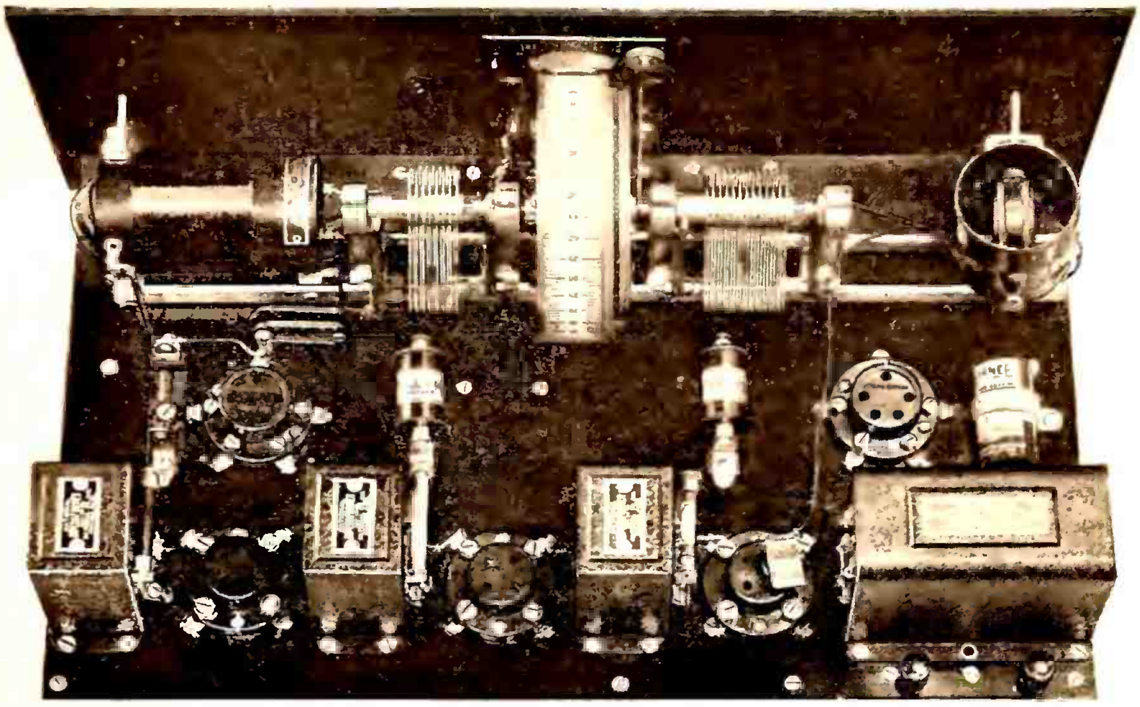

THE A. C. MODEL OF THE NATIONAL SCREEN-GRID FIVE

Operating the National Screen-Grid Five

By James Millen

WHEN the National Screen-Grid Five was designed, it was with the idea of making available to the radio public a receiver that could be easily constructed by the average fan; that would involve no difficult mechanical work in its construction; that would prove sufficiently selective to bring in a few distant stations while the locals were still on early in the evening; that would be easy to tune; and that would not require the use of a conventional antenna.

That these results and even more have been successfully achieved is well proved by the many enthusiastic letters received from readers who have actually built the receiver. One New York City resident wrote that he received KFI, Los Angeles, the first night he tried the set, while letters and phone calls were also received from a number of New England fans who were consistently obtaining far better dx reception than the designer had even hoped possible.

As was pointed out in the previous article, the set itself is an improvement on the original National Browning-Drake Circuit, in that the r.f. transformer has been redesigned to use the new UX-222 screen-grid tube; and the layout and design of parts have been altered to provide for single control tuning and simplicity of wiring.

From the contents of a number of the letters received, it would seem that there are a few questions of rather common interest regarding accessories, operation, and variations in design of the Screen-Grid Five.

IN THE May issue of RADIO BROADCAST *Mr. Millen described the construction of a Five Tube Screen-Grid Receiver. Since this article appeared Mr. Millen has received many letters from builders of the set many of whom desired further information on how to operate it. The operating suggestions and trouble finding hints which are given in this article should therefore prove interesting to those of* RADIO BROADCAST'S *readers who have constructed this set.*

The description in the May issue described the d. c. operated model. The availability of a.c. screen-grid tubes has now made it possible to operate this receiver from the light socket, and the circuit diagram and photograph of the a.c. model are to be found in this article.

—THE EDITOR

THE CORRECT RESISTORS

PERHAPS one of the most important questions that have come up is in regard to the values of filament equalizers or ballasts specified and indicated in the circuit diagrams. The values given were in ohms, which is the system being used by most filament resistor manufacturers at present. The $\frac{4}{5}$-ohm resistor is one which when used with five $\frac{1}{4}$-ampere tubes, will drop the 6-volt filament supply down to the 5 volts required. While only four $\frac{1}{4}$-ampere tubes are used in the set, the current drawn by the 222 plus that drawn by the dial light is equivalent to an additional $\frac{1}{4}$ ampere. The 15-ohm equalizer is used to decrease the five volts available across the filaments of the large tubes down to the 3.3 volts required for use across the 222 tube filament.

In a few cases where trouble has been reported due to the receiver lacking sensitivity, it was found that the difficulty was caused by the use of a 22-ohm filament resistor rather than a 15-ohm unit. The 22-ohm filament ballasts are made for use in cases where the UX-222 is operated directly from six volts and not from five volts, as in the case of this receiver.

In other words, the number 22 designation should not be misconstrued to mean that this resistor is the proper one for use with the UX-222 tube under all conditions.

When a type 22 filament ballast is used with the National Screen Grid Five, the filament voltage on the 222 is too low and the receiver is insensitive. Another cause of lack of sensitivity, which at the same time also results in lack of selectivity, is the failure to "line up" the two tuned circuits.

Perhaps, in order for the operator to become fully impressed with the importance of this adjustment, it would be well to loosen the condenser rotors from their shafts and tune in several local and semi-local stations by separately adjusting each condenser. Then try detuning one of the two condensers and note the difference in results. It might also be well at this same time to study the operation of the antenna variometer or trimmer. With the antenna variometer rotor in mid position detune the larger variable condenser and then retune by means of the trimmer.

Before fastening the condensers to the dial shaft again, tune in a local station with a wavelength somewhere around 360 meters. The antenna trimmer should be in mid-position.

WHAT TUBES TO USE

WHILE the use of a good 200-A detector tube (when the grid leak return has been shifted from the positive to the negative side of the filament circuit) results in increased sensitivity, the lack of stability and the noisy operation encountered offsets these advantages.

Where a sensitive detector tube is desired for dx reception, it is recommended that a high-mu tube such as the UX-240 be employed. While not generally considered as satisfactory as the 112A for all-around use, the 240 will be found of worth-while aid on out-of-town reception. Due to the difference in inter-electrode capacity of the 112A, 200A, and 240, it is necessary to readjust the trimmer and the tuning condensers when changing from one detector tube to another. In some instances, it may even be found necessary to reset the position of one of the variable condenser rotors, as previously described.

There seems to be a trend upon the part of many set builders at present to use smaller values of grid condensers with correspondingly higher values of grid leaks. While the use of a 0.0001-mfd. grid condenser with a 4- or 5-megohm leak will generally result in slightly

