SEVENTH YEAR OF SERVICE

RADIO ENGINEERING

Vol. VII MAY 1927 Number 5

Audio Frequency Regeneration

An explanation of A.F. regeneration, its effect upon the characteristics of amplifying circuits and how it can be employed to advantage

New Slants on Radio Advertising

An experienced advertising head gives his views on the matter and offers suggestions

Improvements in Laboratory Testing

Dealing with the importance of laboratory measurements in the design of radio receivers

Looking Into a Modern Condenser Factory

An interesting narrative on the history and manufacture of paper condensers

Characteristics of Loud Speakers, A.F. and R.F. Amplifiers

A joint discussion on the present and future aspects of these factors, by two noted Consulting Engineers

Power by Radio

Ultra-short wave transmitters used in interesting demonstration by Research Engineer

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Second harmonic distortion and its elimination

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Complete information and samples ready on transformers and chokes used successfully with the new 350-400 MA Tubes. Several types mounted or unmounted

Manufacturers find the newest approved features — in Audio transformers, B Power and Power Amplifier transformers and chokes — designed by Dongan, builders of radio parts, exclusively.

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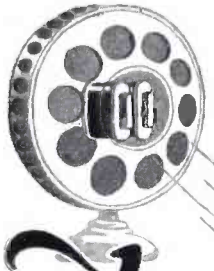

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From Microphone to Loud Speaker

No radio unit is any better than its coil for the coil is the vital part of all radio apparatus.

Coils in the microphone and all the way down the line to the loud speaker determine the volume, the selectivity, the distance, and, most important of all, the tone qualities. Coils cannot be too well made—the wire in them cannot be too good—the insulation cannot be too perfect.

The best radio apparatus in the world, made by the most successful radio manufacturers, is equipped with Dudlo layer wound coils. These manufacturers know from experience that it is *unprofitable* to attempt to wind their own coils and *unwise* to experiment on doubtful sources of supply for parts so highly specialized and so important as their coils.

By standardizing on Dudlo wire and coils, you can avoid all worry as far as these units are concerned.

Dudlo coils are wound to manufacturers' specifications. The Dudlo Engineering Laboratories are at the service of any radio manufacturer to assist in designing the proper coil for certain purposes—samples submitted without obligation.

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EDITORIAL

IT is sincerely hoped that the pages of this issue of *Radio Engineering* will go further to indicate the editorial policy of the magazine than words on my part.

Though there may be a shade of difference in the make-up and in the nature of some of the material presented to the reader, such a difference does not imply that the policy of the magazine has undergone reconstruction.

At the bottom of the front cover of this issue are the words: "The Technical Magazine of the Radio Industry." *Radio Engineering* has carried this phrase since its inception, seven years ago. It means what it says, but it means more, and is more to the point today than last year or the year before.

The Radio Industry is a fast growing child. Radio was once limited in scope, but each year it has forced its way into new channels so that today, when it appears that standardization and stability are not far off, we find very few factors which are not, in some small way, influenced by it.

What factors actually constitute the Industry? There are the Factories with their numerous Departments which handle the purchasing, the engineering, the production, the advertising and the sales. Each Department covers definite work and each is a very important part of the whole. Outside the Factories, but related to them, are the financial backers, the advertising agencies and the "field of supply," constituting portions of other Industries. Then, there are the "song and dance men" of the trade, that clan of sales wizards who may be Distributors, Contact Men, Missionaries or Publicity Agents. The "song and dance men" are very closely related to the Manufacturers and are as much interested in the welfare of the organization or organizations they represent as the men behind the wheel. Both Factory and Sales are in a great measure dependent upon each other for their individual and combined success.

The chain of the Industry does not stop at this point. Beyond the horizon of the sales factors are the Jobbers and the Dealers, the ultimate outlets, and also that new and very important man who has become so strong recently, the Professional Set Builder. These factors constitute the true support of the Industry and their power is undisputably great. All of these factors deal with and are directly interested in the technicalities of the Radio Industry. They all eat out of the same bowl. They are the industry as it is today. Each is a necessary link in a chain which grows stronger with time.

If one is to cater to the Radio Industry—if the Industry as a whole is to be served by a common medium—none of the factors contributing to the commerce can be rightfully slighted. They all work hand in hand and consciously or unconsciously they are all interested in what the other fellow is doing and how and why he is doing it.

There is a common interest and this interest can be intensified to the ultimate benefit of the whole Radio Industry and with benefit to progress in general if the medium which represents, or strives to represent, the entire Radio Industry cooperates with every factor and places at the disposal of all those who would read and learn the meat of the productive field. If the editorial force of an Industrial Journal of this sort keeps in mind that the magazine belongs to the Industry it serves rather than to itself, that the magazine must hold true to its policy, that it must do as little "ballyhooing" as possible and strike a certain note of conservatism, and if these principles are carried out in practice, the magazine has a reason for existence.

M. L. MUHLEMAN, *Editor.*

RADIO ENGINEERING

The Technical Magazine of the Radio Industry

Edited by M. L. MUHLEMAN

Vol. VII. MAY 1927 No. 5

Seventh Year of Publication

CONTENTS

RADIO ENGINEERING

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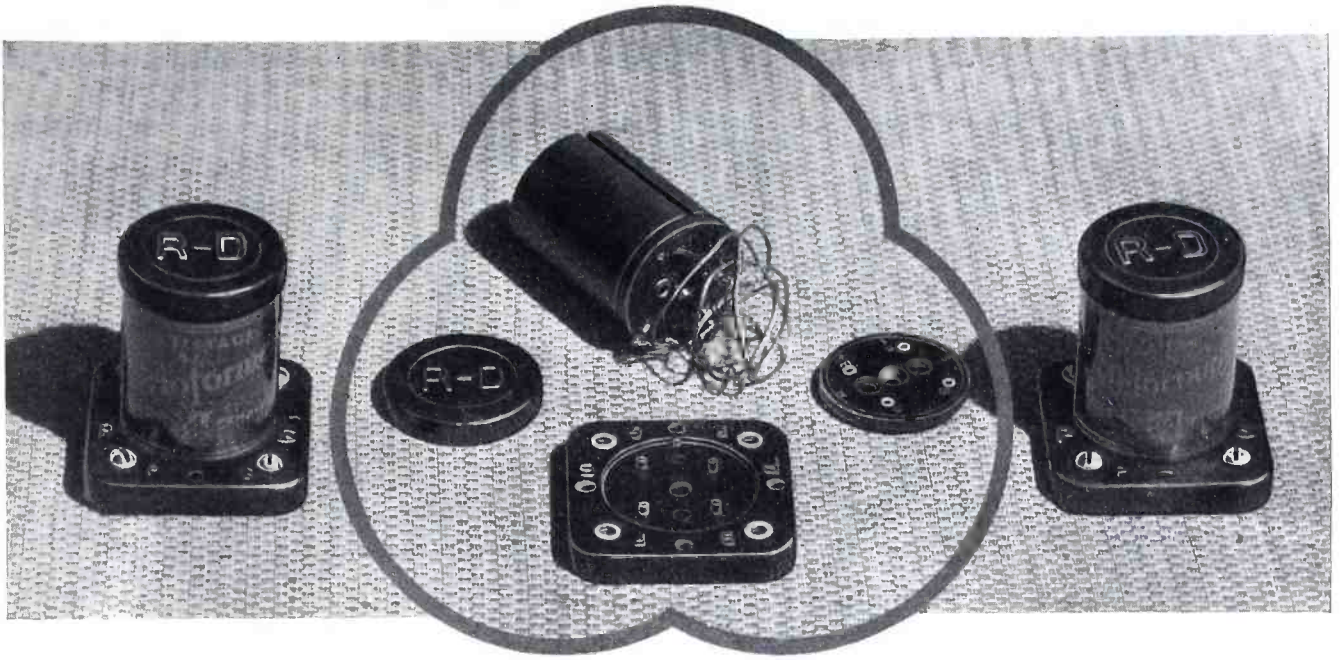

Success attained through the use of *Bakelite Molded*

IN both the Meloformer and Melocoupler the use of Bakelite Molded plays an important part — in fact, the makers say that the design of these transformers was made possible by Bakelite.

The stripped Meloformer shown in the center has a Bakelite cap with four eyelet inserts molded in, and to these the flexible lead wires are anchored. This same cap has four small projections which insulate the leads where they pass through the metal coil spool.

The bases and tops of both Meloformers and Melocouplers are also of Bakelite Molded, completed in one operation with finished relief lettering and metal inserts. Through the use of multiple cavity molds economical production is secured. Twenty-five of the coil caps are molded at one time, and seven each of bases and tops.

A Bakelite Engineer is at your service, covering all methods, processes and equipment relating to the use of Bakelite materials.

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MASTERPIECES of metalcraft—richly finished in bronze, copper and silver, two-tone and oxidized effects.

Drawn, formed or embossed, to meet the structural requirements of receivers having drum or disc tuning units mounted back of panel.

Produced by an organization equipped to serve the radio industry with promptness and efficiency.

Similar effects available in Crowe one-piece metal panels. Let us point the way to economies in manufacture and assembly.

Crowe Name Plate & Mfg. Co.

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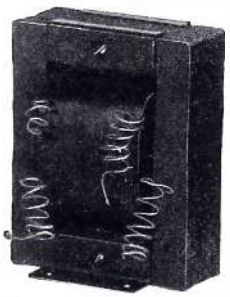
Type A Audio Transformer. The best low priced transformer on the market.

Type D—a transformer for the manufacturer who requires performance above the average.

Type G—the finest small transformer yet designed, with a response almost unbelievable in so small a unit.



Type M—which establishes a new standard of perfection in audio transformers—high impedance, full amplification at 30 cy. and ability to offset the overamplification of the broadcasters above 6400 cy.

MODERN "B" Eliminators for set manufacturers equipped to provide fixed voltages to meet the requirements of the set.

You can avoid delivery disappointments, by buying

MODERN

TRANSFORMERS and "B" ELIMINATORS

It is comparatively easy to contract for your season's requirements, but it is another thing to get deliveries during the "rush." And when the test comes it is too late to change your source of supply if you are disappointed. Then, too, high-pressure production methods during the busy season often result in lowered standards that mean unreliable parts.

Set manufacturers using MODERN Units face neither of these discouragements, for MODERN policies not only call for faith in the scheduling of deliveries, but also in the strict supervising of production to assure the utmost uniformity.

Manufacturer's contracts are taken only in accordance with factory ability to make satisfactory deliveries!

This policy, strictly adhered to by MODERN does more than guarantee you delivery of units when specified—it makes possible the avoidance of an overloaded production department which is bound to result in lowered standards and an ununiform product.

The manufacture of MODERN units is in the hands of experienced engineers, from the designing to the final operation. And these engineers, principals of the company, maintain a jealous supervision over the MODERN standard of quality that has been earned by delivery of reliable, uniform radio units.

If you would enjoy the use of such uniform dependable parts your contract must be concluded before the normal factory capacity is booked up.

The Modern Electric Mfg. Co.

Toledo, Ohio.

Dubilier

CONDENSER BLOCKS

DUBILIER
Buffer
Condenser
Type 350 BA1

.1 Mfd—.1 Mfd. Peak Voltage 600 D. C. Designed especially for incorporation in the Dubilier-Raytheon Unit.

Type 350 BA 2
Has the following terminals:

4 Mfd. 600 Volts
4 Mfd. 600 Volts
Total capacity of Block—8 Mfd.

Your circuit cannot surge over their high voltage resistance.

Type 350 BA 3
Has the following terminals:

Common Terminal
8 Mfd. 400 Volts
1 Mfd. 160 Volts
1 Mfd. 160 Volts
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Designed and Built Expressly for Use With the New—

RAYTHEON

BA (350 Mills)
RECTIFYING TUBE

Behind the Scenes

Dubilier maintains one of the largest, most complete and modern research laboratories of its kind in the world.

Back here tests and experiments are carried on without regard to time or cost.

Much of the progress made by Dubilier in their eighteen years' experience in this highly specialized field can be traced directly to their extensive research work.

DUBILIER *Devices*

Right in step with the big advancement in power-supply units are these two new condenser blocks of Dubilier! In conjunction with the Raytheon BA Tube, they make possible *a perfect source of A, B, and C power which can be incorporated in new sets or added to old.* A complete, heavy-duty power supply of small size and small cost, direct from standard lighting circuits, will be the biggest sensation in the radio field this year. Orders will follow that only Dubilier dealers can fill. Get in touch with us at once, and be the first in your territory to show the condensers built especially for this unit. All instructions on this circuit are enclosed with unit—no long discussions by salesmen.

Don't miss the Dubilier Booth at the R. M. A. Show!

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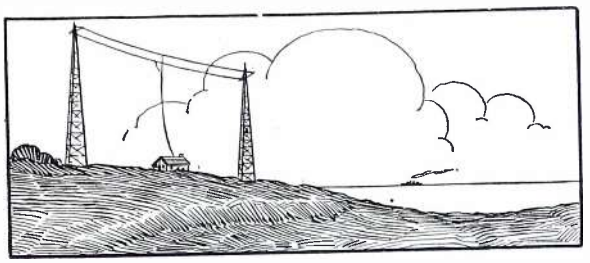


The Manufacture of High Quality Condensers

The history, the technique, the romance and progress of condenser manufacture and how it is accomplished

*By Samuel Siegel**

THE fixed condenser is one of the oldest species of the radio family and has always played an important part in transmitting and receiving equipment. Without condensers, radio would be a dead issue.

In the early days the manufacture of fixed condensers was an easy task, for requirements were not at all rigid. They were usually made of tin foil and waxed or varnished paper and were perfectly satisfactory for the work to which they were put.

It was common practice to make small capacity fixed condensers of the same material as the large ones and it was not until later years when broadcasting became an important factor in the daily lives of the public that any attention was paid to the electrical characteristics of all types of condensers.

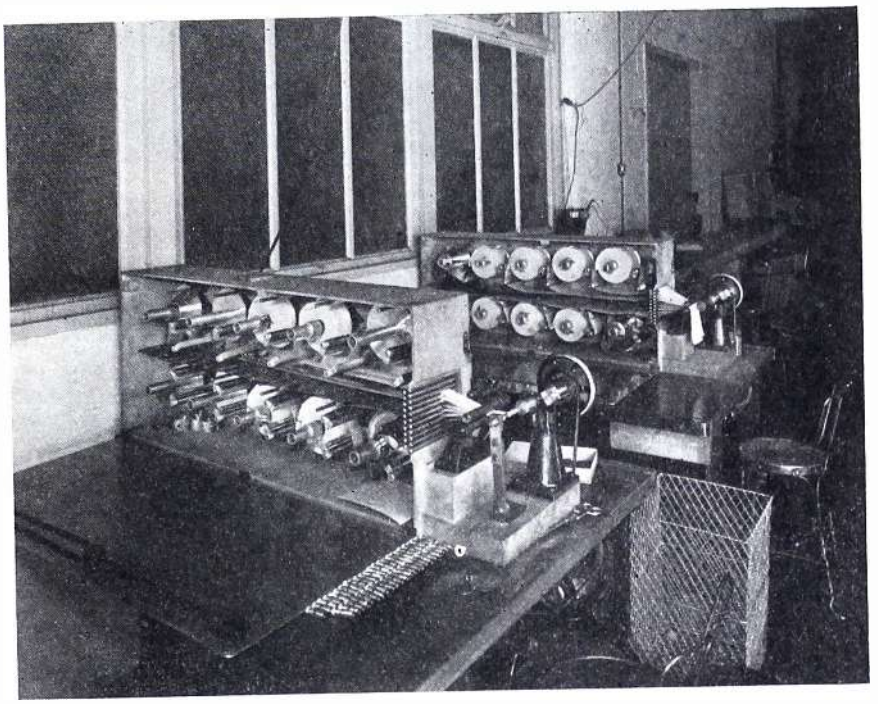
The public demand for better receiving sets compelled the radio engineers to study more closely the characteristics of all radio apparatus when subjected to high frequency currents. Many surprising things were discovered, which today are common knowledge throughout the fraternity.

The most important findings were the losses sustained in condensers and inductances principally when utilized in circuits handling radio frequency currents. Condensers suffered from dielectric losses, eddy current losses and losses through an extended electrostatic field. They had low resistance and high power factor.

Advancements

New materials were employed. Small capacity fixed condensers were made of mica and a better grade of tin foil. Large capacity condensers were made of a better grade of tin foil and linen paper, treated with special waxes, through processes requiring vacuum, pressure and heat.

There was no great demand placed on large capacity fixed condensers until the arrival of "B" eliminators and "A-B-C" power packs. Experience has taught us that a "just as good" condenser is far from being good enough.



Two of the condenser winding machines. The rolls of paper and tin foil can be seen inside the metal casings

Power packs and even low voltage "B" eliminators require condensers which will withstand very high voltages and which will continue to hold up over a long period of time. An old type large capacity fixed condenser designed for low voltage work, such as in telephone equipment, will normally withstand a high voltage breakdown test but if it is subjected to high voltages for any great length of time it will most assuredly break down under the strain.

The real test for a condenser is not that it will withstand a momentary high voltage but that it will stand up continuously under high voltages. Considering the trouble people have had with condensers "flashing" in their "B" eliminators for the past few years or so it is hardly necessary to make the above statement. It is obvious, even to the layman.

New Methods of Manufacture

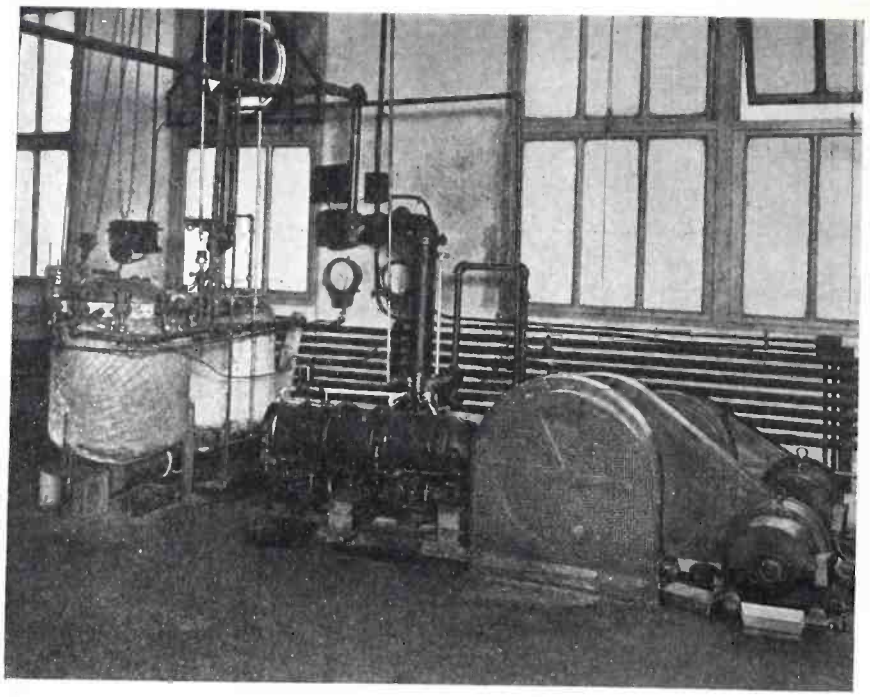
So, new materials and new methods have had to go into the manufacture of large capacity fixed condensers and those manufacturers who have not already taken steps in this direction will soon have to.

The manufacture of condensers which will stand up under all conditions is not an easy one. It has been a hard climb, and required continuous research to determine the proper processes and the best materials. What we have accomplished may be of interest.

Fallacy of Classification

Let us first begin by explaining the fallacy of their classification as "by-pass" and "filter" condensers. As

* *Chief Engineer, Aerovox Wireless Corp.*



Two of the condenser impregnating tanks and, to the right, the immense electric driven vacuum pumps

paper condensers were first used in radio sets connected across the "B" battery to reduce the effective resistance of the battery circuit, and to "by-pass" any radio frequency current in that portion of the circuit, they were named "by-pass condensers." However, as this is only one of the ways paper condensers can be used, the name is misleading. The term "filter condenser" is also a misnomer. It is usually applied to a high voltage condenser of the non-inductive type because of its universal use in filter circuits. The voltage across the condenser is the determining factor as to whether the unit can be used at that point. We assume, of course, that the correct electrical capacity has been selected.

Working Voltage and Flash Test

Flash test and working voltage are much discussed questions. Although it is admitted that the working voltage of a condenser is the governing factor in the life of the unit, some people buy condensers by flash test rating.

In our particular case we have built into the units a factor of safety which will insure long life. As a matter of protection, the individual sections are tested in manufacture at four times the rated voltage which is far in excess of the Underwriter's requirements. This test voltage is cut down in the various stages of manufacture, and the final product is tested at three times the rated working voltage. This series of tests will show up any defects in manufacture or material. They are made for working voltages of 200, 300, 400, 600 and 1,000 volts D.C. As the voltage requirement increases, the number of layers of insulation are increased rather than maintaining the same number of layers, and increasing the thickness of each layer.

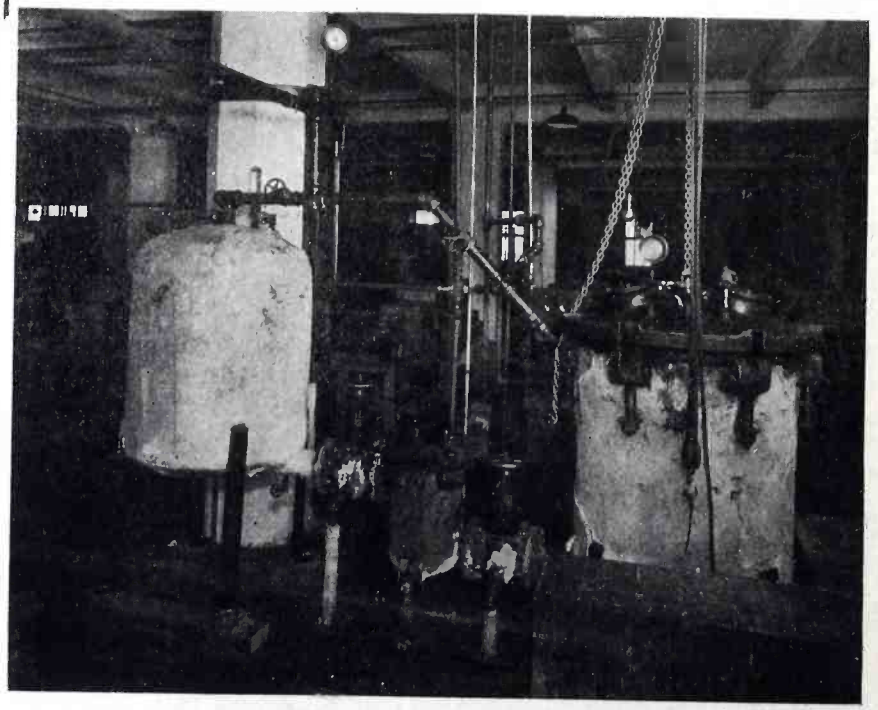
Inductive Type of Winding

There are two ways in which paper condensers can be wound—inductively and non-inductively. In the first type of winding, the foil used is narrower than the paper, and contact is made with the foil plates by a brass or copper strip inserted into the winding, as shown in Fig. 1. The strips make contact at only one point with the foil plates, which in some capacities are 50 feet long. Burrs on the terminal strips are liable to injure the paper. In winding this type of condenser, layer upon layer of foil and paper are wound over the terminal, resulting in creases which also weaken the paper. Inductive type condensers heat up considerably more than the non-inductive type. This decreases the dielectric strength and increases the possibility of breakdown. In radio receiving circuits the inductive type should not be used because of the field set up around the condenser, and because it is not as efficient at radio frequencies as the non-inductive winding.

Non-Inductive Type of Winding

The non-inductive type of condenser is wound with foil, which is usually the same width as the paper. The winding is staggered so that a condenser plate is visible from each end, as shown in Fig. 2. The terminals are metal strips soldered to the foil extending across each end, to which flexible leads are soldered. The terminals thus make contact with every turn of the foil, and that is why the condenser is non-inductive. Furthermore, the resistance of each plate of the condenser is decreased to practically zero, which cuts down the losses and heat generated in the unit.

Because the non-inductive type of winding permits the construction of a section without creases, and by the elimination of terminal burrs the paper is not weakened in any way. This type of assembly uses more foil than the inductive method for the same amount of electrical capacity, but the long life of a condenser is far more important than the small ad-

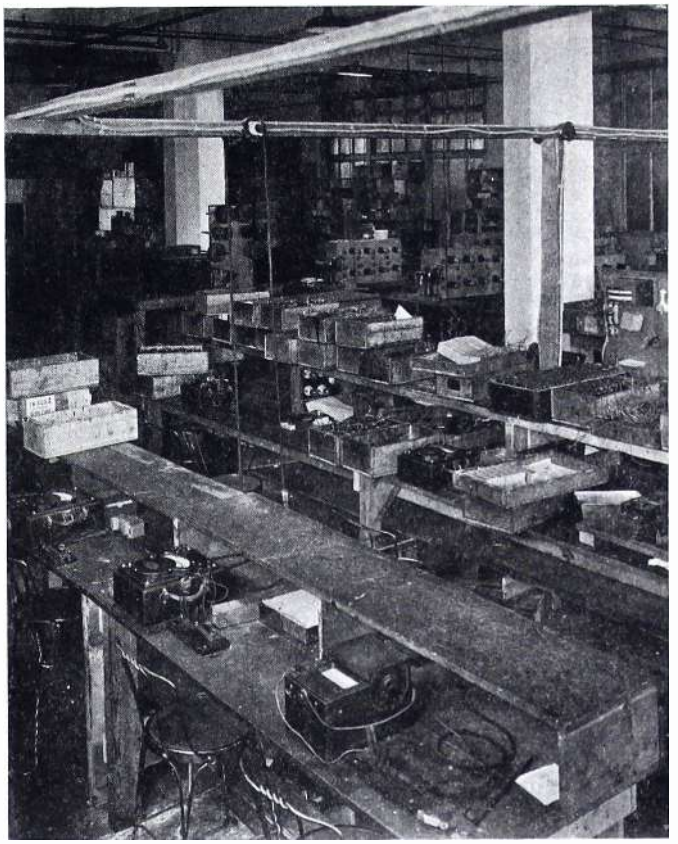


The left-hand tank holds the melted wax which is allowed to flow into the impregnating tank on the right after all moisture has been driven out of the condensers

ditional cost. We have always employed the non-inductive type of winding for those reasons.

The Dielectric

Paper is used as a dielectric in the manufacture of high capacity condensers. The quality of paper used plays a very important part in the efficiency and life of the condenser. It is safe only to use 100% pure linen paper, the highest grade known to the art, and incidentally the most expensive. This paper is free from acid, alkali, or bleaching material of any kind. Condensers made of linen paper even with a small percentage of impurities, or wood pulp paper, which may test well when made, gradually lose their dielectric strength and finally break down because of the disintegration of the paper. A 100% pure linen paper will not deteriorate with age.



A section of the electrical testing department where condensers are given resistance, capacity and voltage breakdown tests. Note the winding machines in the background

The Plates

The conducting plates of paper condensers are made of either tin or aluminum foil. As tinfoil is much softer it will flatten out and conform to the surface of the paper better than aluminum foil. At the present time aluminum is one-third cheaper than tinfoil per unit area, but it does not permit the manufacture of the more desirable non-inductive condensers because terminals cannot be soldered to aluminum. The best type of tin foil can be employed consists of 86% pure tin and 14% lead, which proportion is used as it permits the rolling of a very thin foil, soft, and of great tensile strength.

Details of Manufacture

The condensers first take form in the winding machines one of which is

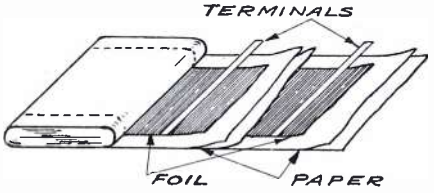


Fig. 1. The inductive type of condenser winding

shown in an accompanying illustration. There are spindles inside the case which hold the rolls of tin foil and paper. The number of rolls of paper in the machine is dependent upon the voltage rating the condenser is to have when completed. There are two layers of paper between each plate of a low voltage condenser. The higher voltage condensers use more layers and thicker paper.

The winding machines are practically automatic in operation and are merely governed by an operator who loads the raw material and removes the winding. When the correct number of turns have been wound for the capacity desired the paper and foil are cut and the wound condenser taken off the spindle on the front of the machine. The rolls are then placed in low pressure presses which hold a great number of the units at one time and the filled presses placed in steam jacketed vacuum dryers where all moisture is removed. This is accomplished by using special vacuum pumps connected with the dryers and vacuum tanks shown in the accompanying illustrations.

When the moisture is removed from the condensers in the dryer, they are placed in the impregnating tank and are again subjected to heat and vacuum. When all moisture is removed the heated wax is allowed to flow into the tank and put thru a process which gives complete impregnation, thus giving the condensers high insulation resistance and long life. Automatic recording instruments chart every step in the impregnating process, guaranteeing the uniformity of the finished product.

Paper condensers are impregnated with waxes which vary from ordinary paraffin to many special compounds developed for this purpose. The melting point of the impregnating material is very important because condensers are often called upon to operate at higher than normal temperatures. Internal heat, which is generated to a larger degree in the inductive condenser, will rapidly lower the resistance and break it down. The special wax used has a melting point of 195 degrees Fahrenheit, as compared with 125 degrees to 135 degrees Fahrenheit, which is the melting point of the average paraffin used for impregnation. The dielectric constant of wax is also an important factor. The compound used has a high dielectric constant, is non-combustible and does not absorb moisture as will paraffin. The cost is approximately six times that of paraffin.

Extra Pitch Coating

Ordinarily, paper condensers, after being impregnated are mounted in metal containers and sealed with wax as a protection against moisture absorption and mechanical injury. If the condenser is not properly sealed, it may absorb moisture and its efficiency will be seriously impaired. To guard against this we have made it a practice to coat the condensers with a wax pitch compound of high melting point almost immediately after impregnation. However, after the condensers come out of the impregnation tank the leads are soldered on and then they are dipped into the protecting compound.

After these processes the condensers are put through a series of tests for breakdown voltage, capacity rating and resistance. A section of the testing department is shown in one of the accompanying illustrations.

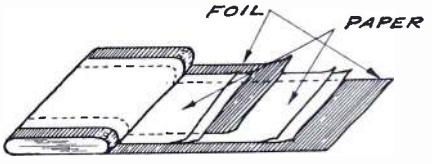


Fig. 2. The non-inductive type of condenser winding

POWER BY RADIO

Advancements in short wave transmission opens up new field for investigation.

POWER by radio was the dream of Nikola Tesla. Very few other men have dared hope for such a thing as the transmission of useful energy through thin air.

Nikola Tesla went so far as to build an immense mushroom shaped tower in Long Island, overlooking the waters of the Sound. It appealed more to the imagination than to pure reason but the hopes of many, and the dreams of Tesla, rested in that tower, which was to light houses, run machinery and do many other marvelous things, from a distance.

The tower has long vanished and it appeared that all thought of the transmission of power by radio ceased at that time.

Television was for a long time but a mere dream but the solution of the problem of transmitting moving images by wire or radio did not appear a hopeless task. There were some tangible things to work with—but power by radio—it smacks too much of black magic. The engineering minds have not had the tools with which to work.

Short Waves to the Fore

Is the time now ripe for power by radio? Does the answer to the problem rest in short waves? At any rate, Nikola Tesla predicted the coming of such a thing and now Dr. Phillips Thomas, Research Engineer of the Westinghouse Electric and Manufacturing Company has actually demonstrated the generation of some properties of short radio waves for power purposes.

The demonstration took place at the last meeting of the New York Electrical Society, on April 20th, in the Engineering Building, New York City, before a large audience.

Dr. Thomas illustrated his talk by experiments which, though rather spectacular, were not based on new theories or supported by special apparatus.

The early part of Dr. Thomas' talk dealt with the fundamentals of radio and he made it very clear from the beginning that his experiments as well as his speculations were based on fundamentals and not on any radically new principles.

Short Wave Oscillator Used

In demonstrating the properties of short waves Dr. Thomas employed a high frequency oscillator working at a wave of 2½ meters. The tube developed about 35 watts and the plate potential employed was 2,000 volts.

Most of the experiments were carried out with a Lecher wire from which small lights and neon tubes were made to function. By the use of a flashlight bulb, employed as a current indicator and a neon tube as a voltage indicator Dr. Thomas showed the audience the nodes and loops of the standing wave along the Lecher wire. The small flashlight bulb would light each time a point of maximum current was reached and the neon tube would glow at all points of maximum voltage.

The rest of his experiments dealt with receptor systems consisting of collectors one wavelength long, in the form of straight copper rods to which were connected 5 watt electric lamps. The bulbs were made to light to full brilliancy when brought in proximity to the oscillator. Truly, this was a perfect demonstration of the transmission of power by radio. There were no connections between the copper rods and the oscillator yet the small 5 watt bulbs burned brightly.

Better Tubes Required

We have witnessed experiments of this sort many times before but not under quite the same conditions. Nor have we watched small bulbs glow, backed by the assurance of Dr. Thomas that larger bulbs will glow in the future. In one night we witness the transmission of heat, light and power in one stroke. And we are told that when better transmitting tubes are developed, for providing a high output at much shorter wavelengths, when a bit more is learned about these very high frequencies, there is all the chance in the world of also having a true "death ray" machine.

Dr. Thomas predicted that still shorter waves will be produced, capable of being concentrated into narrow and powerful beams. "We may visualize," he said, "a parallel beam of radiation ten centimeters or four inches across, along which is being sent ten kilowatts of energy. What sort of effects shall we find? Will this be a means of delivering energy for heat and light to individual houses? Tesla had a similar idea many years ago. Later improvements in the radio art make it interesting to consider such a possibility once more. We may imagine each house furnished with a half-wave oscillator in line with a parallel beam from a sending station, so that heat and light may be obtained very much as at present, by simply turning a switch, but without the costly transmission wire equipment now required.

"Again, suppose it should happen that this four-inch beam of highly-concentrated energy should render conductive the air through which it passes. Then ordinary electric power could be sent along the beam as though the beam were a transmission line. The beam could be directed to any desired spot, with dire results to the target. It would constitute the so-called 'heat ray' employed with such deadly effect by the Martians in H. G. Wells' well-known story of their descent upon the earth."

DR. COHEN AND DR. HUND DEVISE NEW TUNING SYSTEM

INDUCTANCE IS VARIED BY A MOVEABLE METAL CYLINDER

Dr. Louis Cohen and Dr. August Hund have developed a new system of tuning which appears to have numerous advantages over the present system employed.

The device, as a unit, consists of a small cylindrical inductance, shunted by a low capacity fixed condenser, over which is placed a moveable copper cylinder.

All tuning is accomplished by moving the cylinder back and forth along the coil. The variation in inductance gained in this manner is wide enough to do away with the necessity of employing a variable condenser or tapped coil.

The most remarkable feature of the new arrangement is that the very short waves, below 200 meters, can be tuned to, without the receiver, in which the tuning units are incorporated, falling into a state of oscillation. No neutralizing or stabilizing devices are required and yet the short wave stations can be tuned in with practically the same ease as the stations operating within the usual broadcast frequency band.

No detailed information on the new system is available at the present time but judging from the present report it looks as though a radical change in tuning systems may be expected.

Development of Magnetic Shielding in Radio Receivers[1]

*Some very interesting facts concerning the effects of shielding under various conditions.—By Robert F. Gowen**

THE present "chaos of the air" has been responsible for a new line of development in the shielding of radio receivers. Only a year or so ago the broadcast listener could "fish" to his heart's content with the simplest of radio sets and bring in distant stations all over the country without interference. Now the best set that one can buy may have difficulty in the reception of stations over a thousand miles away. The tremendous increase in the number of broadcast stations during the past year demands even better selectivity than can be obtained with present day equipment.

The average set in New York City with over sixty stations operating within a radius of ten to fifteen miles has practically no chance of picking up anything outside of New York, even though the present day receivers are designed for greatly increased sensitivity. There are very few sets on the market at present that are not sensitive enough to receive the California stations but which "gets" the "coast" nowadays? The answer is.—the really selective set and not the highly sensitive set.

Sensitivity Affects Selectivity

As a rule the higher the sensitivity of a set, the worse its selectivity. Adding stages of radio frequency amplification to provide increased sensitivity broadens out the tuning so that, when the signals are delivered to the detector tube, there are usually mixed with them signals from other stations operating on nearly the same frequency. This loss in selectivity results from the fact that the radio frequency stages added are usually damped or neutralized in order to prevent oscillation due to inter-stage feed back of energy from the coupling between the inductances used. Many schemes are used to prevent this feed back without excessive damping. Setting the inductances at what is known as the "sacred angle" to prevent the fields of the coils interlocking is frequently used as well as the addition of a resistance in the grid circuits of a potentiometer control of the grid bias known as a "losser" method.

These methods, when carefully applied to a receiver comprising two stages of radio frequency amplification, produce fairly satisfactory results on either the upper or lower groups of wave-lengths in the broadcast band but not on both groups as it is impossible in the usual TRF receiver to neutralize so that constant or equal efficiency is obtained throughout the whole broadcast spectrum. A new method of attack has just been presented in a circuit in which the inventors use capacitive as well as inductive coupling between the radio frequency units. It is claimed that this method provides equal efficiency over the complete wave-length band as the one type of coupling balances the other to give a definite sensitivity without oscillation on all wave-lengths. When more than two stages of radio frequency are employed, the problem becomes much more difficult and it becomes necessary to use magnetic shielding to prevent coupling between the inductances of the set and to prevent the loss of selectivity as the sensitivity is increased.

Perfect Shielding Impossible

According to theory, perfect shielding to magnetic fields is impossible, yet proper use of metal shields of certain thickness provides excellent magnetic shielding. Interstage shielding is effective if properly done. On the other hand, if it is not employed strictly in accordance with the best engineering practice, it usually does more harm than good. As a rule the shielding is not complete enough, due, no doubt, to manufacturing difficulties. There are, however, several carefully engineered sets on the market in which the shielding produces very fine results. In some sets, metals of too high resistance have been used as the shielding material or the shielding has been too thin, so that its effect for efficiency is practically nil. On the other hand, the manufacturer gains, perhaps, by the advertising of a shielded receiver.

Although the conductivity of the metal is most important, its value is lost if the shields are not designed to properly and completely enclose the parts affected. The writer has designed and built super-heterodyne receivers, for instance, of selectivity such that, if the cover of the completely shielded cabinet is opened only the fraction of an inch, enough energy from high-powered long wave stations one hundred miles away is picked up by the intermediate frequency transformers to produce an interfering signal in the loud speaker. An experiment is cited where a set containing three stages of radio frequency amplification and tuned to a powerful station fifty miles away was enclosed in a copper case inside of an iron case. The cases enclosed the head-set and batteries as well so that there was no chance for pick-up from the leads. When a one-inch hole was made through both cases, signals were received with great audibility and when the lid of the compound case was raised one-sixteenth of an inch all shielding effect disappeared entirely.

An experiment carried out by the author some years ago showed the effect of shielding in no uncertain terms. A sensitive super-heterodyne receiver was taken to the cellar of a bank and placed outside the vault in which location good audible signals were received. The set was then carried slowly into the vault. At a point just sixteen inches inside the threshold of the door, the signals ceased abruptly showing that the set was surrounded by a perfect shield which the field of the transmitting station could not penetrate.

Inter-Stage Shielding Insufficient

These experiments and others show that interstage shielding is not enough and that the day is not far distant when all receivers will be enclosed in completely shielded copper cases. Otherwise it will not be possible, with broadcast stations working on super-power, for a set in a congested transmitting area to be affected by the desired station alone. At the present time, if it were not for the absorption due to the steel buildings in New York City, the field strength of WJZ, WEAF and others would be sufficient to blot out the effect of weaker local stations if allowed to penetrate the inductances of a set. As the power of broadcast stations is increased the more susceptible to "pick-up" will be the battery leads, etc. In fact, it is perfectly possible today to get loud speaker reproduction from WEAF, thirty miles away, with a good sensitive four tube receiver without an aerial. This is an indication that battery leads must be shielded eventually also.

Engineers and manufacturers are now beginning to see that the trend toward the ideal set of the future is to reverse the present practice of building super-sensitive receivers of a great number of tubes as these receivers require an excessive amount of power supply and maintenance with elaborate shielding to prevent inter-stage oscillation in the radio frequency stages. The new line of development is to build a simpler receiver embodying not more than one radio frequency stage of highest efficiency and selectivity in a thoroughly shielded copper cabinet. It is safe to assume that eventually the shielded cabinet will include the power unit (or batteries until power units are fully developed) so that there can be no chance of "pick-up" from cables employed for connection.

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[1] *Prepared for the Copper & Brass Research Association.*

**Member of the Institute of Radio Engineers.*

A Raid On Radio Advertising

The author takes a look into Radio Advertising and finds many interesting things

*By S. M. Masse**

As I start to write the bright remarks which I hope will flow surreptitiously from my Waterman—the time being a few days before the *Torch* goes to press and the place my fireside bench at home—the radio to my left is announcing that the next number will be: "Where do the Mosquitoes go in the Wintertime?"

I'm glad someone else has something to worry about.

My assignment was: "Whither is Radio Advertising Drifting?" or something to that effect. But not knowing for a certainty whether this subject is floating or sinking, I decided to take liberties with the publishers and make a tyrant's raid on radio advertising.

When one is asked to air his views on radio advertising it is like answering the question sometimes put to advertising men—"How much do a thousand two-color folders cost?" The subject is a heavy one, many are the ramifications in radio advertising, much is to be said and the less said perhaps the wiser.

Opinions

If it were possible to state something about radio advertising on which no one would agree, the writer would have a gold mine. To wit:

Whereas, twelve good men and true will claim radio is still in its infancy, an even dozen equally smart fellows will say it is a fully matured, established industry.

Whereas, some define the radio business as being in a chaotic condition, just as many folks will tell you it is sailing along quite smoothly, thank you.