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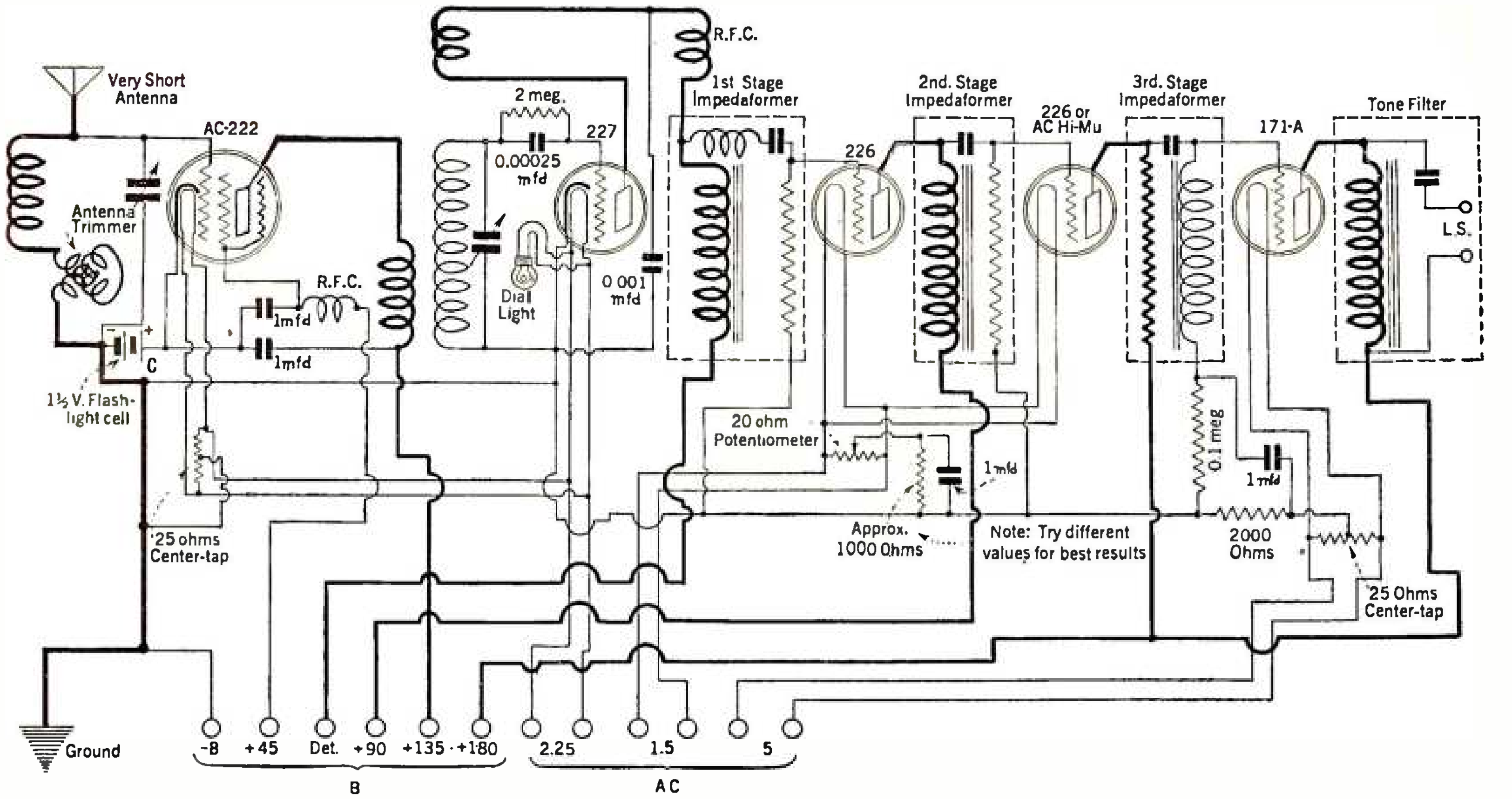

FIG. 1. THE CIRCUIT OF THE A. C. MODEL

better signal strength of dx stations, it has been found that the more conventional 0.00025-mfd. condenser with a 2-megohm leak results in more smooth and uniform regeneration over the entire broadcast band. When the 0.0001-mfd. condenser is used the set will not oscillate at the very upper end of the wavelength range.

The polarity of the primary connections to the r.f. transformer also has a noticeable effect at times on the smoothness of the regeneration. While generally best results are obtained with the plate lead of the 222 tube connected to the primary terminal nearest the front panel, such is not always the case. In some instances it makes no apparent difference which way these leads are connected, while in other instances the reversed connection gives best results.

NOTES ON THE AUDIO SYSTEM

THE audio system used in the original receiver, while capable of very satisfactory results, is not the only type that may be employed. Many inquiries have been received from readers who favored transformer or resistance coupling and wanted to know if one of the other forms of amplification could be employed with quite satisfactory results. The answer is decidedly "Yes." If a pair of high-grade audio transformers, such as the National, Amertran, Ferranti, etc., are employed, just as fine results are obtained with the use of one less tube. In the advent of such a change, the $\frac{4}{5}$-ohm filament equalizer specified for the 5-tube set should be replaced by a 1-ohm resistor.

It has been found that with some of the sets made up by different constructors, it was necessary to ground the case of the tone filter to the A-minus lead. This same condition was also encountered in one transformer-coupled set, in which grounding the cases of both audio transformers, as well as that of the tone filter, proved worth while.

SOCKET POWER OPERATION

WHILE designed for use with a 6-volt storage A battery and a good 180 volt B-power unit, a.c. tubes may be used, if desired, for complete a.c. operation of the Screen-Grid Five receiver. In such event, the new a.c. type 222 tube, such as the CeCo, should be used in the r.f. stage. Alternating current has been used by some experiments directly on the filament of a standard d.c. type of 222 tube, but the results have never been any too satisfactory, due to the resulting 60-cycle modulation of the signal. The new a.c. 222 tube, however, completely overcomes such trouble, as it is of the heater type, similar to the UY-227.

The UY-227 works very well as the detector in conjunction with the a.c. 222 in the r.f. stage. In the first audio stages, either 227's or the 226's may be used. Some tube manufacturers are now making high-mu a.c. tubes of the 226 type, one of which will be quite worth while for use in the second stage. In the output stage the regular 171A with 5 volts a.c. on the filament is used.

> *FREE BLUEPRINTS*
>
> *The interest in the d. c. model of the National Screen-Grid Five has been so great that blueprints of this receiver will be sent to all who write for them. Address requests to Mr. James Millen, care of* RADIO BROADCAST

The layout of the a.c. set is essentially the same as that of the d.c. model except for a few minor substitutions among some of the smaller parts. For the radio-frequency and the detector tubes, 5-prong sockets should be used in place of the 4-prong type. The two filament ballasts of the d.c. set are omitted. The two grid bias resistors, the power tube grid filter resistor and associated condenser, the two center-tapped resistors, the small potentiometer, the bypass condenser and the small 1½-volt biasing cell for the 222 tube are the special parts required for the a.c. receiver. The parts and connections are indicated in Fig. 1.

Flexible No. 18 rubber covered wire should be used for making all the filament connections, which should be run in twisted pairs. The dial light is connected directly across the 2.25-volt a.c. supply. The leads to the dial light should be twisted together. While a center-tapped resistor may, if desired, be used across the 1½-volt filament line, it will be found in most cases that the use of a potentiometer, or other form of adjustable resistor for this work, will result in less a.c. hum from the finished receiver.

The average value of the resistor used for obtaining the grid biasing voltage for the first two audio stages is about 1000 ohms, but it may be found with some sets that a slightly higher value will give better results. Varying the plate voltage of the first a.f. stage is also something well worth trying.

The power unit for the operation of such a receiver may comprise either a standard high-grade 180-volt B unit and separate filament heating transformer, or else one of the special combination A-B units, such as the National No. 7180 A-B unit, in which the filament windings are part of the B-supply transformer. This later arrangement makes a compact and easily connected power supply.

A list of the additional parts necessary for a.c. operation is given on this page. Other makes of parts may be substituted if the set builder desires.

LIST OF ADDITIONAL PARTS FOR A.C. OPERATION

2 General Radio 5-prong sockets
2 25-ohm center-tapped resistors
1 2000-ohm resistor
1 1000-ohm resistor
1 .1-megohm resistor
3 single mountings
1 Carter midget 20-ohm potentiometer.
2 Tobe 1-mfd. condensers
1 1½ volt C Battery
1 CeCo a.c. 222 tube
1 CeCo N 27 tube
1 CeCo M 26 standard tube
1 CeCo AC Hi-Mu tube
1 Ceco J 71A tube

The accessories for a.c. operation are a standard 180-volt B-power unit, and a filament heating transformer.

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New Apparatus

PRODUCTS of radio manufacturers whether new or old are always interesting to our readers. These pages, a feature of RADIO BROADCAST, *explain and illustrate products which have been selected for publication because of their special interest to our readers. This information is prepared by the Technical Staff and is in a form which we believe will be most useful. We have, wherever possible, suggested special uses for the device mentioned. It is of course not possible to include all the information about each device which is available. Each description bears a serial number and if you desire additional information direct from the manufacturer concerned, please address a letter to the Service Department,* RADIO BROADCAST, *Garden City, New York, referring to the serial numbers of the devices which interest you and we shall see that your request is promptly handled.*—THE EDITOR.