Whereas, the claim is made by a certain publishers' association that 1,900,000 of the 2,000,000 sets produced in 1925 were purchased or built by readers of radio magazines, nevertheless the newspapers and general periodicals of the country will dispute this statment very emphatically, and if circulation counts for anything, the latter's argument would hold considerable weight. So, take your choice.

Whereas, others besides radio engineers will tell you it is what goes inside the set and not its looks that sells the goods, there is, however, a distinct role for the radio to fill as a piece of furniture in the living room and some set manufacturers are getting away with it all too powerfully.

Whereas, the seven wise men might recommend certain forms of advertising for radio sets, the chances are that this might be *faux pas* for an advertising campaign on tubes, batteries, chargers and such accessories. The right prescription for radio-accessory advertising might be poisonous publicity for radio parts—transformers, couplers, rheostats, etc.

We could go on and on with the "whereas's" but by this time one must be confirmed in the belief that there isn't a ghost of a chance to establish a standard of understanding on many things anent radio advertising.

So long as there is more than one side to every story, let us continue.

The trouble with radio advertising at large is the tendency to place too much emphasis on the set itself and continually hammer away on the shelf-worn claims of selectivity, distance, power, etc.

READERS' FORUM

Beginning with the June issue of Radio Engineering a page is to be given over each month to readers' comments. This page is to be called the Readers' Forum and will be utilized for no other purpose than that of a medium through which you can express your views.

We have already received many very interesting communications from Manufacturers, Jobbers, Dealers and Professional Set Builders for the Forum which seems to bear out our belief that a section of this nature was desired by the readers of Radio Engineering.

We hope that the Readers' Forum will stimulate your interest in Radio Engineering and that you will eventually make use of it. Please consider it as YOUR page —Editor.

A radio is often compared to an automobile which performs certain definite functions at the will of the owner. But remember, the radio set is absolutely useless except as the broadcasting stations give out material to work with. Prospects are not interested in buying receiving sets; they are interested in buying the boardcasters' programs. Specific advantages of listening to good programs, readily tuned in, easily tuned out when necessary—that's the real story.

There is more need, today, of intensive advertising in local centers. Conditions are so vastly different in one city from another or in a small town from a metropolitan city that the same copy applying in one case may be ineffective in the other.

It would mean more to me, for example, to read an advertisement that stated: "Be able to tune in between WTAM and WJAY," while in the city of Chicago with its thirty-seven stations on the air, there is a problem which is peculiar unto itself.

Lack of Organization

The matter of price maintenance is another thing which has not been encouraged to any extent in the radio industry. This condition is undoubtedly caused by a lack of organization. This lack of organization has been shown by manufacturers allowing petty selfish interests to act as a barrier to cooperative policies, by the dealers themselves who are equally guilty of pulling every which way except together, and even by the reluctance of broadcasters to organize.

Radio advertising has been greatly exaggerated by claims made for this or that set or device. This leads to a tendency on the part of dealers to disparage the products of their competitors. One concern starts to cut the price on a standard brand and the other fellow goes him one better. The result is that the prospective customer begins to decide that he doesn't want a radio after all, or he will wait until prices strike bottom.

One seldom hears an automobile salesman say anything uncomplimentary about other cars on the market. Nor an insurance man. Nor a vacuum cleaner salesman. They usually say, "There are a lot of good cars" or "A great many responsible insurance companies" or "Some mighty good vacuum cleaners on the market, but we think we can show you a feature or two which you will like about our proposition." Here is a lesson it would be well for radio men to learn.

All Year Advertising

During the last year the radio industry awoke to a situation of which they should have taken cognizance long ago. In former years, when it came around to March or April every radio advertiser started to cut down on his advertising—in fact, let down entirely in the majority of cases—then waited until Fall to open up with a big splash. Now they have begun to realize that radio must be kept before the public the year around and that the trade especially must be sold during the summer months just as furnaces and heating appliances are sold at that season, the same as bathing suits are sold during the winter months to the trade in order that when the season opens up the merchant has a definitely prescribed idea of what he is going to sell and how he is to get rid of this merchandise.

If an advertiser cannot afford to continue his general advertising throughout the entire year it is to

*The S. M. Masse Co., Cleveland. Courtesy of "The Torch."

his advantage to start using his appropriation early; that is, forceful, generous advertising to the trade during the summer months and concentrating on the consumer advertising early in the Fall. When the active selling season is in force, newspaper advertising where one can talk in terms of local conditions should be productive of the best returns. General magazines and periodicals should carry the weight of the advertiser's prestige and the general features of the product.

It must be borne in mind that the make-up of the radio buying public has changed materially during the last few years. The so-called radio bugs are rapidly vanishing and with them will vanish some of the radio magazines, although both bug and radio paper still serve a very useful purpose. For the sale of radio parts and some of the more technical products the radio magazine is the one best bet.

What will become of the radio battery and the battery charger? There is no question but that the trend is toward battery eliminators but with some 6,000,000 sets already in the homes of this country it will take considerable time before they will be converted to complete electric-radio reception.

Having referred to the battery eliminator, reminds us that the radio industry has been prone to use terms descriptive of a product which are often weak in expressing the utility of that product. The battery eliminator is just such an example for this device is considerably more than an eliminator of batteries yet the name itself obviously leads one to think of it as simply a substitute for the batteries in the set. As a matter of fact, the so-called battery eliminator gives considerable more power, better tone quality and flexibility of operation, provided, of course, it is a high class product, many of which are on the market.

Woman's Viewpoint

The woman's viewpoint is another important consideration in radio advertising which has apparently been neglected. More and more will women become the dominating factor in the selection of radio sets. In the first place, it is a part of her household equipment. It is she who will be entertained by it during the daytime as well as in the evening. And it takes a woman's discriminating taste to know good tone reception from mediocre quality.

Notwithstanding the fact that the buyer is supposed to be persuaded chiefly by what goes in the set, the beauty and attractiveness of the cabinet is not to be denied as a selling influence. In the writer's opinion there is an exceptional opportunity today for cabinet manufacturers to cash in on a ready-made market. With all the sets in use which expose batteries or uncomely wires to the naked eye the good housewife would never discourage friend husband from purchasing a cabinet in which the radio can be concealed completely. But how infrequently do we read of radio cabinets on sale, and if we do come across such advertisements they very seldom explain their dimensions and what can be accommodated in the way of batteries, battery charger, or complete set if necessary. It is a fact that many two-tube sets, for example, give as good tone quality and compare favorably in "distance" with the larger five or six-tube sets. Housed within an attractive cabinet even this unpretentious "two-tuber" would gain as much favor in the home as some of the more elaborate sets exposing their nude construction.

Service

Another very important influence in radio advertising that has been somewhat neglected is *service*. After buying a set Mr. Prospect doesn't want to feel that he is faced with the serious problem of keeping it in condition without knowing much about radio. When one buys a car he can drive it to the place of service but with radio it is vastly different. It is the manufacturer's duty to encourage the service proposition among its dealers and in its advertising. There is a story of an automotive dealer in Detroit who increased his radio business manyfold by offering a service insurance policy with every set which, in addition to giving adequate service after the sale, protected him from the customer who expects unlimited free attention. Attached to this service insurance policy were six coupons each of which were accepted in full payment of one-half hour's service in accordance with the policy terms. In this way the prospect preserves the coupons so as to use them only when necessary, instead of asking for more service than is absolutely necessary.

A manufacturer of battery eliminators has recently made considerable headway in increasing sales by offering to install, free of charge, each eliminator that was purchased. The reaction was tremendously gratifying, proving that the general public looks somewhat askance at the simplest technique of radio problems and will buy if they do not have to depend on their own ability to install a device properly.

It goes without saying that radio has taken its place among the principal industries of the world as an important business enterprise, and radio advertising will help to develop the industry as much as science itself. Really, the advertising has more latitude and opportunities ahead of it than science whose limitations at this stage are manifest in the radio field.

Obtaining Perfect Vacuum with High Frequency Furnace

High temperatures used to "boil" vacuum tubes

ONE of the most interesting applications of the new high frequency furnace as developed in the Research Laboratory of the General Electric Co. is in the manufacture of radio tubes. It is easy enough to say that, to obtain the necessary high vacuum within the tube, it is simply necessary to remove all instead of most of the gas by means of efficient vacuum pumps, but in actual operation the story is quite different. A tube might appear to be so completely exhausted that no trace of gas is apparent, and yet as soon as the filament is lighted there might be plenty of evidence that the tube contains gas—the presence of gas being indicated by a bluish haze within the tube. The reason is that metals and glass absorb large amounts of gas and water vapor, and added quantities stick to the surfaces. The bubbles are driven out by the heat from the tube filament. They must be expelled from both the glass and metal parts of the tube, and it is not possible to subject the glass to anywhere near as high a temperature as the metal parts require. The high frequency furnace solves the problem.

Boiling Out Gas from Metal Parts

While the tube is being exhausted it is kept at as high a temperature as the glass will withstand without softening and collapsing, but this temperature is not sufficient to boil the gas and moisture from the metal parts. Just before the radio tube is sealed from the vacuum pump it is placed for a moment within a high frequency coil. The metal parts immediately become red hot and the bubbles of gas and vapor are boiled out. The tube is then sealed from the pump, with the knowledge that later heating of the tube by the filament will not cause further release of bubbles.

In this age of machinery, it almost necessarily follows that the high frequency induction heating of the tubes is automatic. Just before the tube is sealed from the pump a high frequency coil on the end of a mechanical arm automatically descends over the tube, and for a few moments the tube is subjected to the field of the coil. The metal parts glow, the gas bubbles escape and are removed by the pump, the coil is automatically removed, and the tube is ready for the sealing process.

The high frequency furnace used in vacuum tube work would hardly be recognized as a furnace. It is simply a coil of copper conductor attached to a wooden handle, drawing its power from a nearby metal cage on wheels. Within the cage is the equipment for changing the ordinary 60-cycle power to oscillatory current of the desired frequency. It includes a step-up transformer, a couple of power oscillator tubes, and a bank of high voltage mica condensers. Frequencies ranging from 90,000 to 1,000,000 cycles per second have been used, with from 300,000 to 500,000 cycles as average.

High frequency and high vacuum—millions of cycles and millionths of an atmosphere—are two requisites of vacuum tubes which research has conquered.

Synthetic Plastics

The manufacture and uses of phenolic condensation materials

THE part that phenolic condensation products have played in radio manufacture is a large one, and Durez therefore, needs but little introduction to the radio engineer and designer.

It is doubtful if many of these men however, have anything more than the very broadest conception of what this material is, and how it is made.

About sixty years ago, the organic chemists of the old world, discovered that a reaction between certain chemicals would produce a material resembling natural resins obtained from the sap of certain trees, and later it was discovered that resin produced from phenol and certain aldehydes, by special treatment, could be made so that they would not melt and were insoluble and excellent insulators to electric current.

The advent of synthetic plastics, thus dates back to the early work of the organic chemists of the old world, and while progress for a number of years was comparatively slow in the synthetic or phenolic condensation field, the rapid development of science has made the early experiments a commercial success and materially assisted to create Durez, the durable economical material of universal application.

Plastic Molding an Old Art

Plastic molding dates from the very beginning of civilization and has advanced through the centuries from clay to porcelain, bronze, iron, glass, natural resins, rubber, bituminous materials and finally synthetic resins.

The discovery of Durez created an entirely new plastic. Its introduction to the public assured its commercial value which was instantly recognized because of the many advantages of the new material, both through the better appearance of the product or parts and the often lessened manufacturing costs on parts molded of it. Its adoption has been almost universal.

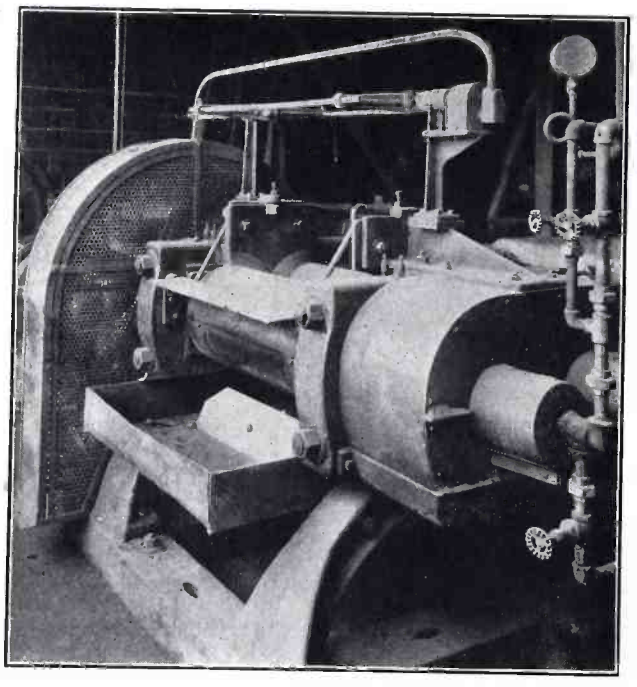
Processes of Manufacture

Durable resin, which is the base of Durez, is made in great, steam-heated vacuum kettles, which with the auxiliary condensers, vacuum pumps, gauges, etc., comprise the equipment necessary for the first stage of the manufacturing process. Details of the process mean little to the layman, the resin having been formed and dehydrated in the condensing kettles, then is cast into slabs which form the raw material for making of the compounds.

The next step in the process is the compounding of the molding powder in which the coloring matter and finely dried wood flour or other filler are incorporated with the pulverized resin, and by mixing and grinding the ingredients together in huge ball mills, the material is very finely ground and thoroughly mixed.

The second operation used to more thoroughly incorporate the wood flour, colors and fillers, are the masticating rolls. These are similar to those used in the compounding of rubber and the soft sheets of fused resin and filler are passed between the rolls until it is perfectly smooth and uniform. The rolls are heated and maintained at proper temperature throughout the process, although not at sufficient heat to polymerize the resin.

The product at the completion of this process is still fusible. The sheets which harden after they cool are then broken up and pulverized; the finished powder resulting, is then screened and ready for shipment.



Huge rolls are used to insure the thorough incorporation of resin and filler in making molding powder.

Various Applications

While the greatest demand has been for black and brown, there is an increased demand as the applications widen, for colors and color combinations, and we find in the radio field, many items made of red, walnut, mahogany and other colors, though the larger demand has been under these classifications.

The greatest consumption of synthetic plastics has been absorbed by the electrical, radio and automobile industries, although it is used in no end of other fields, and thousands of applications, as new uses are being found daily for synthetic plastics.

The following are radio parts which are now almost universally being made of synthetic plastic materials: dials, some panels, grid leak holders, tube sockets, tube bases, terminal bars, transformer parts, loud speakers, ear phones, terminal knobs, dial mountings, jacks (insulating separators), sub-panels, and rheostats.

Audio Frequency Regeneration

The effect of A. F. regeneration on the frequency response curves of amplifier systems and how it can be employed to advantage

*By E. E. Hiler**

This is the second of a series of articles by Mr. Hiler on the mathematics and practical application of his new tuned double impedance amplifier system.

This article is of particular interest as it covers a full explanation of audio frequency regeneration and its first practical adaption to an amplifier system. Mr. Hiler has managed to harness a regenerative force, heretofore undesirable, and use it to full advantage.—THE EDITOR.

IN my first article, "The Theory and Application of Tuned Audio Frequency Amplification" appearing in the April issue of RADIO ENGINEERING, I pointed out the fact that audio frequency regeneration had a marked effect on the frequency response curves of A. F. amplifiers and particularly those of the transformer coupled type. It was also mentioned that audio frequency regeneration could not be employed to advantage in a transformer coupled amplifier because the resonance peaks of most transformers occur between 3,000 and 10,000 cycles.

However, audio frequency regeneration can play a very important part in the tuned double impedance amplifier system, and be used to great advantage, because the resonance peaks are at low frequencies. Furthermore, A. F. regeneration, if properly controlled, will tend to govern, to an extent, the phase angles of the grid and plate coils, allowing the use of standard double impedance units of very low phase angle, whereas, in any other case, high phase angle coils using special iron cores, such as Permalloy would be necessary to obtain equal results.

While the idea of audio frequency regeneration dates back to the time when the regenerative circuit for detectors first came out, it has never been practical to make use of the principle. Moreover, it has been the aim of Engineers to design audio amplifiers so as to avoid regeneration as much as possible. The fact that no precautions against feedback have been taken in most audio circuits of radio sets accounts for the fact that the overall characteristic curve of the amplifier looks very different from the curves of the individual transformers.

A. F. Regeneration in Transformer Amplifier

In Fig. 1 is shown two response curves of the overall amplification of a two-stage transformer coupled amplifier. Curve A was obtained from a straight circuit, as shown in Fig. 3. The broad hump in the curve is the result of audio frequency regeneration. Curve B was obtained from the same amplifier but in this case A. F. regeneration was guarded against by the insertion of A. F. chokes and by-pass condensers in the plate leads, in series with the primary windings of the transformers, and separate "C" batteries for each stage, as shown in Fig. 4. The same could be accomplished

Mr. E. E. Hiler, of the Irvington Varnish & Insulator Co. and the Hiler Audio Corporation.

by employing a separate "B" supply for each tube but this is rather an expensive procedure.

From this it is obvious that the effect of regeneration in audio circuits of this type is detrimental to quality.

It is interesting to investigate the reason for the change in the curve due to feedback and to see what changes have taken place in the values of effective resistance in the circuit to cause such "sharp tuning."

Primarily, the effective resistance of the secondary of a transformer is so high, due to hysteresis and eddy current losses, in the iron, that the resonant frequency peak is pretty well flattened out. However, when regeneration occurs, the effective resistance is lowered and the "tuning sharpened."

General Principles of Regeneration and Their Mathematical Significance

The reason that the effective resistance is lowered by feedback is plain from the formula for predicting conditions necessary for oscillation.

Suppose one volt a. c. is applied to the grid of a vacuum tube having a mu max. and circuit connections such that the amplification at the frequency used is 8. per stage. Then the voltage change in the plate circuit would be 8. Now if we take 1/10th of this and feed it back to the grid in phase with the voltage on the grid, we have remaining in the plate circuit *available for output purposes 7.2 volts.* The fraction thus fed back is .8 and amplified again into the output becomes 6.4. Of this a portion 6.4 x 1/10 or .64 is fed back to the input leaving 6.4—.64 or *5.76 available in the output.* The fraction .64 amplified again into the output becomes 5.12. Of this a portion 5.12 x .10 = .512 is fed back to the input, leaving 5.12—.512 =*4.608 available in the output.* This process is repeated

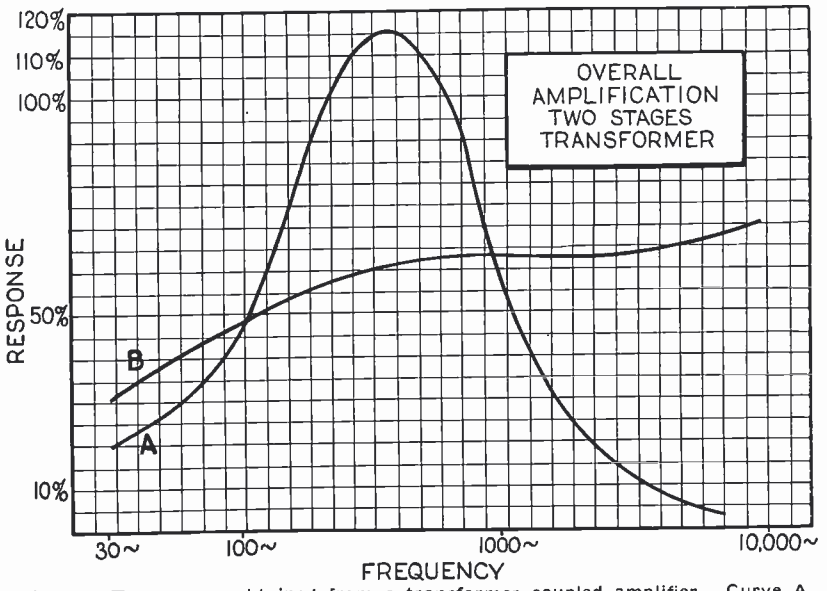


Fig. 1. Two curves obtained from a transformer coupled amplifier. Curve A shows the effect of audio frequency regeneration.

* *Hiler Audio Corporation.*

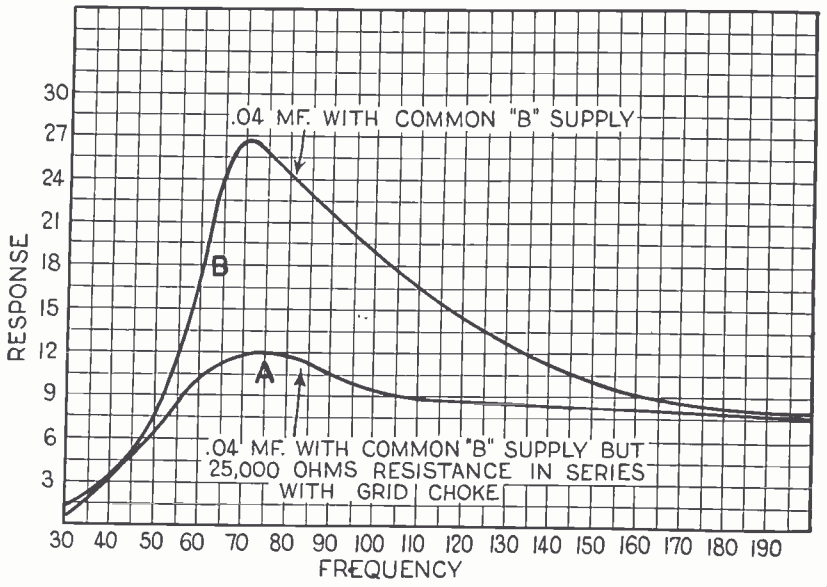


Fig. 2. Two frequency response curves obtained from a tuned double impedance amplifier. Curve B shows the effect of audio frequency regeneration.

again and again, each time the remaining portion *available in the output* becomes smaller and smaller until it is negligible. Thus, if we stopped calculating at this point and added up the *available voltage in the output* we would find we had a voltage of 17.568. If we continue on a little further with the series the following available voltages will be obtained; 3.6864, 2.9491, 2.3594, 1.8878, 1.5106, 1.2082, .9662, .7733, .6185, etc. The total of all these so far is now 33.5575. If carried out further and further the total voltage would approach 36 as a limit, since it can be shown* that the total voltage change in the plate circuit is determined by

$$A = \frac{a\ (1-s)}{1-as} \qquad (1)$$

Wherein A = final output voltage a = amplification factor, s = fraction of voltage and product of $a \times s$ is less than unity. Substituting in (1)

$$A = \frac{8\ (1-1/10)}{1-8/10} = \frac{8 \times .9}{.2} = 40 \times .9 = 36.$$

However, if as in above is greater than or equal to unity the sum of the available voltages increases without limit until checked by some cause determined by the nature of the circuit characteristic. The output becomes independent of the original input voltage, in other words the system produces self-sustaining oscillations. If an inductive circuit is used, it may happen that as becomes greater than unity for one or more frequencies, depending on the impedence and phase relations in the circuit, with the result that the system oscillates, at these frequencies.

Suppose, for example that we fed back ⅛, in the example with which we started, instead of 1/10. Let us see what would happen to the available voltages in the output. To begin with we have 8 volts in the plate circuit and we take ⅛ or 1 volt from this *leaving 7 volts* and feed the 1 volt back to the grid *in phase* with same and amplified again into the output it becomes 8 volts. Of this a portion 8 x ⅛ or 1 volt is fed back to the input, leaving 7, *available in the output*. The fraction is amplified into the plate circuit and so on. In this case the available voltage in the output does not increase or decrease as the process is carried on so that the sum of the series would be infinity if it were not for the limiting factors of the tube, such as filament emission, etc. A maximum voltage swing is thus reached and maintained, regardless of original input voltage.

This could have been predicted from formula (1) by substituting ⅛ for s. Then

$$A = \frac{8\ (1-⅛)}{1-8\times⅛} = \frac{7}{1-1} \text{ or } \frac{7}{0} \text{ (indeterminate).}$$

The question might well arise as to what would happen if we fed back the entire original voltage in the output. In this case we would have *no voltage available in the output* and the oscillations would serve no useful purpose. The solution of equation (1) in this case would give $\frac{0}{8} = 0$

In formula (1) it is apparent therefore that as the value of the denominator approaches zero as a limit regeneration occurs and that after that the plate voltage goes up without limit. This is similar to ohms law. $I = \frac{E}{R-r}$ (2) wherein I = current, E = voltages, R = positive resistance and r = negative resistance.

In (2) if the denominator of the fraction approaches zero as a limit as a result of changing the value of "r" the current increases until R — r = zero when oscillation occurs. The usual method of predicting conditions necessary for oscillation is to place all of the resistance components of the impedances in the circuit equal to zero as shown on page 492 of "Principles of Radio Communication," by J. H. Morecroft. H. J. Van Der Bijl also states that the effect sometimes called regeneration is due to the reduction of the resistance component of the input circuit, the same being reduced by the voltage fed to it from the output circuit. (See page 288 of his book entitled "Thermionic Vacuum Tube.") The well known effect of regeneration on the sharpness of tuning in a regenerative detector circuit is also proof of the fact that *regeneration lowers the resistance component of the grid impedance*. Since the grid impedance is expressed in general as Z=R+jx

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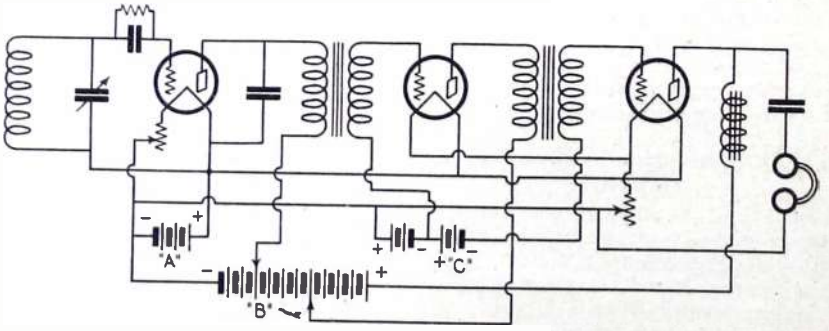


~ CIRCUIT FOR CURVE A IN FIG. 1 ~

Fig. 3. Standard circuit of a two stage transformer coupled amplifier. This is susceptable to A. F. regeneration.

* *Page 258—"Thermionic Vacuum Tube," H. J. Van Der Bijl.*

or $Z=\sqrt{R^2+X^2}$ and the ratio $\frac{X}{R}=$ tan. ϕ determines the phase angle of the impedance, if x is constant and R is decreased the phase angle increases, approaching 90 as a limit. By referring to a table of tangents of angles it is interesting to note that at 45° the ratio of $\frac{X}{R}=\frac{1}{1}$ or 1.0000 and that at 80° the value of $\frac{X}{R}$=5.67128 and that at 85° it is 11.4301 and at 89° 59′ it is 3437.75. It is apparent from this that a constant rate of decrease of resistance R does not produce a constant rise in phase angle in degrees.

While the feedback or fraction "s" of formula (1) is very small in an audio amplifier, this feedback being caused mostly by the use of a single "B" supply for the entire audio amplifier, the amplification of the entire amplifier is large and consequently for an amplification of 400 for an amplifier it is only necessary to feed back one four-hundredth of the output to the input and *in phase with same* in order to produce oscillations. Any feedback less than this value would not cause oscillations but would cause regeneration. However, since the voltage fed back in such manner is usually *not in phase* with the input voltage it is necessary to feed back more than one four-hundredth of the output voltage in order to produce the same effect as one four-hundredths of the output *in phase*. However, at certain frequencies the constants (inductance and capacity of the circuit tend to feed back voltage more nearly in phase with the input voltage and therefore such phenomena as motor boating with "B" eliminators occurs within certain frequency limits.

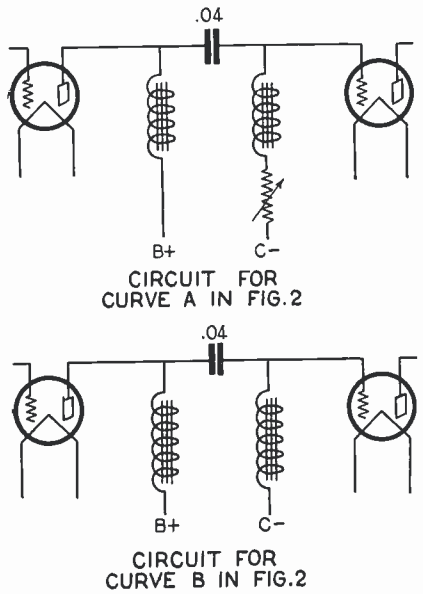


Fig. 6. A. F. regeneration can be controlled by inserting a variable resistance in the grid leg of the tube as shown in the first circuit.

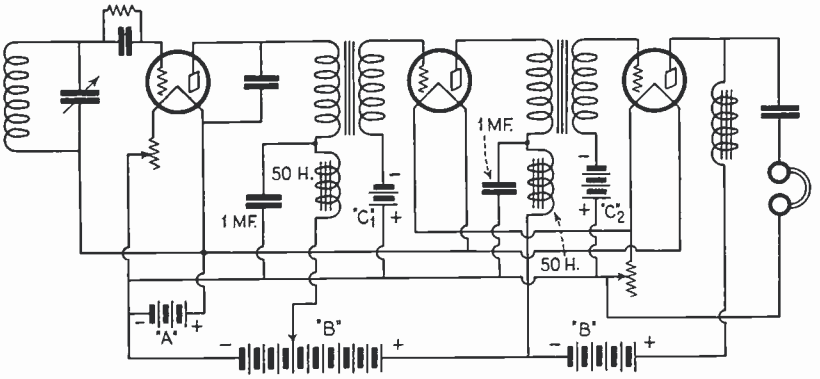


Fig. 4. The transformer coupled amplifier circuit revamped to eliminate A. F. regeneration. Curve B in Fig. 1 shows the result.

It might be of interest to observe at this time that better response can be obtained from a transformer coupled amplifier by inserting an impedance and coupling condenser in the plate circuit of each stage as shown in Fig. 5. This method prevents magnetic saturation of the core of the transformer. By adjusting the capacity of the condenser so that its reactance will be equal to the reactance of the primary at a low frequency, in other words tuned to resonance at say 60 cycles, we can produce a low frequency resonance peak but unfortunately the inherent tuning of the secondary winding will produce a sharp resonance peak at some high frequency, thus giving a response curve with a double peak.

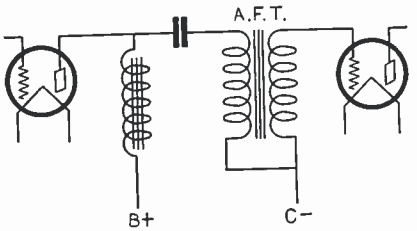


Fig. 5. An "engineered" transformer coupled stage which provides slightly better frequency characteristics.

Resonant Peaks Controllable by Regeneration

In Fig. 2 are shown two response curves obtained from a tuned double impedence amplifier. Curve B was obtained from a standard tuned double impedance amplifier circuit as shown in Fig. 6. Curve A was obtained from the same circuit with resistance added in series with the grid leg of the tube to reduce the phase angle of the grid coil, also shown in Fig. 6. As explained, the reduction of the phase angle reduces the voltage amplification at the resonant frequency.

In Fig. 7 is shown the common circuit for the tuned double impedance amplifier wherein, the grids of the first two tubes are controlled by a potentiometer and only the last tube employs a "C" battery.

The function of the potentiometer is to raise or lower the phase angles of the grid coils by varying the positive or negative bias on the grids of the tubes. If the grids are allowed to swing positive the internal grid-to-filament resistance is reduced in proportion. A reduction of the internal grid-to-filament resistance in turn raises the effective resistance of the grid coil and alters its phase angle. If the phase angle is reduced the voltage amplification at the resonant frequency is also reduced. If the potentiometer is swung negative the phase angles are increased, as is the voltage amplification at the resonant frequency.

It is obvious, that with the potentiometer method several stages are controlled at once. Separate potentiometers could be employed for each stage if desirable but it is simpler to use separate variable resistances in series with the grid legs, as shown in Fig. 6, in which case each stage is controlled separately.

Harmonic Distortion

In connection with the theory of operation of the potentiometer method we can also use the principal of grid currents to prevent overloading caused

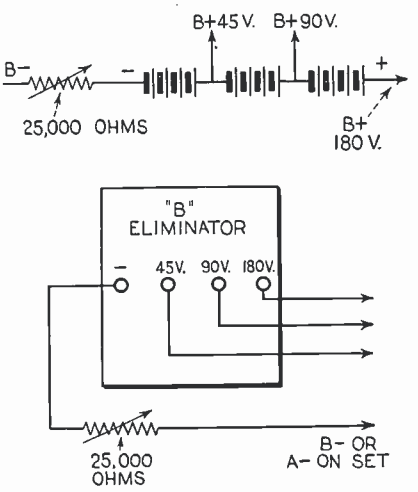


Fig. 9. A. F. regeneration can be promoted by inserting a variable resistance in the common "B" supply lead.

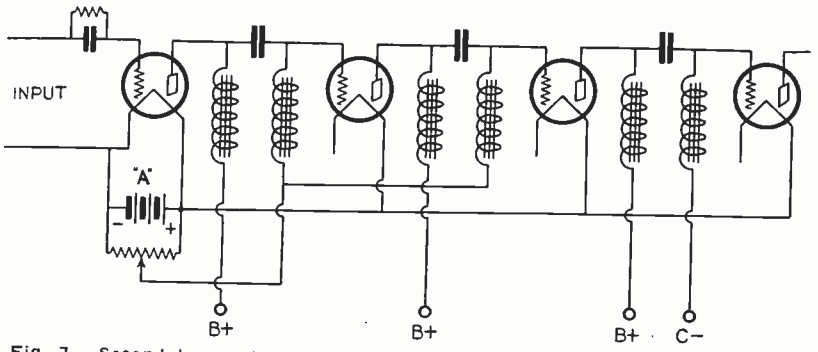


Fig. 7. Second harmonic distortion can be eliminated and the overall A. F. regeneration controlled by the use of a potentiometer for grid biasing.

by sudden strong impulses of low frequencies by an automatic control of the phase angle of the grid choke coil. This leads us into a discussion of second harmonic distortion usually caused by grid currents, which will not be covered in this article but reserved for a detailed treatment later.*

Audio frequency regeneration can be increased by the insertion of resistance in the negative side of the "B" batteries or "B" eliminator as the case may be.

Phase Relations

In order to get a thorough understanding of this let us refer to Fig. 8. Here we have a resistance coupled amplifier. The input voltage is impressed across the first grid resistance. The flow of current for a given instant is indicated by the first arrow. This makes the grid of the first tube less negative with respect to its filament. The plate current in the tube therefore increases and flows in the direction indicated by the second arrow. This makes the grid of the second tube more negative in respect to its filament so that the space current increases in the direction of the third arrow. The space currents in successive tubes are therefore 180° out of phase. It is seen that the current flowing in the output circuit of the last tube is in phase with the current flowing in the plate circuit of the first tube and since it necessarily must flow through a part of the plate resistance of the first tube the potential of the grid of the second tube is increased. It will be noted that a positive bias is placed on the grids of the first two tubes to prevent them from becoming too much negative and choking down the space currents.

The phase relationship existing in the non-reactive circuit of Fig. 8 also exists in the tuned double impedance amplifier although in this case the *degree* of phase relationship can be altered. Since the first and third stages are in phase, or practically so, it is possible to feed back a certain amount of the audio frequency energy through a resistance. The manner of connections is shown in Fig. 9. The degree of feedback can be controlled by varying the value of the resistance.

Conclusion

We therefore can state that audio frequency regeneration, long known as a stumbling block to audio amplifiers, can now be put to work in a double impedance amplifier for the purpose of controlling the heights of resonant peaks at low frequencies and at the same time eliminating the necessity for expensive iron to obtain these resonant peaks. Furthermore, each stage can be adjusted separately, to most any degree desirable by the use of variable resistances in series with the grid legs to reduce the phase angles of the coils and consequently the amplification at the frequency peaks of each stage and a variable resistance in series with the common "B" supply for promoting A. F. regeneration. In this way we obtain the desirable feedback for several stages and control the quantity in the individual stages.

If we use the method indicated in Fig. 9 there is a certain amount of feedback introduced. This A. F. regeneration raises the phase angles of the effective impedance in each of the circuits and therefore increases the voltage amplification at the resonant frequencies. This resonance peak is broad since each individual stage is tuned to a separate low frequency band. It is obvious then, that the response at low frequencies can be increased and decreased by controlling the amount of A. F. regeneration; that the overall amplification can be adjusted to meet the requirements of any speaker and that the desirable low frequency amplification can be obtained by using standard coils with a low phase angle.

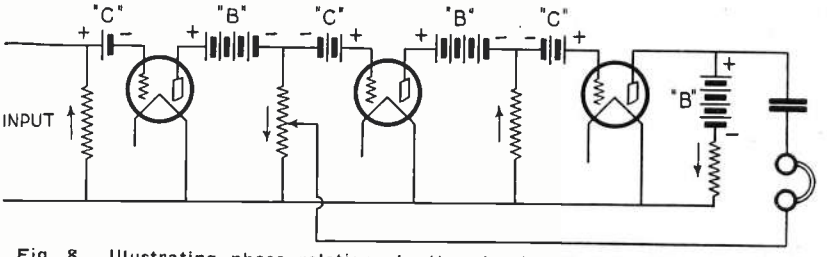


Fig. 8. Illustrating phase relations in the circuits of a non-reactive A. F. amplifier.

New Booklets

Daven

The Daven Radio Corporation, Newark, New Jersey, publishes "The Manual of Daven Amplication." This booklet is a treatise on resistance coupled amplifiers, and is illustrated with suitable diagrams. The questions most often asked about resistance coupled amplifiers are listed and the correct answers are given.

The same company issues a pamphlet "How to Make the Daven Bass Note Circuit." This booklet contains full sized templates and layout sheets for this receiver, and complete instructions are given which cover its construction.

General Radio

The General Radio Company, Cambridge, Massachusetts, issues a number of booklets and catalogs. "The Truth About Variable Condensers" is an appraisal of the low-loss trend in variable condenser design and construction, analysis of the various shapes of condenser plates, and a discussion of the merits and characteristics of dielectrict end-plate condensers and metal end-plate condensers.

Two pamphlets are issued by this company on combined B eliminators and power amplifiers. One describes the construction of an outfit using the Rectron 213 rectifier and 171 power tube, and the other gives constructional details on a unit which incorporates the Raytheon B H as rectifier and the 171 for the power tube.

Of interest to the engineer is the book "General Radio Precision Apparatus" issued by this company. This booklet lists and describes special apparatus for testing and measuring capacities, inductances, resistances and the like. Diagrams are given which show the methods of connecting the apparatus in order to obtain various measurements.

* *Harmonic Distortion will be covered by Mr. Hiler in his next article.*

Laboratory Receiver Design

The importance of laboratory measurements in the design of radio receivers[1]

*By W. A. MacDonald**

THE subject of this paper relates primarily to the measured characteristics of radio receivers and the importance of such measurements on the design of commercial broadcast instruments.

It is obvious that an exact knowledge of the individual and over-all characteristics of a radio receiver should be accurately known, yet experience shows that many manufacturers, including some of the largest, are practically unaware of the exact performance of the apparatus they produce.

Some time ago the Hazeltine Corporation was confronted with the problem of measuring the essential characteristics of a large variety of receivers. The first question to be answered was: What are the essential characteristics? Such a question lends itself to considerable discussion, but after careful consideration of all the possible factors it was decided that thirteen fundamental measurements were absolutely necessary in all cases. Additional measurements can be added to meet special circuits or unusual conditions. The thirteen fundamental measurements are as follows:

(1) Voltage step-up of input coupling transformer.
(2) Voltage step-up of 1st tube and coupling transformer.
(3) Voltage step-up of 2nd tube and coupling transformer.
(4) Voltage step-up of following stages.
(5) Complete R. F. amplification from input coup-coil to the detector.
(6) Resonance characteristic of input coupling transformer.
(7) Resonance characteristic of 1st stage transformer.
(8) Resonance characteristic of 2nd Stage transformer.
(9) Resonance characteristic of following stage transformers.
(10) Resonance characteristic of complete R. F. amplifier from input to the detector.
(11) Amplification and frequency characteristics of 1st audio transformer.
(12) Amplification and frequency characteristics of other audio transformers.
(13) Relative frequency characteristics of complete audio system including detector.

These measurements are selected because they are not especially difficult to make. They can be readily duplicated and the complete series standardized to a degree where the performance of a radio receiver can be accurately determined.

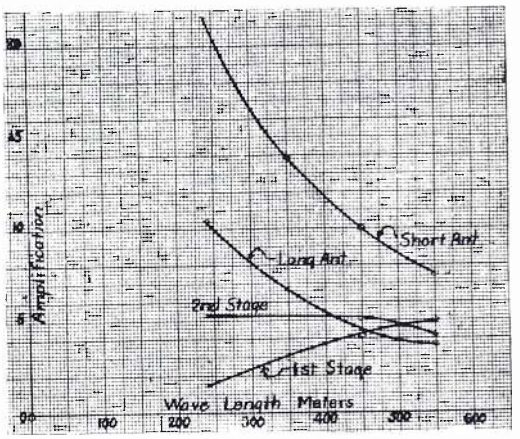


Figure 6—T. R. F. Receiver—R. F. Characteristic

The apparatus required is not unduly complicated. It consists essentially of the following:

(1) Precision wave meter.
(2) Radio frequency oscillator.
(3) Audio frequency oscillator.
(4) Vacuum tube voltmeter.

The wave meter can be of any standard make and requires no description.

The radio frequency oscillator may consist of any convenient oscillating circuit, although one giving reasonably uniform output is preferable. If a simple oscillating circuit is employed it should preferably consist of small inductance and large capacity. Where high accuracy is required the oscillator and all batteries should be completely shielded to eliminate stray fields.