A 12-Conductor Cable for A. C. Sets

X47

Device: YAXLEY CABLE, TYPE 612. A 12-conductor cable designed for use with a.c. receivers. The twelve conductors are arranged as follows:

$1\frac{1}{2}$V No. 1—Red
No. 2—Black
$2\frac{1}{2}$V No. 3—Red, with Green Tracer
No. 4—Black, with Green Tracer
5V No. 5—Red, with Yellow Tracer
No. 6—Black, with Yellow Tracer
B— No. 7—Yellow
B+ Detector, No. 8—Blue
B+ Intermediate, No. 9—Slate
B+ Amplifier, No. 10—Green
B+ Power, No. 11—Brown
Spare, No. 12—White

The plug terminals on the mounting plate are plainly numbered in white. The individual conductors in the cable are colored as is indicated above. In addition, each conductor is also numbered, 1, 2, or 3, etc., to correspond to the numbers of the plug terminals on the mounting plate. In this way it is a simple matter to make the proper connections. *Manufacturer:* Yaxley Manufacturing Company. *Price:* $5.00.
Application: This cable may be used in cases where the transformer supplying the filaments of the a.c. tubes is not located in the set, but with the B-power unit. In such a case it is, of course, necessary to use connecting wires between the set and the filament transformer as well as to provide leads for the B voltages. This requires a 12-conductor cable such as we have described.

YAXLEY CABLE

STERLING TUBE CHECKER

Resistors for B Supply

X 48

Device: VITROHM RESISTOR KIT for use in B-power units. A set of eight separate resistors as follows: 1 750-ohm, 3 1500-ohm, 1 3000-ohm, 1 3500-ohm, 2 5000-ohm. Each resistor measures about 2 inches long. *Manufacturer:* Ward Leonard Electric Company. *Price:* $8.90.
Application: The resistors are of such a size and rating that they may be satisfactorily used as voltage-dividing resistors in B-power units delivering voltages up to 500 volts. The two circuits, Fig. 1, A and B, show how the resistors can be used in two B-power circuits, one delivering up to 135 volts and the other supplying 400 volts. The 135-volt circuit makes use of only four of the resistors. If the experimenter so desires he can make use of all eight units and obtain some additional B-voltage taps at intermediate voltages between 135 volts and 22 volts. As mentioned above these resistors are of such values that they can be applied to any ordinary B supply.

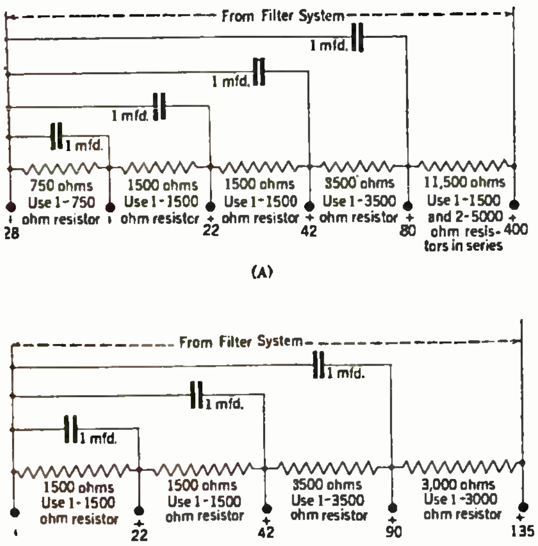


FIG. 1. B-SUPPLY RESISTOR BANKS

A Handy Tube Tester

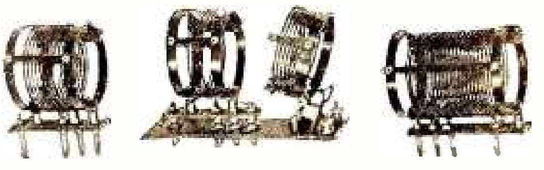
X49

Device: TUBE CHECKER. An easily operated, low priced, rugged instrument with which to check all types of tubes for short circuits between the elements, and to check the emission of a.c. tubes and 199 and 120 type tubes. To operate the unit the plug is connected to a 110-volt light socket and the tube to be tested is plugged into the tube socket on the tester. The meter immediately indicates any defect in the tube. *Manufacturer:* Sterling Manufacturing Company. *Price:* $13.50.
Application: This instrument is a convenient method for the radio dealer or service man to use when selling tubes to a customer, for it can be used to show that the tube being sold is in good condition. It will also be valuable in the repair department or in the hands of the service man.

Coils for Short-Wave Work

X 50

Device: SHORT-WAVE COILS. A set of three coils to cover the band of wavelengths from 13 to 130 meters. Additional coils can be obtained to cover wavelengths up to 550 meters. The coils, illustrated in the photograph, are of the plug-in type, different ranges being covered by changing the secondary-tickler coil. The same primary is used for all wavelengths. The coils are wound with a large size of wire so as to give them considerable mechanical strength. The coil diameter is 2 inches. *Manufacturer:* Aero Products, Inc. *Price:* $12.50 for a set of three coils covering the band from 13 to 130 meters. Two additional coils, sold separately, may be used to reach up to the broadcast band. These coils are $4.00 each.



AERO SHORT-WAVE COILS

Application: The coils may be used in the construction of a short-wave receiver to receive code and short-wave broadcasting. The plug-in base and primary coil mounting are of the same dimensions as were used for previous types of Aero coils, so that either new or old coils may be used interchangeably in the same mounting.

A Way to Remedy R. F. Oscillation

X 51

Device: PHASATROL. A device designed for use in radio-frequency circuits to control oscillation. The unit is connected in the plate circuit of an r.f. amplifier tube and the adjusting screw is then turned until the circuit is stable over the entire broadcast band. *Manufacturer:* Electrad, Inc. *Price:* $2.75.
Application: The item to which we have here brought the reader's attention is not new, but some information regarding its use should be of interest to readers not acquainted with the device and to those not realizing that it may be applied to a wide variety of circuits. The performance of the unit depends, to some extent, upon the fact that if the plate load on a tube is made non-reactive (ordinarily its reactance is inductive) the tube cannot oscillate. Although the device does not give an exact "bridge" balance, it is much more simply adjusted than a bridge system, and can be readily applied to existing receivers. The device can be used to stabilize the intermediate-frequency amplifier of a super-heterodyne. It can also be used in such receivers as the Equamatic, the Bremer-Tully Counterphase, Roberts receivers, all tuned r.f. sets, etc., and its application to such circuits is fully covered in the circular supplied with it. Readers owning such receivers, or similar ones, which cannot be prevented from oscillating, can use a Phasatrol to overcome the difficulty.

THE PHASATROL

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Manufacturers' Booklets

A Varied List of Books Pertaining to Radio and Allied Subjects Obtainable Free With the Accompanying Coupon

READERS may obtain any of the booklets listed below by using the coupon printed on this page. Order by number only.

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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.

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.

9. VOLUME CONTROL—A leaflet showing circuits for distortionless control of volume. CENTRAL RADIO LABORATORIES.

10. VARIABLE RESISTANCE—As used in various circuits. CENTRAL RADIO LABORATORIES.

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.

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.

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.

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.

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.

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.

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, are given in a pamphlet. THE ABOX COMPANY.

86. SHORT-WAVE RECEIVER—A booklet containing data on a short-wave receiver as constructed for experimental purposes. THE ALLEN D. CARDWELL MANUFACTURING CORPORATION.

88. SUPER-HETERODYNE CONSTRUCTION—A booklet giving full instructions, together with a blue print and necessary data, for building an eight-tube receiver. THE GEORGE W. WALKER COMPANY.

89. SHORT-WAVE TRANSMITTER—Data and blue prints are given on the construction of a short-wave transmitter, together with operating instructions, methods of keying, and other pertinent data. RADIO ENGINEERING LABORATORIES.

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101. USING CHOKES—A folder with circuit diagrams of the more popular circuits showing where choke coils may be placed to produce better results. SAMSON ELECTRIC COMPANY.

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23. AUTOMATIC RELAY CONNECTIONS—A data sheet showing how a relay may be used to control A and B circuits. YAXLEY MANUFACTURING COMPANY.

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.

28. B BATTERY LIFE—Battery life curves with general curves on tube characteristics. BURGESS BATTERY COMPANY.

30. TUBE CHARACTERISTICS—A data sheet giving constants of tubes. C. E. MANUFACTURING COMPANY.

32. METERS FOR RADIO—A catalogue of meters used in radio, with diagrams. BURTON-ROGERS COMPANY.

33. SWITCHBOARD AND PORTABLE METERS—A booklet giving dimensions, specifications, and shunts used with various meters. BURTON-ROGERS COMPANY.

36. CHARGING A AND B BATTERIES—Various ways of connecting up batteries for charging purposes. WESTINGHOUSE UNION BATTERY COMPANY.

37. WHY RADIO IS BETTER WITH BATTERY POWER—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.

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.

87. TUBE TESTER—A complete description of how to build and how to operate a tube tester. BURTON-ROGERS COMPANY.

92. RESISTORS FOR A. C. OPERATED RECEIVERS—A booklet giving circuit suggestions for building a. c. operated receivers, together with a diagram of the circuit used with the new 400-milliampere rectifier tube. CARTER RADIO COMPANY.