Figure 1 is the schematic circuit arrangement of such an oscillator.

The audio frequency oscillator may be of a form similar to the radio frequency oscillator. This system might preferably consist of an oscillator and power amplifier and should likewise be shielded.

The one employed was provided with an adjustable frequency range of from 32 to 32000 cycles in octave steps. This oscillator is arranged so that it has a uniform output over the entire frequency range, which of course materially assists in the speed with which measurements can be made.

The vacuum tube voltmeter is similar to that described on the Bell System Technical Journal Vol. III No. 2, Page 185. A UX 112 tube is employed and operated on the square law portion of the curve. This tube should either be debased, or else the indicated results corrected by a suitable constant to compensate for the dielectric loss in the case and socket. The output is read directly on a sensitive micro-ammeter or galvanometer. The effect of the steady direct plate current is balanced out of the meter by a reverse current obtained from the heating battery and suitably adjusted by means of resistances.

Figure 2 is the schematic circuit diagram of a simple form of vacuum tube voltmeter.

In order to illustrate the manner in which the measurements are made, a

*Chief Engineer Hazeltine Corporation Laboratory.
[1]Reprinted from Proceedings of The Institute of Radio Engineers, February, 1927.

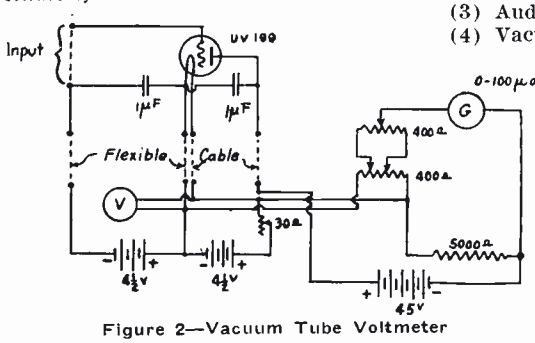


Figure 2—Vacuum Tube Voltmeter

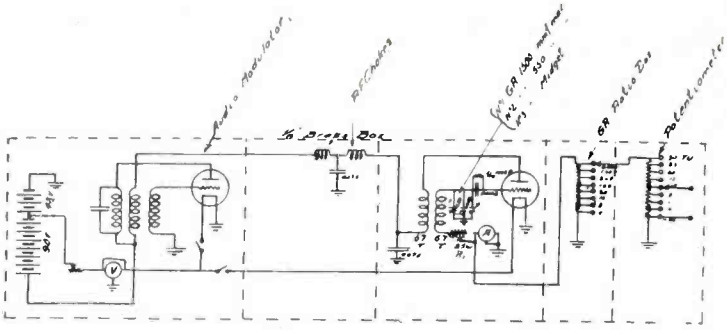


Figure 1

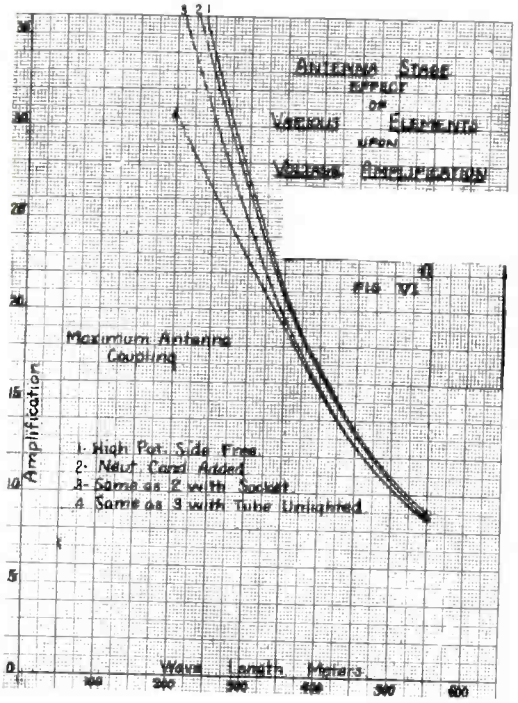


Figure 3

A group of curves made by Mr. Mac Donald in test work on R.F. and A.F. amplifiers. Above is the schematic diagram of the modulated R.F. oscillator used for testing purposes.

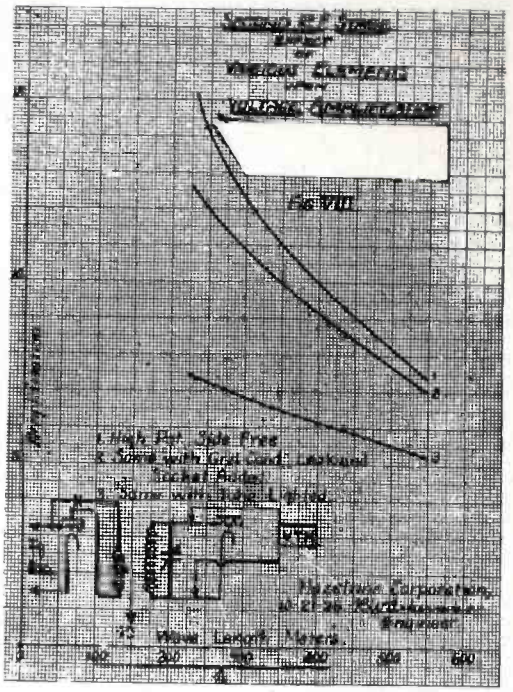


Figure 5

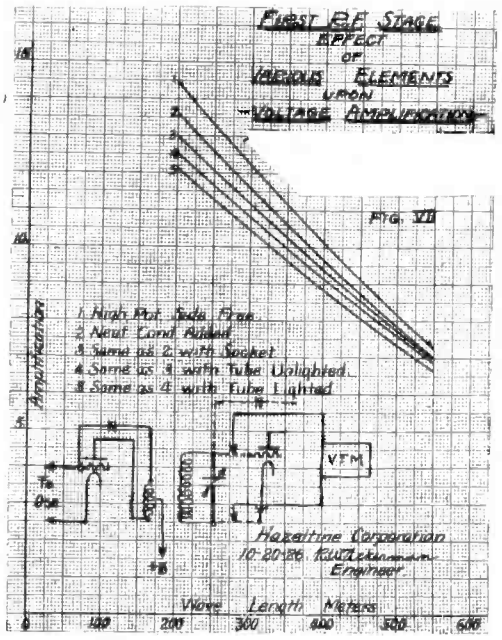


Figure 4

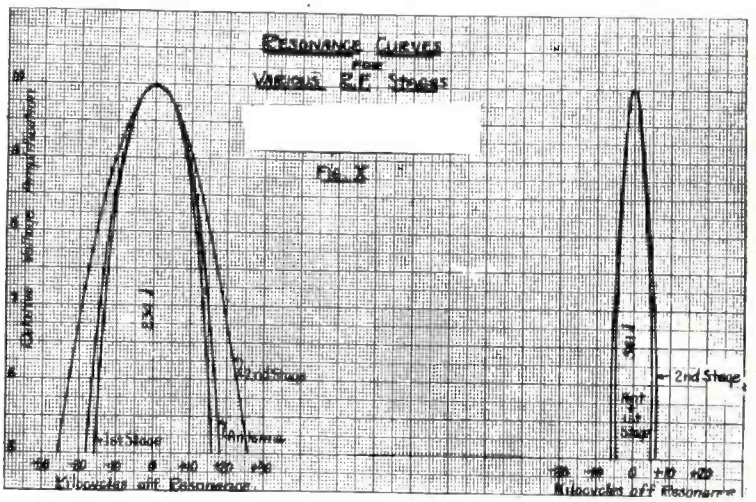


Figure 7

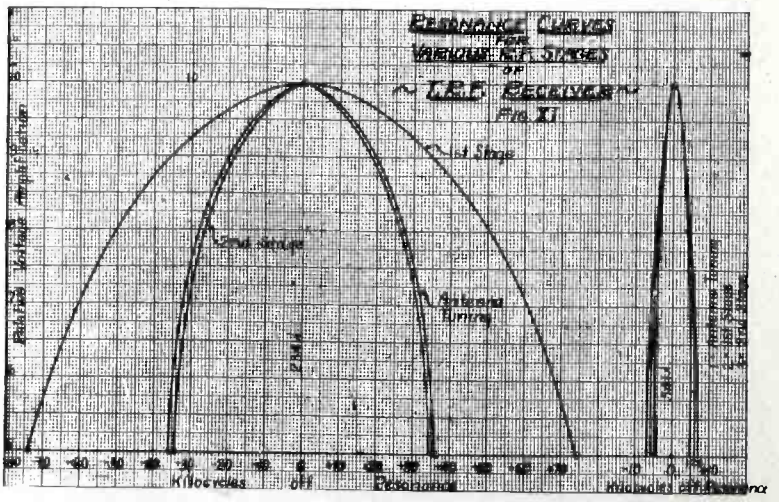


Figure 8

simple laboratory model neutrodyne receiver will be used. It has two stages of tuned radio frequency amplification.

Let us now turn back to the series of measurements previously outlined. No. 1 is a measurement of the voltage step-up in the input coupling coil. This is made by employing a dummy antenna having suitable characteristics of capacity, inductance and resistance. The dummy antenna is connected to the receiver under test. Radio frequency energy is then supplied from the oscillator by means of the output voltage attenuator. The input to the vacuum tube voltmeter is connected across the high voltage terminals of the antenna transformer and the circuit tuned to resonance. The deflection in the output meter of the voltmeter is adjusted to a suitable range by regulation of the voltage attenuator in the output of the oscillator and both the deflection in the meter and value of resistance in the voltage attenuator noted.

The expression for amplification is as follows:

$$A = \sqrt{\frac{\phi_2}{\phi_1}} \frac{R_1}{R_2}$$

where φ_2=Deflection of meter
ϕ_1=Calibration of meter
R_1=Total resistance of voltage attenuator
R_2=Resistance of portion used in measurement.

Figure 3 is a series of curves made on antenna coupling transformer and shows the effect of various losses on the amplification characteristics. Curve 1 is the amplification characteristic in which the voltmeter is connected directly across the tuned circuit with other connections removed. Curve 2 is the same measurement with the neutralizing condenser added and shows the reduction in amplification due to the dielectric loss in the condenser. Curves 3 and 4 show additional losses due to the tube socket and tube base.

Figure 4 is a series of curves taken on the first stage of amplification and includes a vacuum tube with its output transformer. In this measurement the dummy antenna is removed and the signal supplied directly to the grid.

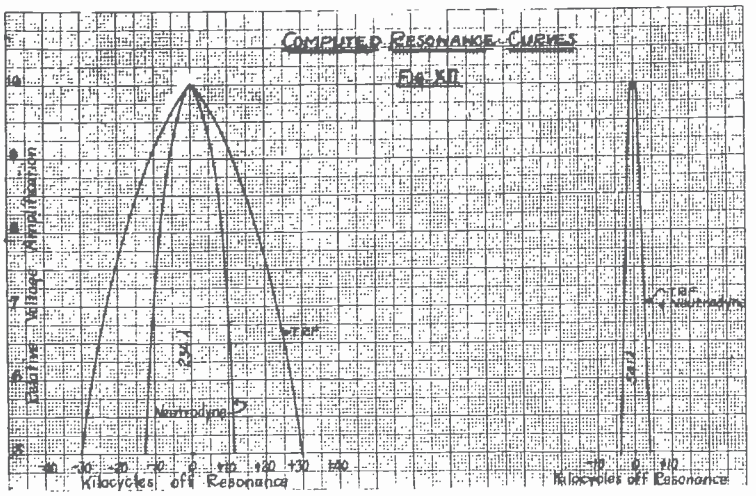


Figure 9

The overall R.F. amplification of a standard Neutrodyne receiver is shown by the curve in Figure 10. Resonance curves are shown in Figure 9.

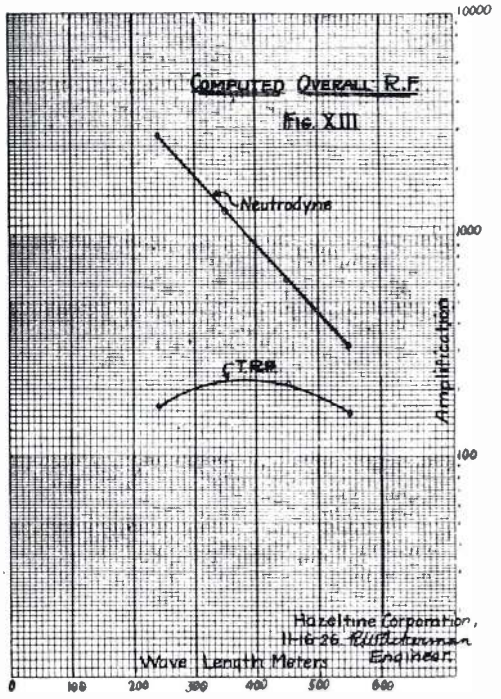


Figure 10

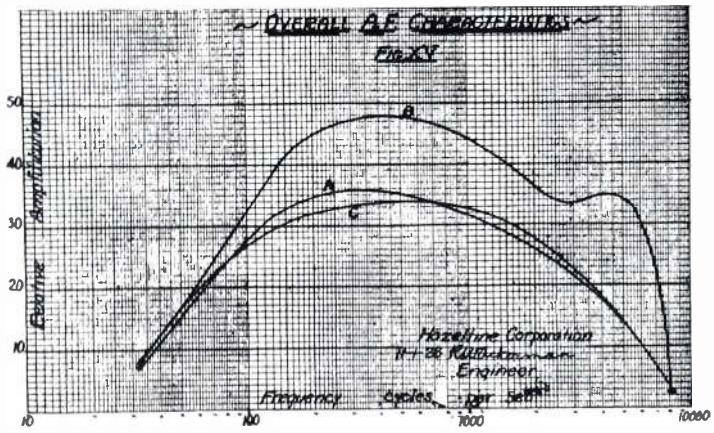


Figure 12

Audio frequency characteristic curves are shown in Figures 11 and 12. These tend to show the effect of A.F. regeneration.

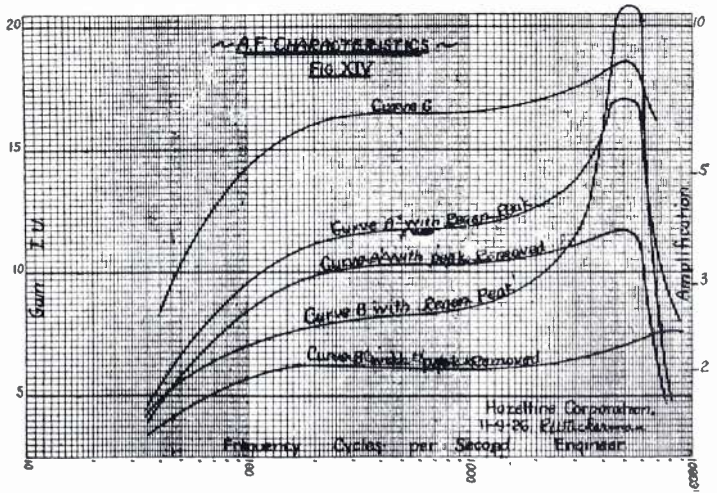


Figure 11

of the tube. Here again the various losses are well defined and consist chiefly of dielectric loss and tube loss.

Figure 5 is the amplification characteristic of the second stage and is made in the same manner as the other measurements. In the case where a grid condenser and leak are employed which impose a load on the tuned circuit, the measurement is made with the detector tube in an operative condition.

Before going further it might be interesting if we examined the amplification characteristic obtained from a popular model T. R. F. receiver which depends for its stability, that is freedom from oscillation, on highly damped circuits.

Figure 6 shows the amplification curves obtained from the three tunings of this receiver.

The next point of special interest is the resonance characteristics of the individual tunings. This measurement should be made at two frequencies and can be conveniently done when making the amplification measurements. The curves may be taken by tuning the signal to resonance on the receiver and the detuning of the oscillator by means of the vernier adjustment which can be calibrated in kilocycles.

Figure 7 is a series of resonance curves for the various stages of the receiver under test.

Figure 8 is the resonance curve of the T. R. F. receiver previously mentioned. It is an excellent illustration of the manner in which the frequency admission band of a receiver can be altered by highly damped circuits.

From the measurements so far made the total R. F. amplification as well as the complete resonance curve may be computed, and these are shown in Figures 9 and 10 respectively. Curves of Figures 9 and 10 show the resonance characteristic and voltage amplification of the receivers previously referred to.

The next measurements are made on the audio frequency portions of the amplifier. The first involves the voltage step-up and frequency characteristic of the individual transformers. This measurement is made by connecting the primary of the transformer to the output voltage divider of the audio oscillator. The tube resistance may be simulated by a fixed resistance connected in series with the primary winding. The vacuum tube voltmeter can be connected directly across the secondary terminals of the transformer and the amplification computed as in the R. F. measurements.

Figure 11 is a typical frequency characteristic of two audio transformers and shows particularly the second rise due to the effect of the leakage inductance. Curve *C* of the same figure shows the computed frequency characteristic of the complete amplifier. Unfortunately, however, this curve has little significance in a complete amplifier because of the effect of the detector grid condenser and the grid leak as well as the regenerative effects due to common battery couplings.

A relative frequency characteristic of the complete amplifier may easily be obtained, however, by supplying the A. F. oscillation to the detector tube in series with the grid leak and measuring the response between grid and filament of the last tube. This will give an amplification curve as shown in curve *A*. Figure 12 which is approximately the way a signal is heard in the loudspeaker. With regeneration present, such as due to common "B" batteries, the curve may easily be altered to that shown in curve *B* unless its effect is eliminated by suitable circuit arrangements. Curve *C* of the same figure shows the frequency characteristic of the audio system with the regeneration and second peak removed and is a good example of the present day high class audio system.

In analyzing the R. F. amplification and resonance curves, it must be remembered that innumerable factors enter into the results which may be obtained. Among these factors are poor transformers, excessive dielectric losses, high resistance of parts, etc. All these effects can be improved and, in many cases, entirely eliminated once their nature has been determined by suitable measurement.

The audio system responds to like treatment and as rule can be easily corrected when the cause is known.

In conclusion, I wish to acknowledge the assistance of Mr. R. W. Ackerman, a member of the laboratory staff, in the preparation of this paper.

A Newly Developed A. C. Tube

*Radical type of filament answers the problem of A. C. operation.—By L. E. Crist**

TREMENDOUS interest is being evidenced in the new alternating current tube developed by the Van Horne Company, of Franklin, Ohio. Its announcement demonstrates conclusively that the receiving set of the immediate future must use, as its sole and direct source of current supply, the light socket or floor plug in its owner's home.

This need has been recognized for several years by radio engineers and the laboratories of practically all tube manufacturers have been the scene of constant research work, looking toward the perfection of a tube that would function efficiently under these conditions, but it remained for The Van Horne Company to be the first to successfully demonstrate the operation of such a tube.

The history of this tube goes back over a number of years and is extremely interesting. Experiments with the standard five volt tube, when operating on alternating current definitely showed the existence of three major conditions which must be overcome before any electron tube could successfully use alternating current at its direct source of filament supply. In order to appreciate the importance of these conditions certain fundamental principles must be understood.

First, the whole theory of radio reception is founded upon the detection and amplification of alternating impulses radiating from a transmitting station. Now, in about 97 per cent of the homes in the United States, the light current is delivered at 110 volts and alternates in its flow at the rate of 60 cycles per second. Therefore, if the filament of a radio tube be lit by this house current we are deliberately introducing another alternating impulse within the tube and, in the natural performance of its duty, the tube will also detect and amplify this impulse. The reaction on the output of the tube is a steady, low-pitched hum, which seriously impairs, if not actually destroys the signal to which we wish to listen.

The voltage or the energy behind any signal is reflected in the volume with which this signal is delivered by the loud speaker. The ordinary radio tube operates at 5 volts and the hum resulting from such voltage is entirely too great for the purposes of radio reception. On the other hand, if the voltage be reduced beyond a given point the filament in such a tube will cease to throw off the electrons that are necessary to its operation.

Low Voltage Filament Required

This showed that the first and greatest need was a filament that would function efficiently at a voltage so low that the resultant hum would not be audible to the human ear. At first thought, it might seem necessary to reduce the voltage on the filament to a level as low as that of the signal being introduced into the set. However, when we realize that a good radio set will pick out of the ether a signal that is only one one-millionth of a volt in volume, the impossibility of this is easily seen. On the other hand, such an extreme re-

* *The Van Horne Company.*

duction is unnecessary as a certain proportion of the energy must be absorbed or dissipated in the heating of the filament. It was proven by experiment that if the voltage on the filament could be reduced to approximately one volt without impairing the efficiency of the tube, the heating of the filament would absorb so much of the energy that any audible hum resulting from this cause alone would be eliminated.

It next developed that certain other factors contributed to this undesirable hum. One of these was the effect caused by the continual heating and cooling of the filament itself. To appreciate the importance of this condition it must be understood that, when subjected to alternating current, the temperature of the filament is fluctuating 120 times per second and this constant process of heating and cooling produces a hum reaction of its own which, in its amplitude, is directly proportional to the speed with which the filament material changes its temperature. It was also found that the physical reaction of the filament to these alternating impulses was a vibration which in itself contributed to the hum. These developments showed that the proper filament for this purpose was one having a high degree of thermal and mechanical inertia.

The next important discovery had to do with the actual shape of the filament. In the ordinary radio tube the filament is bent like a hair pin so that for quite a distance its two halves are parallel and its two extremities directly opposite each other. At the instant when one of these two extremities is negative in its potential and the opposite extremity positive in its potential, there is a tendency for the positive end to attract to itself the electrons which are being given off by the negative end. In 1/120th of a second this condition changes and the electrons are attracted in the opposite direction.

During the course of this change there is, of course, an instant when both ends have no potential whatever and at such an instant the electron flow between them necessarily ceases entirely. This alternate flow of electrons from one leg of the filament to the other and back again, in itself, causes a distinct hum. This can be definitely proven by lighting the filament of a radio tube with alternating current and attaching a set of head phones between the plate and either of the filament terminals. Without the use of any "B" batteries on the plate a steady, audible hum will be noticed in the ear phones. This is the direct result of the flow of electrons between the extremities of the filament in the manner above described.

Filament of High Emission

It was found by experiment that if the filament was absolutely straight, this "stealing" effect was naturally eliminated. However, this would cut the filament in half and, with any materials then known a filament of such short length would not give off a sufficient quantity of electrons to permit the proper functioning of the tube. Therefore, a filament of much higher natural emissivity was absolutely necessary.

Tests definitely proved that none of the existing filaments would function satisfactorily in such a tube. Thoriated tungsten, the material used in the great majority of filaments, was entirely out of the question on account of its high natural resistance. The so-called oxide-coated filament was equally inefficient for, while it would pass the heavy current necessary, it had a tendency to develop gas which would ruin the efficiency of the tube.

It is, therefore, apparent that the success of this new tube is primarily dependent upon its filament. This is the invention of J. S. Van Horne, President of The Van Horne Company. In its composition and treatment, both of which are fully covered by patents and patent applications, this filament is a complete departure from any other filament ever used.

This filament is so free in its emission of electrons that when subjected to considerably less than one volt it will function properly although only heated to a dull red glow. This low operating temperature permits it to physically withstand the heavy current which must pass through it (.8 volt, 2.5 amps.). Furthermore, the bulk of the filament is so great that its mechanical and thermal inertia successfully overcome any tendency to hum arising from temperature changes and mechanical vibration.

Having a cross-sectional area several times as large, its actual radiating surface is so much greater than that of an ordinary filament even twice its length, that it is possible to maintain the emission level of the best five volt tube and at the same time to materially increase the distance between the filament and the plate. This change automatically increases the control over the electron flow exercised by the grid of the tube (generally spoken of as a mutual conductance) and thereby makes the tube much more sensitive to weak signals than the ordinary tube could possibly be.

The efficiency of this filament has been proven by life tests over thousands of hours with no decrease in electronic emission and no tendency of the tube to become the least bit gaseous.

Standard Construction

The tube is extremely simple in its construction and being built on the standard UX base, without any other terminals or connections of any sort, it will fit in the standard socket. With a few minor and inexpensive changes practically any of the standard circuits can be easily adapted to the use of these tubes. Construction articles giving full detailed information on this phase of the situation will be released as rapidly as they can be prepared.

Another characteristic of this new tube which, incidentally was more of a happy coincidence than an objective deliberately sought, is its unique tonal quality. This is directly due to the size and composition of the filament. Just as the so-called 112 type of tube, the filament in which is much heavier than that of the 201-A type, makes a particularly efficient detector due to the smoothness of the tone it delivers, just so but only to a much greater degree, has this new filiament accomplished this same result.

Unit Construction Essential in Radio Manufacture

Tends to simplify work and Proves of great saving in production

RADIO, like the automobile, is rapidly taking the form of a stabilized industry, which means that competition increases daily, and efficiency and economy become the twin watchwords of a new business. Probably the shortest path to economy, with no sacrifice of efficiency, is the so-called "unit construction" method adopted by a few progressive manufacturers, and carried out to its greatest limits by the Federal Radio Corporation, makers of Ortho-sonic receivers.

Unit construction, as applied to the Ortho-sonic line, includes the manufacture and use of standard, interchangeable parts, and more particularly the assembly and testing of complete stages of the receiver circuit. Standard parts, which may be used in two or more of the receivers, permit greater specialization, require fewer men and machines, and allow Federal's production engineers to concentrate upon reducing costs. It is often startling to learn that a single machine tool, needed for some additional radio part, may cost $2,000, and require weeks of skilled handling. Naturally, then, the elimination of special parts, which can be replaced by standard items through advanced engineering.

reflects itself in greater value for the radio buyer's dollar, and is of vital concern to the public.

As just mentioned, the radio consumer has a direct interest in engineering efficiency which permits the economical duplication of many radio parts. Federal unit construction is of still greater immediate benefit to the man who services receivers in his community. It goes without saying that there is great value in any construction which makes unnecessary the dissection of a complete circuit in order to replace or repair any major part. The unit method of Ortho-sonic construction does just this thing. Each stage is assembled complete with coils, mounting plates, shielding, etc., in final position before being tested. A complete index card tabulating the qualities and characteristics of the stage is then made for permanent record. Units of identical characteristics, after being thoroughly tested, are grouped together and delivered to the assembly department, where they are readily set in place beneath the receiver shelf.

Every unit then, is tested complete before assembly. Coils are matched when fully mounted in conjunction with the other component parts. The more common method is to test coils before mounting, and allowance is seldom made for the inevitable change which occurs in the coils after they are placed in proximity to other current-bearing parts. In addition, the Federal engineering department "pre-balances" each separate stage. Hence the Ortho-sonic receiver is actually ready to operate when the last assembly screw is tightened. No such thing as a defective circuit reaches the final test, because no imperfect stage can enter the assembly room. All this is accomplished through the unit construction perfected by Federal engineers.

Now what happens when something goes wrong? The service man's testing apparatus quickly points out the particular unit which has become defective. Without disturbing any other part of the circuit, he merely removes the offending unit assembly by means of the special terminals which are a feature of all Federal sets. He then determines, by factory markings on the assembly, its special characteristics. He selects from his stock of replacement units and assembly of identical characteristics, slides it into place, and the receiver is again ready to operate. It will be seen that this method means minimum trouble, minimum expense, and almost no loss of service to the consumer.

High-Voltage Supply for Super-Power Amplification

Double rectifier system employed to obtain necessary wattage for power tube

WITH the trend decidedly toward higher operating voltages, especially in connection with the UX-210 or CX-310 type of super-power amplifier tube, there is often a desire for doubling the voltage of the usual Raytheon radio power unit. Requiring no filament current, highly economical in operation, and most rugged in everyday practice, the gaseous rectifier has proved a favorite in "B"-power units even though it has been limited to use with power tubes of the 171 type or smaller. Hence the following suggestion, which enables one to employ the Raytheon type of tube for the highest operating voltage found in present-day reception.

Two standard Raytheon tubes may be connected in series to furnish plate voltages, up to 435 volts D. C. at 20 milliamperes, when using the Type B, and at 35 milliamperes, when using the Type BH.

Standard designs of Raytheon-approved transformers and choke coils are employed the same as are found in the usual "B"-power unit employing a single tube. When different makes of transformers and choke coils are used in this arrangement, there will be variations in the output voltages and in the millampere loads for each type of tube.

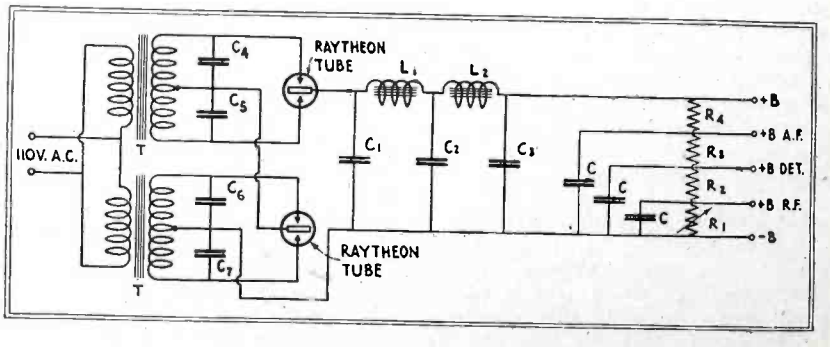
The condensers are of the same values as in the standard Raytheon circuit, namely, C-1 and C-2, 2 mfd.; C-3, 8 mfd.: C-4, C-5, C-6 and C-7, 0.1 mfd. However, the condensers should be designed for a *working* voltage of 750. The necessity of having condensers designed and built for this working voltage is to take care of the high voltage which would be delivered if there were no load on the radio power unit, such as when the filament of the power tube is not lighted. In fact, care should be exercised that the filament of the power tube is always turned on while the "B"-power is turned on. If the "B"-power and filament circuits are under one control, this is automatically arranged for; otherwise, peak voltages, even as high as 800 volts, may be encountered, severely straining the filter condensers, when the radio power unit is working on no load.

The filament of the power tube may be operated either from a storage battery or from raw alternating current supplied by a separate transformer capable of delivering a current of at least 1.25 amperes at 7.5 volts.

While the "C" or grid bias can be obtained for the power tube by means of a suitable resistance drop, it is advisable to employ a tapped "B"-battery with from 28 to 35 volts in the grid circuit. This is a simpler arrangement, and since there is virtually no drain on the battery, it should last for a year or more.

Various voltage taps may be obtained by the use of suitable resistance units and by-pass condensers. Thus the full voltage is delivered to the power tube, or approximately 425 volts. If the "B" or plate supply is to be furnished to the usual four-or five-tube receiver, employing 201-A type tubes, a variable resistor should be used for R-1, allowing a range of from 0 to about 20,000 ohms, and fixed resistors of 10,000 ohms each for R-2 and R-3, and 18,000 ohms for R-4, with by-pass condensors of 1. mfd. in each case, as indicated.

Remarkable volume, together with extreme depth and utmost realism, may be obtained through the use of the UX-210 or CX-310 tube, operating with this double Raytheon arrangement. Furthermore, there will be a complete absence of hum. There is ample voltage available for operating a high-power resistance-coupled amplifier at its maximum efficiency, with the UX-210 or CX-310 power tube in the final stage.



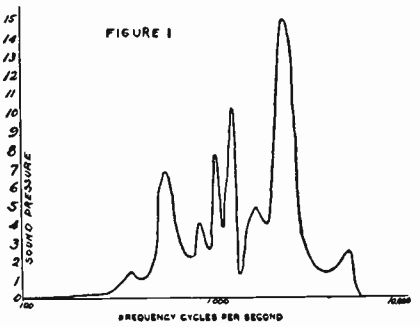
Schematic diagram of heavy duty plate supply unit

Characteristics of Radio Receiving Apparatus*

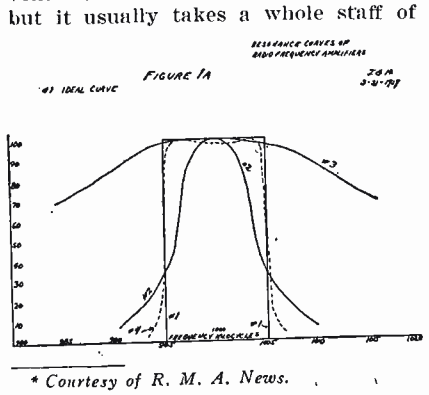
Address by Dr. John P. Minton and I. G. Maloff, Consulting Engineers, at Meeting of Radio Manufacturers Association, in New York.

Dr. Minton's Talk

WE have a sort of an ideal held before us all the time. It is the perfect or faithful reception and reproduction of radio broadcast programs. In some ways it is always well to have an ideal of this nature held up before us for it gives the engineers something definite to strive for. On the other



hand, I don't want to hold this faithful reception and reproduction before you as an ideal at all, because you are apt to consider it merely as an ideal and will consider it of theoretical importance and of no practical value. It is true that the practical consideration is important but it seems to me that up to the present time radio manufacturers and engineers have worked the practical "game" too much. Much progress is just ahead for many of us if we shall learn to apply to radio reception the results of theoretical and experimental research. The period of rapid development brought about by the usual "cut and dry" methods is over. The results obtained by the application of this method have been encouraging. Perhaps we might call this period the "inventive" period. But invention in the field of radio requires but a small portion of the total effort necessary to produce the best possible results. This is the reason why we have so many engineers and so few inventors. An inventor discloses an idea but it usually takes a whole staff of



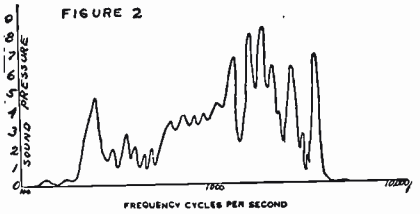
engineers to make the idea work. Fundamental inventions in radio have made possible radio broadcast and reception and it will require the best type of theoretical and research skill to bring the inventions from the present state of development to what may be termed practical perfection.

In a few curves I want to show the progress which has been made in the reproduction of speech and musical sounds by loud speakers and also to show the basis for the requirements for faithful reception and reproduction.

In Figs. 1, 2 and 3 are shown curves, for a horn type of speaker, for a commercial cone speaker of average reproducing value and for one of the best cone speakers which has been constructed, respectively. These curves show the sound pressure produced by the speaker at the various frequencies when the speaker is operated at a constant voltage through a few thousand ohms to represent the impedance of a definite type of tube. When the speaker is operated under these specific conditions (or any other definite set of conditions) it should give a constant sound pressure at the various frequencies for best results. In other words, we should have curves which are smooth and without pronounced resonant peaks. The range of response should extend from the lowest to the highest frequencies which are important for speech and musical reproduction.

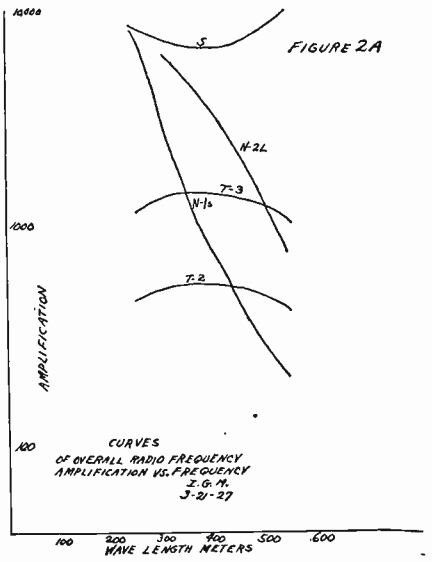
The curves in Figs. 1 and 2 do not fulfill these conditions for good reproduction. Fig. 1 is particularly bad in that the range of response is from perhaps 450 or so to about 3000 cycles. Fig. 2 covers a wider range, extending from about 200 to 3600 cycles, but it has many resonant peaks and has a marked depression from 250 to 600 cycles. Fig. 3 covers a much wider range than either of the two speakers referred to above. Here the range of response is from 60 to 6000 cycles with very close to constant sound pressure throughout this range, with the exception of the peak at about 1800 cycles. The height of this one peak, however, can be reduced without affecting the rest of the curve. This curve is an indication that as far as perfect reproduction is concerned we have been able to accomplish a great deal. This result speaks strongly for the application of scientific methods to development of speakers. It represents results obtained by the replacement of the ear with scientific apparatus, or, in other words, it makes reproduction a branch of engineering instead of a division of psychology.

How will these three speakers perform on broadcast signals? To answer this question briefly, I have included but two curves here. These are shown in Figs. 4 and 5. Fig. 4 shows the relative sound pressure at various frequencies for pipe organ music. The horn speaker will reproduce a range from 450 to 3000 cycles of this curve while the cone speaker shown in Fig. 2 will reproduce the range from 200 to 3600 cycles. Both these speakers will



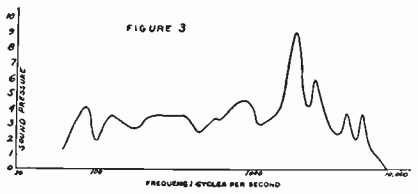
distort the curve for the pipe organ into something which does not represent an organ at all. The speaker whose curve is shown in Fig. 3, however, will reproduce this pipe organ music quite accurately and the resultant reproduction will be very much superior to that obtained by either of the first two speakers.

Fig. 5 shows an analysis made of speech sounds. The two curves marked "L" represent results obtained when frequencies above any desired frequencies are cut off and are not reproduced. The curves marked "H" represent results obtained when frequencies below any desired frequency are eliminated. If we consider 500 cycles on the "H" curves, the graphs indicate that, if a



* *Courtesy of R. M. A. News.*

speaker does not reproduce any frequency below this value, there is but 40% of the speech energy present in the reproduction but the articulation is 97% or so, provided there is no other distortion present. Consequently,



it is necessary from the viewpoint of speech energy and therefore, naturalness and loudness, to have a satisfactory reproduction of low frequencies down to at least 100 cycles. These low frequencies are not so important for articulation or intelligibility.

On the other hand, the higher frequencies, as shown by the "L" group of curves are important for articulation and differentiation but not so necessary for speech energy. Take 1000 cycles, if all frequencies above 1000 are not reproduced, we have but 40% articulation or intelligibility and over 80% of the speech energy. When we reproduce up to 5000 cycles, there is little, if any, to be gained by trying to include higher frequencies. However, some speakers, as indicated by Fig. 1 do not reproduce efficiently above 2500 cycles or so and with such speakers it is difficult to bring out all the beauty and inflections of speech sounds, and, furthermore, the higher harmonics of musical sounds are absent and the delicate shaded characteristics of the high musical notes of various instruments are wanting.

These remarks indicate the relative importance of the various audio frequencies for speech and musical reproduction. The curves on the speakers indicate how well these frequencies are being covered by the speakers at the present time. Mr. Maloff will now discuss with you some of the problems of the radio receiver and indicate along what lines we may expect the greatest improvements in receiving sets. I again remind you in closing my portion of this talk that I do not see how much further progress can be made except by resorting to precise engineering data in substitution for aural observations.

Dr. Maloff's Talk

Dr. Minton outlined to you the most important properties of devices for the reproduction of speech and music. I am taking the liberty in summarizing his words this way:

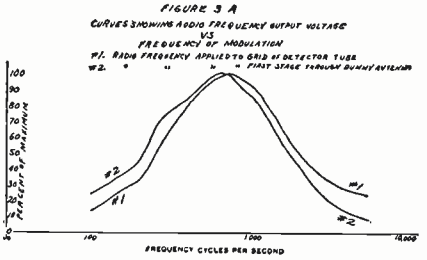
The ideal loud speaker is the one which gives uniform undistorted response over the entire range of the audible frequencies. The best models of loud speakers approach very closely this standard.

Now it is up to the receiving set to give the speaker a fair chance to respond to all those frequencies. I mean, that the receiving set must let all these frequencies go through and be delivered to the terminals of the loud speaker in form of the electrical pulsations.

The purpose of my talk is to outline to you a few factors involved in performance of the receiving sets. Also I am going to describe the most important properties of receiving sets and the relation these properties have to the faithful reproduction of speech and music by receiver and loud speaker combined. It is known to everybody that a modern broadcast receiver consists of, first, an antenna in some form; second, a radio frequency amplifier, and third, an audio frequency amplifier. The radio frequency amplifier overlaps with the audio frequency amplifier in the circuit of the detector. Details of all of these four parts seriously affect the properties of a receiver as a whole.

The present day requirements for a broadcast receiver can be summarized as follows:

(1) A high and a uniform sensitivity, which means the ability for long distance reception and also the



uniformity of this ability in the whole range of broadcast frequencies (550 to 1500 kilocycles).

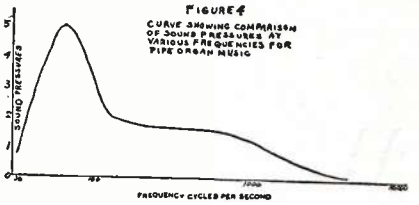
The high sensitivity is usually obtained by making the radio frequency amplifier of a high voltage gain. However, the audio frequency amplifier is also partly responsible for that.

(2) A high and uniform selectivity, which means the ability of tuning out of powerful local stations, while listening to the weak distant ones. The design details of the radio frequency amplifier and of antenna tuning arrangement are completely responsible for this property. The audio part of the receiver has nothing to do with it.

(3) High and uniform quality, which property combines fidelity or the truthful response at all audio frequencies and also the freedom from noises.

The sensitivity and the selectivity go together without any trouble. I mean that it is comparatively easy in a receiver to combine a high selectivity with a high sensitivity, but the quality does not go as well with either of them. The high sensitivity means a very high radio frequency voltage amplification. Noise, static and sometimes the signals from other stations interfere with the reception and ruin the quality. The most efficient radio frequency amplifiers are those using tuned circuits, because by using these circuits the full amplification power of the tubes can be benefited.