102. RADIO POWER BULLETINS—Circuit diagrams, theory constants, and trouble-shooting hints for units employing the BH or B rectifier tubes. RAYTHEON MANUFACTURING COMPANY.

103. A. C. TUBES—The design and operating characteristics of a new a. c. tube. Five circuit diagrams show how to convert well-known circuits. SOVEREIGN ELECTRIC & MANUFACTURING COMPANY.

58. HOW TO SELECT A RECEIVER—A commonsense 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.

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.

95. RESISTANCE DATA—Successive bulletins regarding the use of resistors in various parts of the radio circuit. INTERNATIONAL RESISTANCE COMPANY.

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110. RECEIVER CONSTRUCTION—Circuit diagram and constructional information for building a five-tube set using restricted field coils. BODINE ELECTRIC COMPANY.

111. STORAGE BATTERY CARE—Booklet describing the care and operation of the storage battery in the home. MARKO STORAGE BATTERY COMPANY.

112. HEAVY-DUTY RESISTORS—Circuit calculations and data on receiving and transmitting resistances for a variety of uses, diagrams for popular power supply circuits, d.c. resistors for battery charging use. WARD LEONARD ELECTRIC COMPANY.

113. CONE LOUD SPEAKERS—Technical and practical information on electro-dynamic and permanent magnet type cone loud speakers. THE MAGNAVOX COMPANY.

114. TUBE ADAPTERS—Concise information concerning simplified methods of including various power tubes in existing receivers. ALDEN MANUFACTURING COMPANY.

115. WHAT SET SHALL I BUILD?—Descriptive matter, with illustrations, of fourteen popular receivers for the home constructor. HERBERT H. FROST, INCORPORATED.

104. OSCILLATION CONTROL WITH THE "PHASATROL"—Circuit diagrams, details for connection in circuit, and specific operating suggestions for using the "Phasatrol" as a balancing device to control oscillation. ELECTRAD, INCORPORATED.

116. USING A B POWER UNIT—A comprehensive booklet detailing the use of a B power unit. Tables of voltages—both B and C—are shown. There is a chapter on trouble-shooting. MODERN ELECTRIC MFG. CO.

118. RADIO INSTRUMENTS, CIRCULAR "J"—A descriptive manual on the use of measuring instruments for every radio circuit requirement. A complete listing of models for transmitters, receivers, set servicing, and power unit control. WESTON ELECTRICAL INSTRUMENT CORPORATION.

120. THE RESEARCH WORKER—A monthly bulletin of interest to the home constructor. A typical feature article describes the construction of a special audio amplifier—AEROVOX WIRELESS CORPORATION.

121. FILTER CONDENSERS—Some practical points on the manufacture and use of filter condensers. The difference between inductive and non-inductive condensers. POLYMET MFG. CORP.

122. RADIO TUBES—Specifications and operating characteristics of vacuum tubes. Twenty-four pages. E. T. CUNNINGHAM, INC.

123. B SUPPLY DEVICES—Circuit diagrams, characteristics, and list of parts for nationally known power supply units. ELECTRAD, INC.

124. POWER AMPLIFIER AND B SUPPLY—A booklet giving several circuit arrangements and constructional information and a combined B supply and push-pull audio amplifier, the latter using 210 type tubes. THORDARSON ELECTRIC MFG. CO.

125. A. C. TUBE OPERATION—A small but complete booklet describing a method of filament supply for a.c. tubes. THORDARSON ELECTRIC MFG. CO.

126. MICROMETRIC RESISTANCE—How to use resistances for: Sensitivity control; oscillation control; volume control; regeneration control; tone control; detector plate voltage control; resistance and impedance coupling: loud speaker control, etc. AMERICAN MECHANICAL LABORATORIES.

127. VITROHM NEWS—A monthly bulletin dealing with the resistance problems of the home constructor and experimenter. WARD LEONARD ELECTRIC CO.

128. SANGAMO CONDENSERS—A helpful table for converting capacities from microfarads to micromicrofarads. SANGAMO ELECTRIC CO.

129. TONE—Some model audio hook-ups, with an explanation of the proper use of transformers and chokes. SANGAMO ELECTRIC CO.

130. SCREEN-GRID AUDIO AMPLIFICATION—Diagrams and constructional details for remodeling old audio amplifiers for operation with screen-grid tubes. THORDARSON ELECTRIC MFG. CO.

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132. THE NATIONAL SCREEN GRID SHORT-WAVE RECEIVER—Constructional and operating data, with diagrams and photographs. JAMES MILLEN.

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134. REMLER SERVICE BULLETINS—A regular service for the professional set builder, giving constructional data, blueprints, and hints on marketing. GRAY & DANIELSON MFG. CO.

135. THE RADIOBUILDER—A periodic bulletin giving advance information, constructional and operating data on S-M products. SILVER-MARSHALL, INC.

136. SILVER-MARSHALL DATA SHEET No. 1—Building and operating instructions for the S-M 670-B and 670-ABC power units. SILVER-MARSHALL, INC.

137. SILVER-MARSHALL DATA SHEET No. 2—Illustrated building and operating data on the S-M 685 Public Address Unipac. SILVER-MARSHALL INC.

138. SILVER-MARSHALL DATA SHEET No. 3—How to build and operate the S-M four-tube, short-wave receiver and the S-M short-wave adapter. SILVER-MARSHALL, INC.

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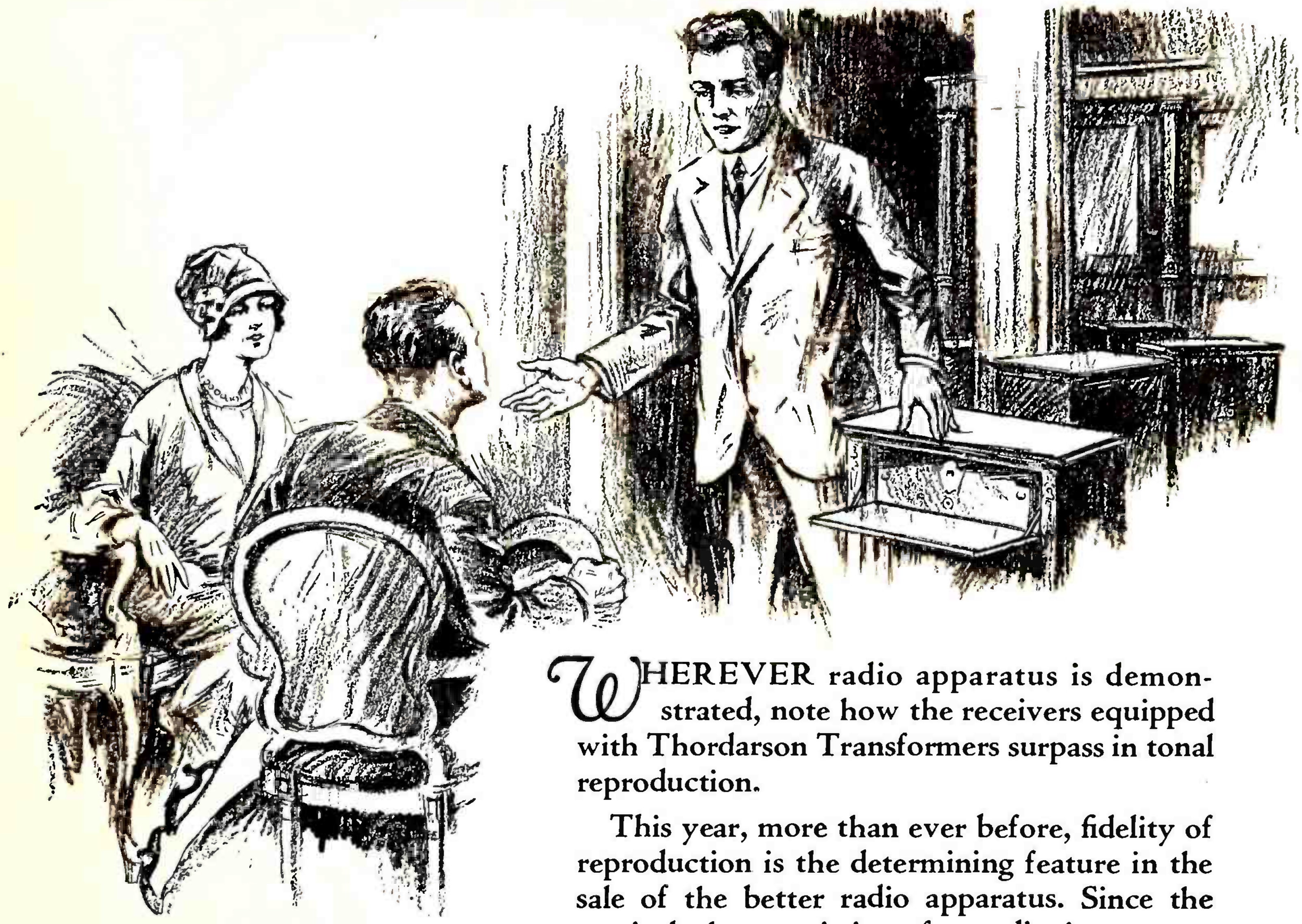

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LABORATORY INFORMATION SHEETS

THE RADIO BROADCAST Laboratory Information Sheets are a regular feature of this magazine and have appeared since our June, 1926, issue. They cover a wide range of information of value to the experimenter and to the technical radio man. It is not our purpose always to include new information but to present concise and accurate facts in the most convenient form. The sheets are arranged so that they may be cut from the magazine and preserved for constant reference, and we suggest that each sheet be cut out with a razor blade and pasted on 4" x 6" filing cards, or in a notebook. The cards should be arranged in numerical order. In July, 1927, an index to all sheets appearing up to that time was printed. Last month we printed an index covering the sheets published from August, 1927, to May, 1928, inclusive.

All of the 1926 issues of RADIO BROADCAST are out of print. A complete set of sheets, Nos. 1 to 88, can be secured from the Circulation Department, Doubleday, Doran & Company, Inc., Garden City, New York, for $1.00. Orders for the next set following can also be sent. Some readers have asked what provision is made to rectify possible errors in these sheets. In the unfortunate event that any serious errors do occur, a new Laboratory Sheet with the old number will appear.

—THE EDITOR.

No. 209 RADIO BROADCAST Laboratory Information Sheet August, 1928

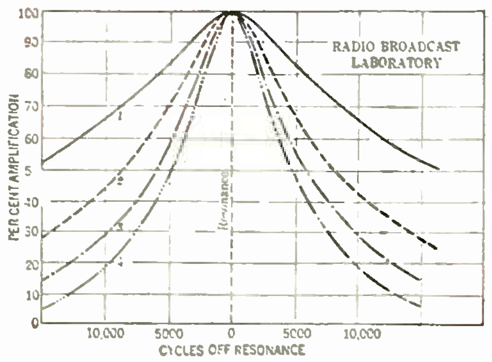
Selectivity

AS EFFECTED BY NUMBER OF R.F. STAGES

THE selectivity of a radio circuit depends upon many things, including the number of tuned stages, amount of coupling in the r.f. transformers, the characteristics of the tubes, the amount of regeneration in the circuit, the accuracy with which the individual circuits are tuned, etc. In this Sheet we will consider the effect on selectivity of increasing the number of tuned stages in a receiver. Future Laboratory Sheets will discuss the influence, on selectivity, of some of the other factors mentioned above.

Curve 1 represents the selectivity curve of a single r.f. stage. At a point 5,000 cycles off resonance the circuit gives 83 per cent. of the amplification at resonance; at 10,000 cycles off resonance the amplification has dropped to 65 per cent.

Now suppose we add more r.f. stages, with characteristics the same as that of the first stage. We then get the selective action indicated in Curve 2.



If, at a certain point off resonance, the first stage reduced the amplification to 83 per cent., then the second stage would reduce the amplification to 83 per cent. of what came through the first stage. Referring to the curves, at a point 5,000 cycles off resonance, the various stages introduce a selective action as indicated below.

First stage = 83 per cent.
Second stage = 83 x 83 = 69 per cent.
Third stage = 83 x 83 x 83 = 57 per cent.
Fourth stage = 83 x 83 x 83 x 83 = 47 per cent.

This means that if we had a four-stage r.f. amplifier with these characteristics, that a signal 5,000 cycles off the resonance frequency to which the stages were tuned, would be amplified only 47 per cent. as much as a signal at the resonant frequency. Since a radio wave includes modulation frequencies up to 5,000 cycles off resonance, it is evident that such an r.f. amplifier would cause considerable side band suppression with consequent signal distortion.

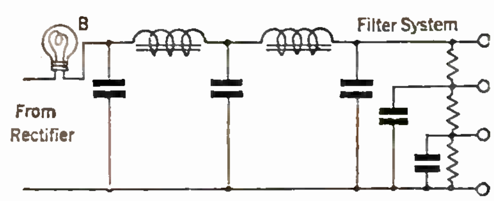
No. 210 RADIO BROADCAST Laboratory Information Sheet August, 1928

Protecting the Rectifier Tube

A PILOT LAMP TO INDICATE OVERLOAD

MOST of the rectifier tubes available at the present time will be severly injured if they are subjected to accidental short circuits or to excessive overload for any considerable period of time. In constructing power units it is therefore wise to place in the circuit some device which will serve to indicate any overload. Such an indicator is described in this Sheet and is applicable to power units of all types whether they use gaseous or filament type rectifiers.

The main precaution to be observed in operating rectifier tubes is that of avoiding an overload with respect to plate current. The shorting of the rectifier output, such as may occasionally occur due to the failure of some part of the apparatus (as by the breakdown of a filter condenser) will overload the filament and result in filament failure (in the case of filament type rectifiers) unless the current is turned off promptly.



To indicate an overload it is a good idea to connect a small lamp in series with the rectifier output as indicated at B in the circuit diagram on this Sheet. A small lamp such as is used as a dial light may be used for this purpose. Excessive brilliancy of this lamp will immediately indicate an overload, which can then be remedied before damage results.

In constructing power amplifiers and B supplies it is also a good idea to place a fuse in the primary side of the power transformer. This fuse will protect the transformer from damage in case its secondary is accidentally short circuited. The fuse should preferably be of the ordinary plug type with a rating of about three amperes. Only one fuse need be used, connected in series with one side of the line and the transformer.

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Letters from Readers

What a Vacuum Tube Can't Do

ANOTHER good fiction—and this one countenanced by RADIO BROADCAST—has received its death blow at the stern hands of reality. Witness this letter:

To the Editor:

With no thought of destroying the sentiment of the interesting and informative article, "The Haven of a Sea-going Audion," in the June issue of RADIO BROADCAST, I would like to protest the author's theory that the audion "may have started in the Atlantic, bobbed through the Canal, crossed the Pacific, etc."

If he were to visit the Canal (I presume he means the Panama Canal) he would find that it would be impossible for any floating object to drift through from one ocean to the other. The level of Gatun Lake is eighty odd feet above the sea. The water used in raising and lowering ships in the locks as they enter or leave the Canal comes from the lake, and flows to the sea through the locks at either end of the Canal. The frail glass bulb would have a poor chance reaching the lake against such a counter current thus created.

This is the second time in the last two or three years I have noticed the same mistake in the press. The general public is obsessed with the mistaken notion of things floating through the Panama Canal from one ocean to the other. Don't you think a correct impression ought to be made?

R. S. FULTON,
Radio Operator, S.S. Hochelega

Greenwich Mean or Civil Time?

THE list of short-wave transmissions which appeared in the May number of RADIO BROADCAST has brought forth several interesting letters in regard to the confusion existing about the meaning of the terms "Greenwich Mean Time" (G. M. T.) and "Greenwich Civil Time" (G. C. T.) The list of short-wave stations was reprinted from *Wireless World*, London, England, and retained the time designations of the English magazine. RADIO BROADCAST also printed in the May number (page 53) a conversion table for G. C. T., G. M. T., and 75th meridian time (E. S. T.) That this conversion table was in error is shown by the following letter from C. S. Freeman, Superintendent of the U. S. Naval Observatory in Washington D. C.

To the Editor:

It is unfortunate that the usage of the terms "Greenwich Mean Time" and "Greenwich Civil Time" is not the same in the United States and foreign countries. Originally the term "Mean Time" was universally used to refer to a day beginning at noon, but on January 1, 1925, an international agreement went into effect by which the use of such time was discontinued, and all solar time computed beginning from midnight. In the United States this new time was designated as "Civil Time," but foreign countries retained the designation "Mean Time." Both these designations therefore now refer to the same kind of time.

Your table (page 53) should read:

G. C. T. or G. M. T. Hours	75TH MERIDIAN (E. S. T.)
0	7:00 P. M.
6	1:00 A. M.
12	7:00 A. M.
14	9:00 A. M.
18	1:00 P. M.
22	5:00 P. M.
24	7:00 P. M.

It should be noted, however, that the expression "24 hours" is not in use, "0 hours" being in use instead. In your table all the 75th meridian times are marked "P. M.," although the second, third, and fourth should be marked "A. M."