A tuned circuit is a coil and a condenser in parallel, this coil and condenser so proportioned, that the response of the circuit to a particular

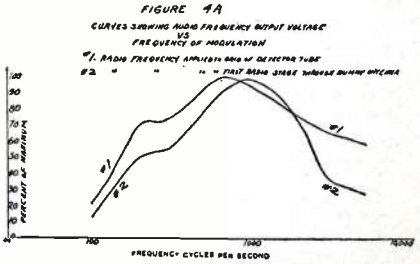


frequency is very pronounced. This response drops off rapidly with the impressed frequency increasing or decreasing. It becomes very small for the frequencies distant from the frequency to which the current is tuned.

When the radio frequency wave of a radio station is modulated by an audio frequency wave, the resultant electromagnetic wave is no more of a single frequency or wave length. The analysis of the resultant complex wave shows that this resultant wave consists of three waves having three different frequencies. One wave has the frequency of the original wave (when no modulation was used), the second one is of frequency equal to the original frequency plus the frequency of the modulating wave and the third one is of the frequency equal to the original frequency minus the frequency of the modulating wave.

Take a carrier wave of say one thousand kilocycles (300 meters). If we modulate it with an audio frequency wave of 5000 cycles, we get a complex wave of three frequencies, namely 995, 1000 and 1005 kilocycles. Under ideal conditions a receiving set should let these three frequencies go through equally amplified in magnitude.

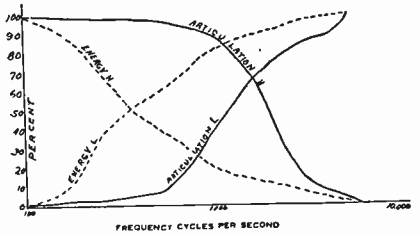
Dr. Minton has explained to you that for a sufficiently faithful reproduction of speech and music a uniform response to all audio frequencies from 75 to 5000 cycles is necessary. Now if the resonance or tuning of our radio fre-



quency amplifier is too sharp the higher audio frequencies will not go through it, because the circuit will have very little response to: first, the frequency of the carrier plus the frequency of modulation; and second, the frequency of the carrier minus the frequency of modulation. The latter

two frequencies are often called the side bands. This means that the resonance peak of a radio frequency amplifier must be at least 10 k.c. wide at the top for good reproduction, and at the same time it means that broadcasting stations must be spaced at least at 10 k.c. apart to prevent interference.

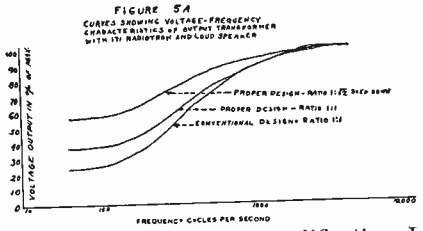
FIGURE 5
CURVES SHOWING SPEECH ENERGY AND ARTICULATION WHEN VARIOUS FREQUENCY REGIONS ARE ELIMINATED



Referring to Fig. 1A, curve No. 1 represents the ideal response curve of a radio frequency amplifier. It is ideal from the standpoint of sensitivity, selectivity and quality. Curve No. 2 represents a very selective radio frequency amplifier but causing a very poor quality. Curve No. 3 is for an amplifier with a very broad tuning, good from the standpoint of quality but very poor from that of selectivity. Curve No. 4 represents the best amplifier obtainable in actual practice. It is rather expensive for a receiving circuit because it requires two tuned and loosely coupled tuned circuits for each stage instead of one. All good broadcasting stations resort to this kind of tuning and this is why so many of them are almost reproachless regarding the quality of their signals.

The radio receivers differ one from another chiefly in the principle on which their radio frequency amplifying systems are built. Fig. 2A shows how most important types of radio frequency amplifiers compare each with other. Curve S shows r. f. amplification for a 6-tube receiver employing the beat or the heterodyne method of reception. Curve N-1 shows the same for a unicontrol receiver utilizing one of the popular methods of neutralization. Curve N-2 is for a similar "two dial control" receiver. Curve T_2 is for a receiver using two resistance neutralized tuned radio frequency stages and curve T_3 is for a similar three tuned radio frequency stages receiver.

FIGURE 5A
CURVES SHOWING VOLTAGE-FREQUENCY CHARACTERISTICS OF OUTPUT TRANSFORMER WITH 171 RADIOTRON AND LOUD SPEAKER



By radio frequency amplification I mean the ratio of r.f. voltage which the set delivers to the grid of its detector tube, to the r.f. voltage induced by the electromagnetic waves in the antenna or its substitute of this receiving set.

The function of the detector is to separate the modulated carrier wave from the wave of modulation and deliver it to the audio frequency amplifier. The detector itself can introduce only a very little of frequency distortion, but when overloaded it distorts the wave itself, causing mushy and very unpleasant reception. However, if the audio frequency amplifier is able to give a sufficient gain, there is no need of overloading the detector.

For some unknown reason the importance of adequate audio amplifier was overlooked by many manufacturers. Many sets on the market have very good r.f. circuits, but very few of them have the audio circuits of the same grade.

The audio frequency stages usually utilize one of the three kinds of coupling: transformer impedance, or resistance. An amplifier can be made just as good by using one as well as another of these three types of coupling. The trouble is however that often too much or too little is required from them. For instance, there is a receiver on the market utilizing resistance method of interstage coupling. The designer tried to get the highest gain obtainable and placed resistances of one-half megohm as couplings. In order to get high response at low frequencies he used condensers of very high capacities and as a result his set is subject to flutter, or as it is often called, motorboating when used with battery eliminators and larks in high frequency response on account of the grid circuit of the following tube shunting this coupling resistance.

In another commercial set the transformer type of coupling is used, the transformers being of high ratio and insufficient primary impedance. This set is very quiet even with the worst kind of battery eliminator, but responds only to the frequencies in the middle range which means the lack of depth and lack of brilliancy of the reproduced sound. In the latter case the trouble can be easily corrected by using a high grade of iron as the core material for the transformers. Nickel-iron alloy or copper-nickel-iron alloy usually saves the situation. In the case of resistance coupling a complete redesign is usually necessary.

So you see there is quite a number of various factors involved in the performance of a receiver. The designer of a radio set must take all of them into consideration, analyze everyone of them and step by step work out the complete receiver. However the slide-rule alone is not sufficient, one must be able to check his calculations. Many designers have to depend on their ear for this check. They put receiver together and try it out. If it sounds not as expected, they make a few changes and try it again. If they are lucky they get good results, if not, they put out sets that are unsatisfactory. Another important point against them is that these people test their sets under a particular set of conditions and must guess the rest. Other manufacturers and designers resorted to laboratories to replace their ears in the task of development of receiving sets. In order to be able to tell how good or bad a receiver or its component part is, the following equipment is necessary: a radio frequency oscillator covering the whole range of broadcast frequencies; an audio frequency oscillator covering the whole range of audible frequencies; arrangements for modulating the r.f. oscillator by audio frequencies; devices for measurements of output and input signals; and sound measuring equipment.

FIGURE 8A
CURVES SHOWING MAXIMUM VALUES OF APPARENT A.C. PERMEABILITY VS. D.C MAGNETIZING FORCE

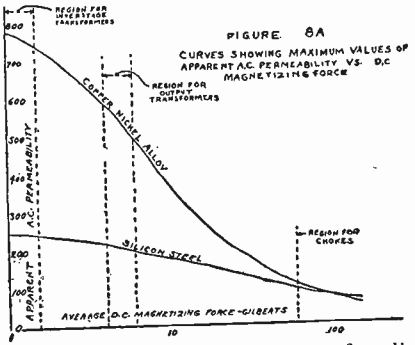


Fig. 3A shows an overall audio frequency voltage characteristics of a 6-tube neutralized receiver. Fig. 4A shows same characteristics for a 5-tube receiver using a different kind of neutralization.

These curves were obtained by using an equipment as one just described.

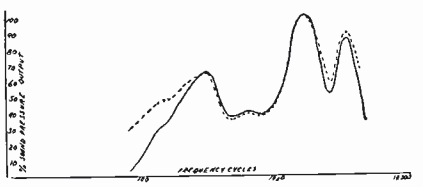
The voltage drop on high audio frequencies as shown on these curves is caused chiefly by the r.f. by-pass condensers while the drop at low frequencies is caused by the low impedance of the loud speaker and output transformer at those frequencies. The problem of the output transformer is a very serious one and should not be overlooked.

Fig. 5A shows what can be done by using various output transformers. Again the nickel-iron alloy and copper-nickel alloy help us out of trouble. The permeability curves of these metals are shown in Fig. 8A.

Fig. 6A shows what a good output transformer does to an overall sound pressure characteristic of a receiver combined with a loud speaker. Of course, the difference will be negligible on speech and very pronounced on organ music due to the difference in pitch between the two.

To conclude my talk I will say that all the indications are that the Radio

FIGURE 6A
OVERALL AUDIO FREQUENCY CHARACTERISTICS OF RECEIVER SHOWING THE EFFECT OF OUTPUT TRANSFORMER



Industry is through with "the cut and dry" methods of development. Individual experimentors are replaced by engineering departments and laboratories and the progress may be slower but surely more certain.

Constructional Developments of the Month

Interbalanced Regenerator

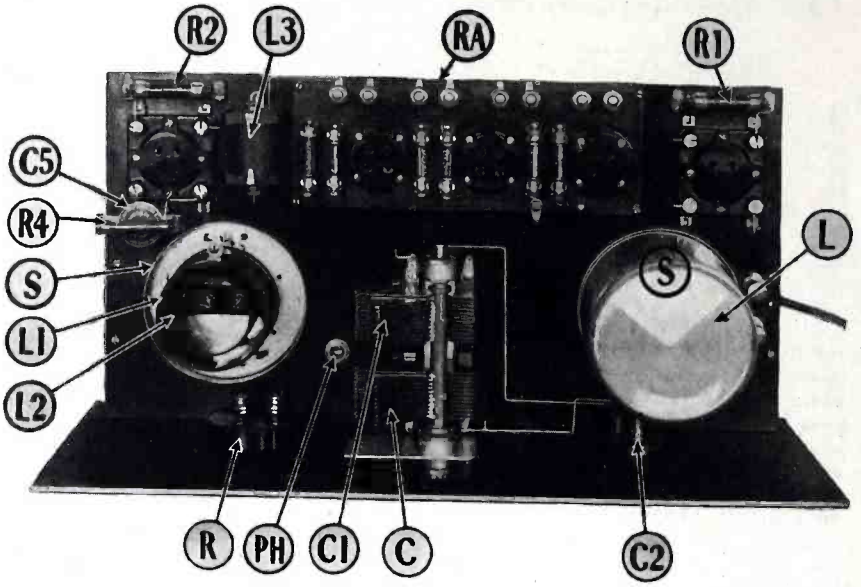
THE "Interbalanced Regenerative Receiver," full details of which are to be found in the *June issue of Radio News*, is a five-tube set whose circuit comprises one stage of tuned-radio-frequency amplification, a regenerative detector, and three audio amplifier stages of the resistance-capacity-coupled variety. It derives its name from its main features: *i. e.*, the simultaneous adjustment, by one control, of both the coupling between the R.F. and detector tubes and the regenerative action of the latter. This control takes the form of of a variable resistor of 10,000 ohms maximum, connected in such fashion that it provides for the closest coupling and the strongest regeneration when its resistance is highest. This action is assisted by the phase-shifting device known as the "Phasatrol," which is connected in the plate circuit of the R.F. tube, between the plate and the primary of the R.F. transformer.

The operation of the system can be understood from a brief study of the schematic circuit shown herewith. The diagram shows an antenna coupler L (consisting of the usual untuned primary and the secondary tuned by the large condenser, C, and the "vernier," C2), wired to the grid of the first (the R.F.) tube. The plate is coupled to the detector by a similar transformer, L1, which is fitted in addition with a fixed tickler coil, L2. The tickler is connected to the plate of the detector through the fixed condenser C6, completing its circuit back through the *primary of the R.F. transformer*. It should be noted particularly that the tickler is actually in series with the primary; *both coils, therefore, act upon the secondary of the transformer as feed-back mediums.* The variable resistor is connected across the outer ends of the respective coils, and thus acts as a throttle (in a way, as a variable short-circuit) on them. The fixed condenser and resistor enclosed in the dotted circle represent the Phasatrol.

The latter device prevents oscillation in the R.F. stage by shifting the phase relationship of the feed-back current (through the grid-plate capacity of the tube) to the original signal impulse. Its presence also accounts for another phase shift in the feed-back current flowing through the tickler coil L2 (and also through the primary, L1) from the plate of the detector, this shift taking place in such a manner that the inductive effects of both the legitimate tickler and the erstwhile primary on the secondary coil are *additive*, in other words, the primary, in addition to acting as such, acts also as a tickler coil.

As previously mentioned, the variable resistor R regulates the dual effects of the primary and of the tickler. It is adjusted for maximum response while the set is being tuned to various wavelengths.

The R.F. choke L3 is very important in that it prevents leakage of the R.F. currents through the "B" circuit.



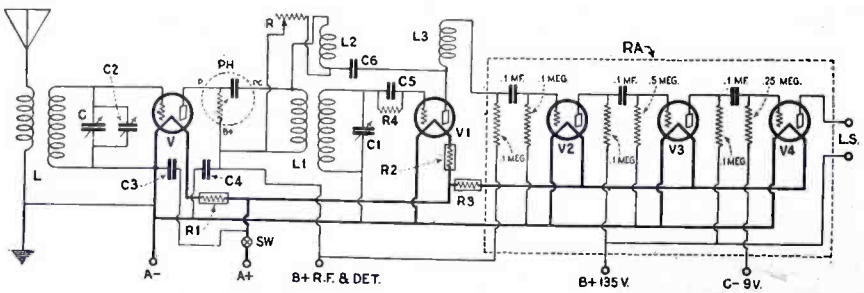
Top view of the Interbalanced Regenerative Receiver. The right-hand shield encloses the antenna coupler. The list of parts below provides the key to the symbols.

Simple Control Methods

The advantages of the Interbalanced Regenerative Receiver are obvious. The manual operation of the receiver is simplified, for what ordinarily are two fairly critical adjustments are reduced in number to one. Also, the system of control reduces the detuning effect of the tickler on the secondary coil of the R.F. transformer, and allows the use of a double variable condenser for the tuning of the R.F. and detector circuits. A midget condenser (C2), for supplementary adjustment of the R.F. condenser (C), is provided; but in actual use it is set once and then left alone. The tuning of the receiver then resolves itself into the mere manipulation of the condenser dial and the resistor knob.

Following is the list of parts:

L—1 General Radio Ant. Coupler.
L1—1 General Radio R.F. transformer.
L2—1 Tickler coil (15 turns of No. 24 D.S.C. wire on a 2" dia. tube).
L3—1 Samson 85 M. H., R.F. choke.
C, C1—1 Hammarlund .0005 mfd. gang condenser.
C2—1 Cardwell 50 m-mfd. midget variable condenser.
C3, C4—2 Carter 0.5 mfd. by-pass condensers.
C5—1 Carter .00025 mfd. molded grid condenser with mounting clips.
C6—1 Carter .002 mfd. molded by-pass condenser.
R—1 Centralab 0-10,000 ohm variable resistance.
R, R2—2 Elkay 5V. ¼ amp. filament ballasts.
R3—1 Elkay 5 V. 1 amp. fil. ballast.
R4—1 Electrad 2 megohm grid leak.
PH—1 Electrad Phasatrol.
RA—1 De Jur 3 stage resistance coupled amplifier.



The schematic diagram of the Interbalanced Regenerative Receiver. Note that the radio frequency currents in the plate circuit of the detector tube are by-passed through the condenser C6.

Left: A view of the completed Modulated Oscillator and a group of plug-in coils for covering various frequency ranges. The frequency of the R.F. oscillator is controlled by the dial. Below: The schematic diagram of the test oscillator. Note that the negative filament leg is grounded.

S—2 Silver-Marshall coil shields.
SW—1 Carter filament switch.
V, V1—2 R. C. A. 5 V. ¼ amp. standard type tubes.
V2, V3—2 R. C. A. 5 V. ¼ amp. high-mu tubes.
V4—1 R. C. A. 5 V. ½ amp. semi-power tube.
2 Eby tube sockets.
2 X-L binding posts.
1 Cornell vernier dial.
2 Silver-Marshall panel brackets.
1 Celoron panel, 7 x 18 x 3/16".
1 Celoron sub-base, 6¾ x 17 x 3/16".
1 Belden 5-wire battery cable.
1 roll Belden hookup wire.

(For list of alternate parts see June issue of *Radio News.*)

Modulated Oscillator for Test Work

"An Instrument for the Home Laboratory" is the title of a constructional article by Mr. Keith Henney appearing in the *June issue of Radio Broadcast* which should be of special interest to professional set builders and laboratory engineers.

It deals with the construction of a modulated oscillator. The purpose of the oscillator is to provide a source of modulated radio frequency energy with which to accomplish various laboratory tests and measurements.

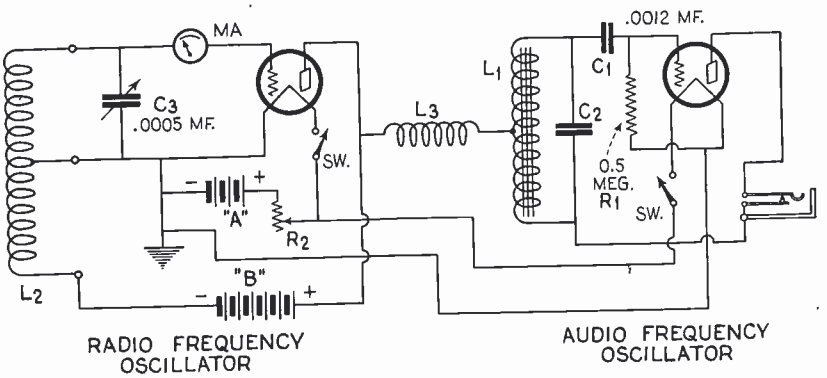
The circuit, shown herewith, comprises one radio frequency oscillator which is modulated by an audio frequency oscillator. One and one-half volt vacuum tubes are employed which are operated from a number of 1½ volt dry cells connected in parallel.

A milliammeter is included in the grid circuit of the radio frequency oscillator which is valuable in indicating resonance.

Plug-in coils are utilized in connection with the radio frequency oscillator so that a wide band of frequencies can be produced. They are shown in the accompanying illustration.

An output transformer L1, is employed as the inductance for the audio frequency oscillator.

The parts employed in the construction of this oscillator are as follows:
L_1—1 Pacent 27-B output transformer.
L_2—4 General Radio Coils:
277-A.
277-B.
277-C.
277-D.
L_3—1 Samson Radio Frequency Choke No. 85.
C_1—1 Sangamo Condenser 0.0012 Mfd.
C_2—1 Small Fixed Condenser.
C_3—1 Karas Straight Frequency-Line Condenser, 0.0005 mfd.
R_1—1 Carborundum Grid Leak, 5 Megs.
R2—2 Frost Rheostats, 10 ohms.
2 Carter "Imp" Battery Switches.
1 Carter Closed-Circuit Short Jack.
1 Weston Milliammeter 0-1.5 mils.
2 Benjamin Brackets.
3 General Radio Binding Posts.
2 Benjamin Sockets.
1 Main Panel 10" x 12½" x 3/16".
1 Sub-Panel 6" x 9" x 16".
Machine Screws, Wire Solder, etc.



R. M. A. Activities

R. M. A. Convention Preparations

All that is, and all who are, Radio will be found in Chicago during the week of June 13th to 17th for the Annual Conventions of the Radio Manufacturers Association, the Federated Radio Trade Association and the First Annual Radio Trade Show. All three events will be staged simultaneously at the new Hotel Stevens.

Without undue optimism, the facts at hand at this time indicate that still another important milestone in the history of the Radio Industry will be reached at this time. Reduced fares on a fare and a half certificate plan have been granted by the Western and Central Passenger Associations, and already more than five special trains have been sold out on the several railroads which were the first to organize such services.

The vanguard of the luminaries who will take part in the two conventions is headed by the Honorable Herbert H. Hoover, Secretary of Commerce, who will be the guest of honor and principal speaker at the R. M. A. Banquet on Thursday evening, July 16th. Paul B. Klugh of the National Association of Broadcasters will officiate as Toastmaster, and in addition to Secretary Hoover will introduce the newly elected officers of the R. M. A. and Mr. Merlin H. Aylesworth of the National Broadcasting Company, who will also address the Banquet.

On Thursday morning there will be the open technical meeting of the newly organized Engineering Division under the direction of Mr. H. B. Richmond of the General Radio Company

of Cambridge, Mass. This will constiture the first time that the engineers of the industry and the dealers and jobbers are brought together.

The standards which the R. M. A. has been working on for more than a year, the majority of which are in practice at the present time by its members, will come before this meeting for a final revision and adoption.

In the general open meeting, both the R. M. A. and the dealers and jobbers organization, which in addition to the President's address will be featured by discussion of new and further merchandising plans, Mr. Fred Woods, head of the Statistical Department of the Hearst organization, will lead the program. Mr. Woods is an acknowledged authority on market analysis.

The R. M. A., comprising as it does virtually all of the outstanding manufacturers in the Radio Industry, expects a full attendance of their members, which number close to 500, while the Federated Radio Trades Association, of which Harold J. Wrape of St. Louis is President, anticipate an attendance of over 2,000 jobbers and dealers. The entire Stevens Hotel has been taken over by the R. M. A., and the problem is now to find additional facilities for the overflow. All exhibition space in the Trade Show has been reserved for more than sixty days.