(*Continued on page 233*)

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Write for Short-Wave Bulletin 128-B

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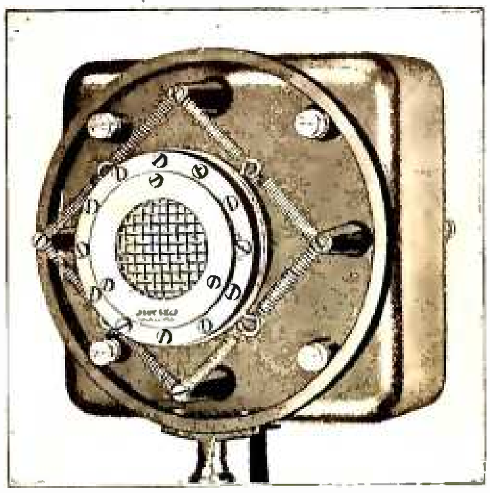

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Here is my $1.00 for the "B Eliminator Treatise" to be mailed postpaid to

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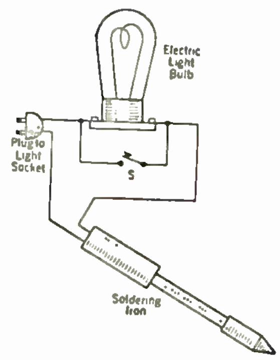
No. 211 RADIO BROADCAST Laboratory Information Sheet August, 1928

Soldering Irons

HOW TO CARE FOR THEM

PRACTICALLY all commercial soldering irons are designed to heat rapidly so that they will be brought to an operating temperature within a short time after they are connected to the line. Unfortunately, however, if they are left connected to the line after they have reached an operating temperature they become too hot for satisfactory work, the tip blackens very quickly, becomes pitted, and in a comparatively short while the iron requires a new soldering tip. All this trouble can be easily overcome, and the manner in which it is done in the Laboratory may be of interest to readers.

The arrangement used in the Laboratory is indicated in the diagram. The soldering iron is connected in series with an ordinary electric light bulb across the power line. A short-circuiting switch, S, is provided across the bulb. The procedure when some soldering is to be done is to push the plug in to the light socket and close switch, S. With the switch, S, closed the iron is then connected directly across the line and reaches a satisfactory operating temperature quickly. When this temperature is reached the switch is reopened so that the electric light is in series with the iron. The size of electric light used is such that the iron is maintained at the correct temperature and does not overheat even though the power is left on for hours without using the iron. If an arrangement such as this is used the tip of the iron will remain tinned for a long time, and a better soldering job can be done.



The wattage of the electric light bulb that is used depends upon the soldering iron. The particular irons used in the Laboratory work best with a 75-watt lamp. The switch, S, may be almost any type although it is a good idea to use some kind of enclosed switch designed for use on 110-volt lighting circuits.

No. 212 RADIO BROADCAST Laboratory Information Sheet August, 1928

Equalizers

WHY THEY ARE USED

IN TRANSMITTING outside events (programs that do not originate in the studio) broadcasting stations have to make use of wire lines to connect the control room of the station with the microphone and amplifier apparatus located at the point at which the program originates. These wire lines must transmit with equal efficiency a band of frequencies from about 100 cycles to about 5,000 cycles. In order to give a wire line such a characteristic it is necessary that it be "equalized" so that the transmission efficiency will be equal over the entire band of audio frequencies. The device used to give a line such a characteristic is termed an "equalizer" and its action will be explained in this sheet in conjunction with the diagram on Sheet No. 213.

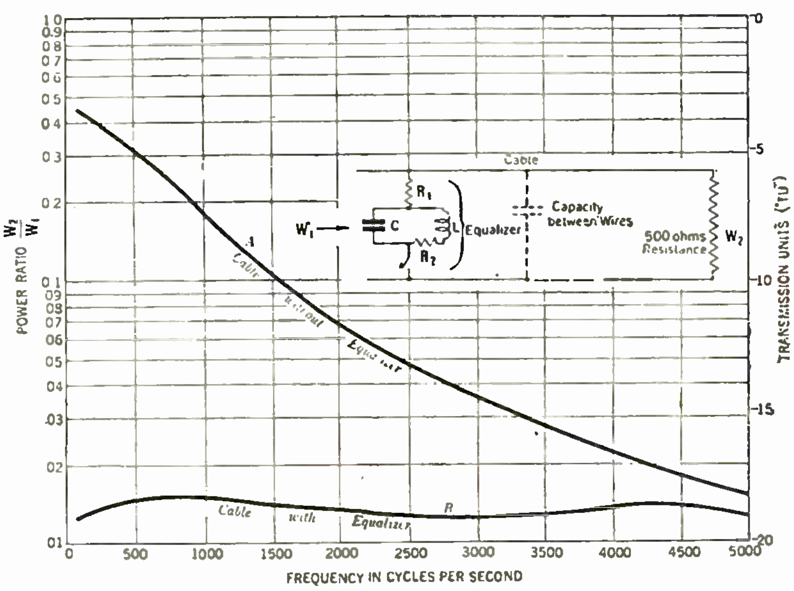
The frequency characteristic of a seven-mile length of cable is indicated in curve A on Sheet No. 213. This characteristic shows that the cable transmits the low frequencies much better than the high frequencies, due to the fact that there is considerable capacity between the two wires that form the pair of cables and this capacity tends to bypass the higher frequencies. Equalization is accomplished by introducing into the circuit a device that will lower the transmission efficiency at low frequencies to a value equal to the efficiency at high frequencies; this is the function of the equalizer.

The equalizer consists of a network of resistances, capacities, and inductances of values such that they introduce a considerable loss at low frequencies where the transmission efficiency of the cable is high and practically no loss in efficiency at the high frequencies where the transmission efficiency is low. The result is that the efficiency of the entire system is reduced to approximately the efficiency of the cable at the highest frequencies to be transmitted.

The curve B shows the characteristics of the cable with the equalizer in use; the frequency characteristic is sensibly flat from 100 cycles to 5,000 cycles. As was mentioned above this betterment in the frequency characteristic is obtained at a considerable reduction in overall efficiency. The low efficiency is then compensated by connecting repeaters (power amplifiers) in the circuit to raise the power level of the entire system. The broadcasting circuit connecting New York with Chicago contains about eight repeater points. Power amplifiers are located at these points and function to boost the power in the line to overcome the loss in the cable. As a result we frequently find cases where the final amount of power at the receiving end is considerably greater than the power originally introduced in the line at the transmitting end.

No. 213 RADIO BROADCAST Laboratory Information Sheet August, 1928

Frequency Characteristic of a Seven-Mile Cable



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Letters from Readers

(*Continued from page 231*)

From this letter it appears that the Greenwich Mean Time used in the list reprinted from the *Wireless World* is the continental equivalent of the United States Greenwich Civil Time. This fact explains the following letter from a Toronto, Canada, reader of the magazine;

To the Editor:

May I take the liberty of pointing out an error in the May RADIO BROADCAST? At the top of the list on page 44 of the May number you state that "all the times are given in Greenwich Mean Time (G. M. T.)"—nevertheless the times *actually were given in G. C. T.* (Greenwich Civil Time). Also note that five o'clock P. M. London time, which is noon E. S. T., certainly is *not* 5:00 P. M. G. M. T.

For your information I would state the following:

1. The term "Greenwich Time" is ambiguous and doesn't mean anything as far as we are concerned.

2. G. C. T. (which is the same as London time) *is* five hours ahead of E. S. T.

3. G. M. T. or Greenwich Mean Time is the mean day, astronomical or solar day, commencing at noon of the civil day of the same date.

This was shown at the bottom of page 53, only there was another error here—all the times under "75th Meridian" were "P. M."

The corrected column should read as follows: (page 53)

G. C. T.	G. M. T.	75TH MERIDIAN
00	12	07 P. M.
06	18	01 A. M.
12	00	07 A. M.
14	02	09 A. M.
18	06	1 P. M.
22	10	5 P. M.
24	12	7 P. M.

It is apparent that you listed the right times but called them by the wrong name and also that the two tables (pp. 44 and 52) do not conflict.

It is amazing how universal this error of confusing G. C. T. and G. M. T. has been. Apparently people thought G. M. T. meant 'Greenwich Meridian Time."

I am a ship operator and I certainly know that 10 P. M. E. S. T. is 0300 G. C. T. I also know that 5SW transmits phone from 1930 G. C. T., or 2:30 P. M. E. S. T., onwards.

If the U. S. Naval Observatory is correct, the second column of this conversion table refers to the *old* Greenwich Mean Time, which is no longer used. It does not yet seem clear to us, however, whether or not there is any recognized method of time computation employed at present here or abroad which begins its day at noon.

An Old-Timer Recalls

To the Editor:

The picture of the Wireless Room on the *SS Bermuda* in your June issue [page 71] came to me like a voice from the past. The gear was that of the Marconi Co. of London, a firm I worked for from 1915 to 1927.

On looking over the gear I noticed a slight error: the ½-kw. quenched spark transmitter should read ¼-kw. quenched spark transmitter. It is a 1925 model originally intended for lifeboats but radiates up to 7 amps. and may be tuned to 300, 450, 600, and 800 meters. It is identical with the auxiliary transmitter on my own ship. Our main installation is an R. C. A. c. w. and i. c. w. transmitter with a range of waves from 600 to 2500 meters.

WILLIAM I. BOOBYER
Radio Operator, S.S. Beaconstreet

A Correction in the July Number

In the article "How to Build a Beat-frequency Oscillator", by G. F. Lampkin, in the July number of RADIO BROADCAST, an error occurred in the picture at the bottom of page 157. The two coils marked 40T should be marked 55T, and the two marked 55T marked 40T. The coil diagram in Fig. 1 is correct in these dimensions.

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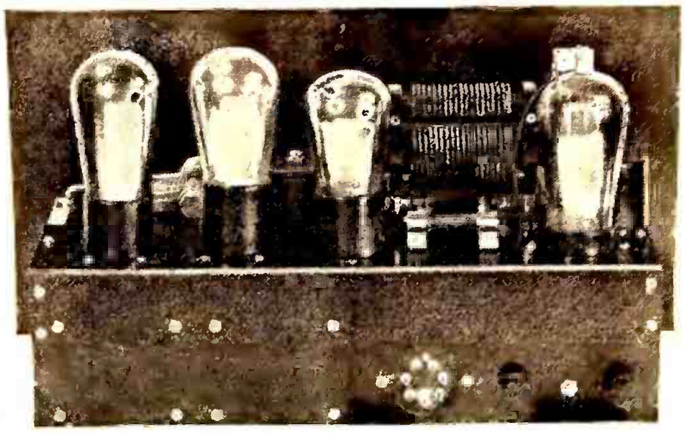
The Aero International Four

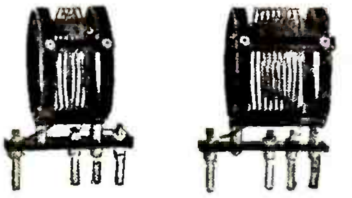
This new Aero Receiver embodies many noteworthy improvements. Uses latest design Aero Interchangeable Coils that provide materially increased efficiency of operation. Sensitivity has been increased, control made easier, noises eliminated. Particularly adapted to musical broadcasts.



(Rear Panel View)

Uses New Kit

The coils illustrated are the new L. W. T. 10 kit, price $10.50. Designed for use with special foundation unit which includes mounting base. These coils are only 2" in diameter, insuring smaller external field and better performance. They embody the patented Aero construction feature which *provides* 95% *air di-electric*—by far the most efficient inductances as yet perfected.



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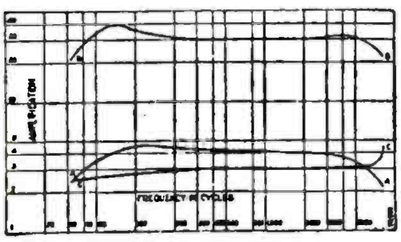
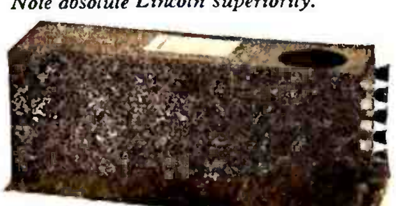


Curve "A" is Lincoln 105 first stage transformer. Curve "B" is Lincoln 106 second stage transformer. Curve "C" is a $10.00 high-grade audio transformer of standard make. All curves are under actual amplifier operating conditions. Note absolute Lincoln superiority.

LINCOLN offers new radio transformers of phenomenally high amplification and precision manufacture, designed by Kendall Clough. Look at the actual operating curves for these new Lincoln products! Where have you ever seen such high amplification and excellent frequency characteristics as these new transformers offer!

The new 105 first stage audio transformer has an average effective ratio of 4.4:1—nearly 50% more than other more expensive transformers. The 106 second stage audio transformer is 3.7:1 or nearly 25% more than other types. And the tone—it simply must be heard to be appreciated, so far superior is it to that of ordinary $8.00 and $12.00 transformers. No matter what set you have, or what you're going to build, Lincoln's are the best audios, for they'll give you finer tone and 50% more amplification on weak signals.



POWER UNITS—B and ABC

TWO new Lincoln power supplies, one a "B" eliminator only, and the other a complete "ABC" power supply for A. C. tube sets, are contained in attractive brown crystaline steel shielding cases, long and narrow so that they may be placed in a radio set cabinet by the receiver itself. Each case is 13" long over two mounting feet, 3¾" wide, and 5½" high, or 6½" over the single 280 type tube used.

Model 110 B power unit delivers from 180 to 200 volts at 50 to 60 m. a. from the "high voltage" binding post, and 22½, 90, and 135 volts from other posts. From a special post, a variable voltage of 22½ to 90 volts is available. This powerful eliminator will operate any set of one to ten tubes, and is especially designed for high quality Lincoln audio amplifiers, its filtration being remarkably fine.

The model 110-ABC unit furnishes just the same B voltages, plus 1.5, 2.25, and 5 volts for up to five 226 tubes, three 227 tubes, and four 112A tubes. C voltage is obtained by suitable bias resistors in any A. C. set. Type 110B is priced at $36.00, and type 110-ABC at $39.00 retail list, fully guaranteed. Both will operate from any 105 to 120 volt, 60 cycle alternating current lamp socket.

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Loomis Publishing Company

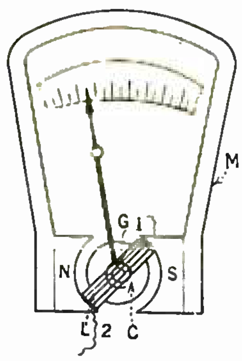
Dept. 10 Washington, D. C.

No. 214 — Radio Broadcast Laboratory Information Sheet — August, 1928

Measuring Instruments

HOW THEY WORK

THE drawing on this sheet shows in simple form the arrangement of the parts in an electrical measuring instrument such as might be used to measure the currents and voltages in a radio receiver. The instrument consists essentially of a very strong permanent magnet, M, a cylindrical soft iron core, C, a moving coil, L, the ends of which connect to the leads 1 and 2 which would be connected to the binding posts on the instrument. The space between the poles of the magnet, marked N and S, and the iron core, C, is made quite small so that an intense magnetic field will exist in the air space between the core and the pole pieces. The coil, L, is free to move in this gap. To the coil is fastened a small spring, G, and a pointer which is generally made of aluminum so that it will be very light in weight. The coil is pivoted at its center on jeweled bearings and the spring is adjusted so that with no current flowing through the instrument the pointer rests at zero on the scale. When current passes through the coil, it moves on its pivots. This motion is opposed by the spring and for each value of current there is some position of the coil at which the turning force produced by the current is exactly balanced by the force due to the spring; the pointer therefore comes to rest at a position on the scale corresponding to the point at which these two forces balance. The scale can be marked off in values so as to indicate by its position on the scale the amount of current flowing through the instrument.



With strong magnets, delicate parts, and accurate workmanship, instruments can be built which take only a very small fraction of an ampere to move the pointer over its entire range; the scale may be calibrated in thousandths of an ampere, or milliamperes; the instrument is then known as a milliammeter.

No. 215 — Radio Broadcast Laboratory Information Sheet — August, 1928

The Hi-Q Six

THE PARTS USED

THE circuit diagram of the Hi-Q Six, the 1928 model of the kit receiver produced by the Hammarlund-Roberts Corporation, is published on Laboratory Sheet No. 216. On this Sheet we give some details regarding the circuit and parts used so that readers who are keeping a file of these sheets may have on hand for ready reference the data on this kit. Other sheets to follow will give information on other popular kits.

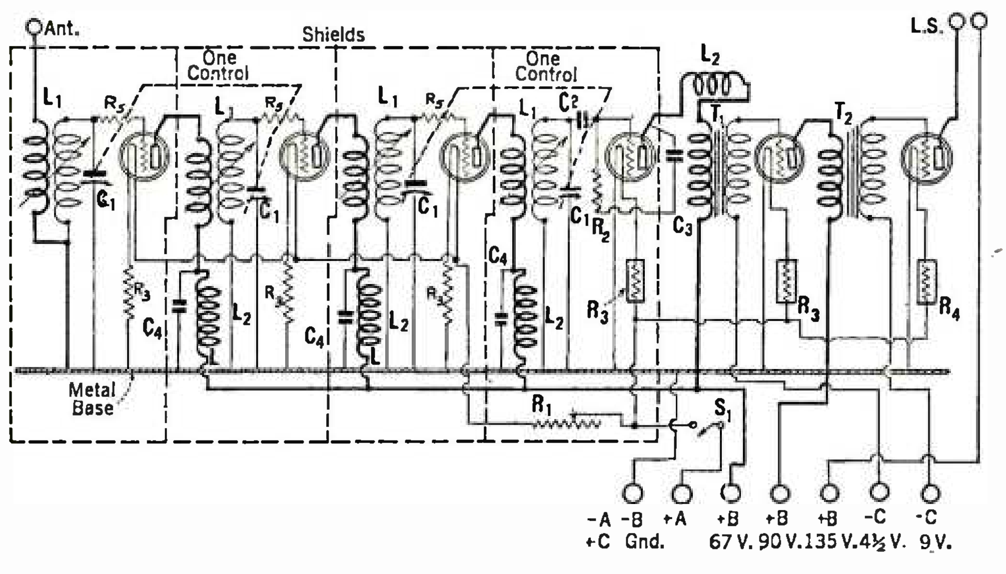
The circuit consists of three stages of r.f. amplification, followed by a non-regenerative detector and a two-stage transformer-coupled audio amplifier. The r.f. coils are arranged so that the coupling between the primary and secondary is varied automatically as the receiver is tuned. This feature helps to make the receiver perform equally well over the entire broadcast band. The first two tuning condensers are ganged to one tuning control and the other two condensers are ganged to the other control on the drum dial. Volume control is accomplished by means of a rheostat in the filament leads of the r.f. tubes. All of the r.f. stages are shielded.

The following parts were specified for the official kit; the notation in this list refers to the diagram on the following Laboratory Sheet.

T_1—Samson Symphonic Transformer. T_2—Samson Type HW-A3 Transformer (3–1 Ratio). C_1—4 Hammarlund 0.0005-Mfd. Midline Condensers. L_1—4 Hammarlund "Hi-Q" Six Auto-Couple Coils. L_2—4 Hammarlund Type RFC-85 Radio-Frequency Chokes. C_2—Sangamo 0.00025-Mfd. Mica Fixed Condenser. C_3—Sangamo 0.001-Mfd. Mica Fixed Condenser. R_1—Carter 1R-6 "Imp" Rheostat, 6 Ohms. S_1—Carter "Imp" Battery Switch. R_2—Durham Metallized Resistor, 2 Megohms. C_4—3 Parvolt 0.5-Mfd. Series A Condenser. R_3—4 Amperites No. 1-A. R_4—Amperite No. 112. R_5—3 500-ohm grid resistors. Hammarlund illuminated Drum Dial. 1 Pr. of Sangamo Grid Leak Clips. 6 Benjamin No. 9040 Sockets. 3 Eby Engraved Binding Posts. 1 Yaxley No. 660 Cable Connector and Cable. 1 Hammarlund Roberts "Hi-Q" Six Foundation Unit (containing drilled and engraved Westinghouse Bakelite Micarta panel, completely finished Van Doorn steel chassis, four complete heavy aluminum shields, extension shafts, screws, cams, rocker arms, wire, nuts, and all special hardware required to complete receiver).

No. 216 — Radio Broadcast Laboratory Information Sheet — August, 1928

The Circuit of the Hi-Q Six



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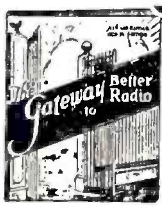

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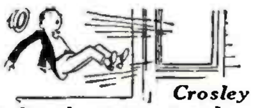
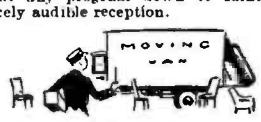
Crosley Radios are very selective
In crowded districts where many local stations fill the air you find in Crosley radio a means of listening to ONE at a time.



Crosley Radios have great volume
Volume may be increased to tremendous proportions without distortion. This provides plenty of volume for power speakers.

Crosley Radios can be softened to a whisper
A positive volume control enables operator to cut any program down to faint and scarcely audible reception.



Crosley Radios fit any kind of furniture
Outside cases are easily removable and chassis are quickly fitted into any type of shape console cabinet.

Crosley Radios have illuminated dials
The modern way enables you to see clearly in the dusk or in shadowy corners.

Your set has served you well *but* you will *not be satisfied with its strained stringy tones when* you hear a *new full toned power speaker* Crosley set

$25 New Dynamic DYNACONE *Amazing Speaker*

6 tube GEMBOX AC ELECTRIC $65

FIVE DAYS FREE TRIAL IN YOUR OWN HOME

Crosley originated the idea of a national policy of home demonstration. Home is the place to buy a radio set. Compare a Crosley radio set with any other that you are contemplating buying and you will choose the Crosley. If you have electric current in your home, your set should be a modern, AC electric receiver. A converted battery set is out of date. If you pay more than $65.00 for a radio set, it should have two 171 output tubes, push-pull instead of one, eight tubes instead of seven. To be up-to-date, your new radio set should be designed to take and supply the current for a power or dynamic type of speaker. Crosley sets are so designed. Other sets designed for power speaker use are much more costly. You should demand the tone quality and the performance resulting from high power output coupled with dynamic speaker. Your set should be completely shielded and incorporate the highly sensitive, genuine, neutrodyne circuit. It should have a modern illuminated dial. An examination of Crosley radio sets will show you many other modern exclusive features.

$25.00 NEW DYNAMIC DYNACONE AMAZING SPEAKER!

The Dynacone is a new revolutionary speaker at a price less than many good magnetic speakers. The first minute you hear this new reproducer, it will thrill you to a new conception of what radio broadcast reception should be. Crosley manufacturing speed and straight line methods permit the extremely low price.

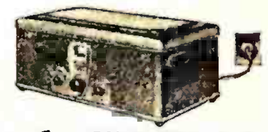
WHY PAY MORE THAN CROSLEY PRICES?

We urge you to listen to a Crosley radio set, try it, put it to any test you can think of. No sets that approximate Crosley prices can compare in performance. Why pay a high price for a set that can compare favorably with Crosley?

SIX TUBE GEMBOX AC ELECTRIC, $65.00

Self-contained AC electric receiver. It utilizes two radio, detector, two audio and a rectifier tube—171 power output tube. Designed for use with the new Crosley Dynamic power speaker. Operates from 110 volts 60 cycle AC house lighting current.

1928's greatest radio



8 tube SHOWBOX $80

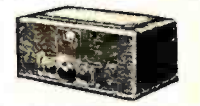
Genuine Neutrodyne, 3 stages radio amplification, detector, 3 stages audio (last two being 171 push-pull power tubes) and 280 rectifier tube. Newly perfected audio frequency system creates marvelous tone quality. Modern illuminated dial.

8 tube JEWELBOX $95

Genuine Neutrodyne 3 stages radio amplification—227 detector tube, 3 stages audio frequency, and 280 rectifier. Shielded coils, modern illuminated dials, highly selective and powerful.

6 tube BANDBOX $55

An improved model of the 1927 receiver that led the world to better radio. Genuine Neutrodyne—every modern fitting and refinement, including illuminated dial. The set you can safely buy where AC current is not available—selective, sensitive, powerful!



5 tube BANDBOX JR. $35

Operates entirely from dry cells and is especially designed where no electric current is available either for AC radio or recharging storage batteries. Modern radio with all the features of good reception Crosley engineers have developed.

Improved MUSICONE $15

The outstanding Magnetic type speaker available, still maintaining its leadership, today, as from its inception in 1925. Improved, it is without question the greatest speaker value you can find.

CROSLEY

When the pennant winners meet...

The Crosley Radio Corporation
Powel Crosley, Jr., *Pres.*
Cincinnati, Ohio

Montana, Wyoming, Colorado, New Mexico and West, prices slightly higher.

Your name ....
Address ....

5 DAY FREE TRIAL COUPON

Mail this coupon to the factory. Nearest dealer will bring you receiver checked.

Please let me try, receiver and proper speaker, I have checked, in my own home without obligation for 5 days.

JEWELBOX ☐ SHOWBOX ☐
GEMBOX ☐ BANDBOX ☐ BANDBOX JR ☐

www.americanradiohistory.com