The detailed program follows:

Monday—10:00 a. m......
Registration of Delegates and Alternates.
Registration of Visiting Dealers and Jobbers.
(Committee Chairmen will arrange their meetings at this time.)

Monday—2:00 p. m.
Opening of the Trade Show.
First showing of new 1928 lines.

Monday—10:00 p. m.
Closing of the Trade Show.

Tuesday—10:00 a. m.
R. M. A. General Open Meeting.
President's address—*Arthur T. Haugh*. Addresses by *Mr. Fred Woods and Maj. H. H. Frost*.
(Dealers and Jobbers invited.)

Tuesday—2:00 p. m to 10:00 p. m.
Trade Show open.

Tuesday—8:00 p. m.
Meeting of all Jobber and Dealer Associations, *Mr. Harold J. Wrape*, President of the Federated Radio Trades' Association, presiding.
Address by *Maj. H. H. Frost* on Merchandising.

Wednesday—10:00 a. m
Closed R. M. A. meeting; election of officers and transaction of general business.
Opening meeting, Federated Radio Trades' Association.
(Dealers and Jobbers invited.)

Wednesday—12:30 p. m.
Luncheon 4th Annual Radio Industries Banquet Committee, *Paul B. Klugh*, General Chairman.

Wednesday—2:00 p. m. to 10:00 p. m.
Trade Show open.

Thursday—10:00 a. m.
Open Technical meeting, Engineering Divisions, *Mr. H. B. Richmond*, directing.
(Dealers and Jobbers invited.)

Thursday—10:00 a. m. to 6:00 p. m.
Trade Show open. (Please note special hours of Trade Show for today.)

Thursday—7:30 p. m.
Annual R. M. A. Banquet, *Paul B. Klugh*, Toastmaster.
Introduction of new officers.
Address by *Hon. Herbert H. Hoover*.
Address by *Mr. M. H. Aylesworth* of the National Broadcasting Company.

Friday—10:00 a. m.
R. M. A. Closed Meeting. Committee Reports.

Mr. L. S. Baker—Assistant to Executive Chairman of National Assn. of Broadcasters; Executive Secretary of National Radio Coordinating Committee and Executive Vice-President of R.M.A.

Appointments of new committees.
Completion of unfinished business.
Closed Meeting of the Federated Radio Trades' Association.

Friday—2:00 p. m. to 10:00 p. m.
Trade Show open. LAST DAY.

Special Convention Railroad Rates to All Members

A reduction of one and one-half fare on the "Certificate Plan" will apply for all members attending the R. M. A. meeting to be held at the Stevens Hotel, Chicago, Illinois, June 13 to 17, 1927, and also for the dependent members of their families.

The following directions are submitted for your guidance:

1. Tickets at the regular one-way tariff fare for the going journey may be obtained on any of the following dates (but not on any other date), JUNE 9th to 15th, INCLUSIVE. Be sure that, when purchasing your going ticket, you request a CERTIFICATE. *Do not make the mistake of asking for a "Receipt."*

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

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

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

5. Arrangements have been made for validation of certificate by a Special Agent of the carriers on June 13th to 17th, inclusive, if the required minimum of 250 certificates is presented.

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

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

8. If the necessary minimum of 250 certificates is presented to the Special Agent as above explained, and your certificate is duly validated, you will be entitled up to and including June 22, 1927, to a return ticket via the same route over which you made the going journey, at one-half of the regular one-way tariff fare from the place of meeting to the point at which your certificate was issued.

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

Radio Banquet Committee Meets in Chicago June 15

The organization meeting of the Fourth Annual Radio Industries Banquet Committee will be held at the Stevens Hotel, at luncheon, at 12:30 on Wednesday, June 15th, according to announcement by Paul B. Klugh, general chairman of the committee, for the fourth annual banquet.

More than seventy members of the Banquet Committee are expected to attend this organization meeting, according to Mr. Klugh, where reports of the various sub committees will be heard and plans for the coming year's affair discussed and arranged.

NEWS OF THE INDUSTRY

Radio Corporation of America Licenses Four Radio Manufacturers

It is officially announced that the Radio Corporation of America has licensed the All-American Radio Corporation, of Chicago; the Zenith Radio Corporation, of Chicago; the Splitdorf Electrical Co., of Newark, N. J., and the Radio Receptor Co., of New York, to manufacture under the one hundred or more basic patents owned or controlled by the Radio Corporation group. This group embraces in addition to the Radio Corporation of America, the General Electric Company, the American Telephone & Telegraph Company, and the Westinghouse Electric & Manufacturing Company.

As yet, no official announcements relative to next season's programs have been given out by the four licensed manufacturers.

Kimball Stark Goes to Crosley

In line with the plan of Mr. Powel Crosley, Jr., to improve merchandising this year, Kimball H. Stark has been appointed Advertising Manager.

Mr. Stark has been actively employed in the radio industry for the last ten years.

From March, 1917, to July, 1918, he was with DeForest Radio, Telephone and Telegraph Company in the factory and laboratory, working on vacuum tube pumps, which included the manufacture of both receiving and transmitting tubes.

From August, 1918, to September, 1919, he was with the Sperry Gyroscope Company, New York City, employed in Radio engineering and test work in connection with the Navy war-time receiving equipment, including special short wave and special long wave receivers and airplane radio transmitters.

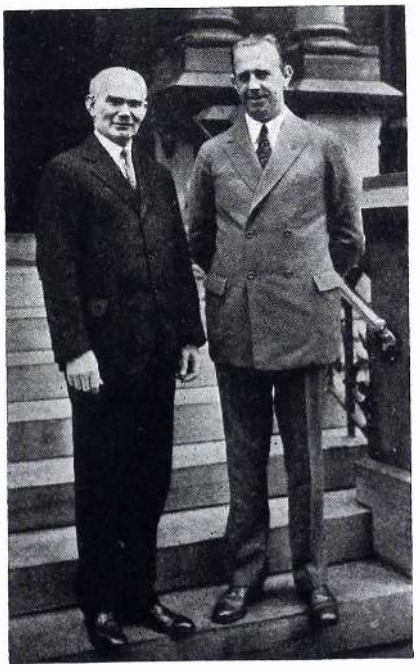
From October, 1919, to January 1920, he was with the Wireless Improvement Company, Jersey City, as a radio test engineer on special Navy radio compass receiving equipment.

In January, 1920, he returned to the Sperry Gyroscope Company as a radio engineer, in charge of test of special Navy compass equipment, including experimental and design work. March 1, 1921, he joined F. A. D. Andrea, Incorporated, New York City. For a period of three years Mr. Stark was Fada Chief engineer. In addition to these duties, he managed the advertising and sales departments.

In June, 1926, Mr. Stark had charge of purchase, inventory and production control, including the organization of statistical methods, of the Charles Freshman Company, New York.

Radio's Premier Publicity Man Signs Off

The human mouthpiece of the Radio Corporation of America, the man



Dr. Lee DeForest and Powel Crosley, Jr. Mr. Crosley is now President of the DeForest Radio Corp. and Dr. DeForest, Vice-president and Consulting Engineer. Mr. Crosley retains his other interests.

through whom the RCA has announced its policies to the public and heralded its plans and important announcements—the man who, through the press, told the story of the flashing of the first picture across the Atlantic Ocean—is signing off. Probably one of the best known and yet the least known man in the field, for he has always been speaking for the RCA and not for himself, is J. L. Bernard who will now blow his own horn for a change, probably giving it an extra toot for Isolantite, a new ceramic product recently introduced in the radio, electrical, chemical and thermal fields of application.

Mr. Bernard has organized under the name of J. L. Bernard Company, with headquarters in the Tribune Building, New York City, to represent the Isolantite Company of America, Belleville, N. J., in an engineering-sales capacity. He will continue his active participation in the radio field, but in the new role of telling radio and electrical manufacturers at the very start how to simplify production problems and how to turn out better products, rather than at the finish in telling of their achievements, as in the past.

Joseph J. Braun Goes to Micarta Fabricators, Inc.

Joseph J. Braun formerly president and general manager of the Accurate Gear Corporation, Brooklyn, N. Y., has taken up his new duties as chief engineer of the Micarta Fabricators, Inc., 307-11 Canal Street, New York City, and general manager of the Accurate Gear division of this company.

Mr. Braun's long experience in the application of Micarta in the gear and general industrial field brings to the Micarta Fabricators, Inc., who are just entering this field the necessary practical knowledge and engineering experience for a successful carrying out of their plans.

Grigsby-Grunow-Hinds Co. Secure New Men

Mr. J. J. Schratwieser has recently become associated with Grigsby-Grunow-Hinds Company, Chicago, manufacturers of the Majestic power Units.

Mr. Schratwieser has had considerable experience in merchandising radio and musical instruments, especially in the Brooklyn trade area where he is now promoting Majestic products.

Mr. Schratwieser was instrumental to a considerable degree, in securing remarkable dealer co-operation for the Sonora Phonograph Company in the Brooklyn trade area and this experience will be valuable to him in his connection with the Majestic Company. He will work under the direction of Herbert E. Young, eastern manager.

J. P. Miller, until recently manager of the radio and phonograph department of one of the largest Worcester, Mass. stores, has joined the eastern sales office of Grigsby-Grunow-Hinds Company. Mr. Miller will call on Majestic dealers in Pennsylvania, West Virginia and northeastern Ohio, which territory he formerly covered for a

Pittsburgh Victor Talking Machine wholesaler.

Mr. Miller will closely co-operate with Herbert E. Young, eastern sales manager for the G-G-H organization. Mr. Miller's years of experience in the retail radio field will serve him in good stead, in giving advice and assistance to Majestic dealers.

Albert Boehlke has been appointed Sales Manager for the Chicago district, for Majestic Current Supply Units.

Mr. Boehlke has been engaged in dealer promotion work with Grigsby-Grunow-Hinds Co. in the Chicago zone for some time past, and therefore is exceptionally well qualified to fill his new position. He will co-operate closely with Majestic distributors in the Chicago territory in merchandising Majestics to dealers.

Insulation Manufacturing Company

The General Insulate Company, Inc. has been acquired by the Insulation Manufacturing Company, Inc. (Electrose Products) of 70 Washington Street, Brooklyn, N. Y., and will be continued as the Department of the new owners under the name of General Insulate Company, Inc.

With the merger of these two plants occupying thirty thousand square feet of the most modern type of factory space, with new and improved machinery, each company will continue to specialize in Bakelite and the various kinds of moulded products and insulators for which they have been known as the originators and largest manufacturers.

The combined organizations cover an experience of over 25 years in insulation and moulded products specialties, as well as an especially equipped machine shop with experts for the making of the most complicated and difficult dies and moulds. Our big production, efficient methods, and high grade materials mean dependable results and right prices.

Buckingham Chassis Merchandizing Plans

In its sales plan for the coming year the Buckingham Radio Corporation of Chicago, is including an attractively and splendidly prepared booklet on the subject of chassis merchandising. This booklet tells the story in a convincing manner, and should be of interest to every large buyer of radio receiving sets. It shows in concrete form just how the large jobber, department store and large retailer can profit by purchasing a guaranteed chassis under his own name and marketing it as his own product.

The Buckingham Corporation is offering to the trade a definite chassis merchandising service; tying up the Buckingham chassis line with a complete assortment of unusually attractive and moderate priced consoles. These consoles are being built particularly for the Buckingham chassis line and are equipped with special speakers and units. The Buckingham Corporation do not handle the cabinets but are placing before their customers a direct and certain source of cabinet supply. The whole arrangement is a complete and interesting radio merchandising plan which should be of interest to every class of radio distributor.

O. M. Hovgaard Joins Briggs & Stratton Corp.

The Briggs & Stratton Corp. announces that Mr. O. M. Hovgaard has become associated with the organization and will take charge of the Radio Research Department.

Mr. O. M. Hovgaard, now chief of Research Department, Briggs & Stratton Corp.

Mr. Hovgaard just finished a four year course in Radio Communication at the Massachusetts Institute of Technology. Previous to completing this course he was six years as Instructor on Research Assistance at the Institute.

Mr. Hovgaard is going to devote all of his time in the field of research on both "A" and "B" eliminators.

NEMA Radio Standards

The first comprehensive group of standards for the radio industry have just been published by the National Electrical Manufacturers' Association, according to announcement by L. B. F. Raycroft, vice-president of the Radio Division. These standards are available to any manufacturer, distributor, dealer, service shop, public utility or amateur and may be obtained from the association headquarters at 420 Lexington avenue, New York, for one dollar a copy.

In this fifty-page handbook are standards for such items as antenna package, instructions for antenna installation, radio jacks, condenser and rheostat mounting, temperature tests for loud speakers, tests for audio coupling devices, allowable potentials on loud speaker cords, etc.

The handbook establishes the frequency range of broadcast receivers in the band from 550 kilocycles (541.1 meters) to 1500 kilocycles (199.0 meters). Standards are also given for such items as control markings for receiving sets, and defining such terms as "volume," "intensity," "station selector," etc.

In the vacuum tube section dimensions and drawings are given for various standard tubes and bases, and definitions for such terms as diode, triode, control electrode, grid potential. Formulae are shown for a number of technical values as plate resistance, input admittance and mutual conductance.

Engineer and amateur will appreciate the appendix giving fundamental symbols for inductance, capacity, resistance and also other familiar electrical terms which have special application to radio, such as "inductor shielded," "coil antenna," etc. The symbols are really the radio man's shorthand for both conversation and record.

The appendix also deals with specifications for the construction and test of power operated radio receiving appliances which is a proposed standard, not yet adopted by NEMA, but "distributed at this time for study and criticism."

Commenting on these standards, C. A. Bates of the Bryant Electric Company, who is chairman of the Standards Committee for the entire association which issued the handbook, said: "The technical requirements of radio today are almost entirely electrical, and in the preparation of radio standards it is therefore necessary to refer them for final check to the current practice in the electrical industry, with regard to both problems of design, manufacture and operation of equipment.

"NEMA standards are obtained by considering the many elements of both commercial and technical nature which are affected. Each division in our association operates independently with regard to the equipment of their special field until it affects some other group. By clearing the final results through a central standards committee, we have a product which is approved and tested, and fits in with the best experience and practice as well as being an authoritative and truly representative agreement, from the many branches of our electrical industry who serve or are affected by radio. In my opinion these standards are a genuine contribution, and will help in stablizing and promoting the business of the radio manufacturer."

NEMA to Hold Annual Meeting at Hot Springs, Va.

Apparatus, Supply and Radio Divisions of the National Electrical Manufacturers' Association will hold their annual meeting May 28th to June 3rd at Hot Springs, Va.

The Board of Governors, the Standards Committee and the Radio Division will meet on Saturday, May 28th. Meetings for all divisions will open Monday morning. General sessions will be held on Monday to Thursday evenings, inclusive. There will be section meetings Friday morning for Supply and Apparatus Divisions, and the Radio Division will meet as a whole on June 3rd.

Rochester Radio Show Coming

Rochester Radio Trades, Inc., Rochester, N. Y., will hold its third annual Rochester Radio Show at Convention Hall from September 26th to October 1st, it is announced by Thomas B. Sharar, president of the Association.

Chas. L. Hohman, vice-president of the Association, will act as show manager, and Herbert C. Siller will be assistant show manager.

The Australian National Band, which made such a hit at the Rochester Radio Show last year, has been contracted for to play at the show this year with two concerts daily. The band returns to America on May 27th to play in a number of the larger coast cities, and at the big Western Canadian fairs, then at the Ottawa fair, and other cities. It is composed of thirty champion musicians who have won over three hundred medals in competitions with musicians throughout the world.

Freed-Eisemann Radio Corporation and Caswell-Runyan Company Combine in Huge Deal

One of the largest deals in the history of the radio industry has just been consummated between the Caswell-Runyan Company, cabinet makers of Huntington, Ind., occupying a plant of 625,000 square feet, and the Freed-Eisemann Radio Corporation, Brooklyn, N. Y.

Under the new arrangement, the Caswell-Runyan Company is to manufacture radio cabinets exclusively for Freed-Eisemann. Freed-Eisemann will do the national advertising but Caswell-Runyan will sell direct to Freed-Eisemann distributors. Freed-Eisemann will supply the distributors with chasses to be mounted in the cabinets.

In an interview on the subject of combination of interests of the Caswell-Runyan Company and the Freed-Eisemann Radio Corporation, Mr. Alexander Eisemann stated:

"Under the arrangements recently consummated between our Company and the Caswell-Runyan Company, we have what we believe is the first feasible plan of distribution of cabinets, since the inception of the great demand for furniture models. We have found the means of eliminating the necessity for distributor or dealer making large commitments far in advance of the season and the danger of a shortage of consoles if such early commitments are not made.

"The agreement of our Company with the Caswell-Runyan Company comprises a standardization of their line of consoles into a few acceptable models. We display and advertise this furniture in the national advertising media. By virtue of this standardization and advertising, the Caswell-Runyan Company finds it possible and in fact is obligated to build by August 1st, a huge quantity of four styles of cabinets.

W. J. Seroy, Pacific Coast Representative of "Majestic," uses his tire carrier as bill board.

"The Freed-Eisemann Radio Corporation, under this plan, functions as national sales agent — not as national distributor. No deliveries of Caswell-Runyan cabinets may be made to any distributor or dealer without entry of the order and sanction by us. However, in billing the distributor direct, the transportation, overhead charges and profit which would otherwise be necessary for us to add, are eliminated and the merchandise is brought down to a figure far below that at which it would be possible to sell the radio furniture under any of the plans heretofore in operation.

Solves Economic Problem

"From an economic standpoint, the manufacturer of radio apparatus cannot function as a national super-jobber of furniture. The radio manufacturer's problem heretofore has been somewhat as follows: The public demands cabinet-housed radios. The radio manufacturer builds his radio set but does not own a furniture factory. In order to supply distributors and dealers with furniture, consoles, etc., the radio manufacturer has been obliged to purchase consoles, take them into his plant, add transportation charges, carrying charges, overhead expense and profit. He then has his radio apparatus housed in this furniture and rebills not only the set but the furniture as well to his distributor, creating an uneconomic situation through the duplication of railroad carriage, handling charges, overhead, profit and the increased freight rate covering the whole combination. (Furniture with radio apparatus carries a much higher freight rate than furniture without radio.)

"Thus, while the manufacturer functions economically in the manufacture and sales of the radio instruments, he is at the same time, however, a sort of super-jobber on the furniture housing and it is my belief that this is not a sound merchandising set-up. A palliative plan was in operation last season under which the radio manufacturer shipped his sets in chassis form and left it to the distributor or dealer to select and buy consoles to house the chasses. This system results in the manufacturer's set being housed in many different styles of consoles and makes it necessary for the jobber and dealer to enter into commitments far in advance of the season if the jobber or dealer is to receive deliveries of consoles in time for marketing.

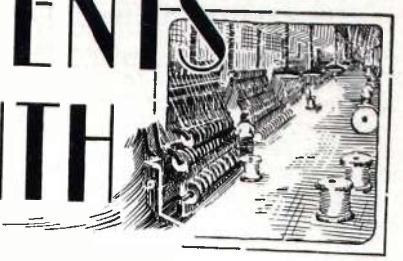
Standardized Models

"Under the new contract, supplies are assured early in the season to Freed-Eisemann distributors and dealers. The models will be standardized; thus no distributor or dealer will find it necessary to make a large commitment far in advance of the season. The same standardization assures the jobber and dealer of always being able to get the necessary quantities and instead of distributors and dealers being obliged to choose and order designs of many kinds, a definite concrete and nationally advertised cabinet will be available and available in advance of the season.

"Every indication points to *this* being a furniture year. We all remember the early days of the phonograph with its table models and how it devolved on the manufacturer to satisfy the necessities of the modern drawing room by building phonographs in acceptable furniture form. Radio will surely follow this trend and the problem of keeping down the cost of the complete installation can only be solved by the elimination of the radio manufacturer as a super-jobber of furniture.

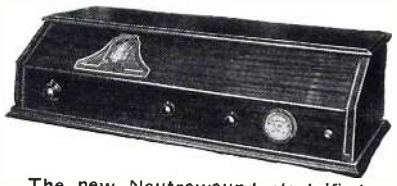
"There are thousands of table models now in use and the wise dealer this season will instruct his service man who calls on the consumer, to suggest that the consumer buy a cabinet in which to house the consumer's present set. There is a tremendous amount of cabinet business available to the wise dealer who will sell separate cabinets to house table models sold last season."

NEW DEVELOPMENTS OF THE MONTH



Neutrowound Radio Mfg. Co. Announce New Electric Receiver

The Neutrowound Radio Mfg. Co. of Homewood, Ill., announce the Neutrowound "Allectric" operating direct from the electric light socket, using from 85 to 125 volts 60-cycle current. The "Allectric" dispenses entirely with "A," "B" and "C" batteries. The radio set and power supply unit are all contained in the one compact cabinet. It is equipped with a specially designed compensating device which regulates the fluctuation in the line current, thus insuring steady and efficient operation of the receiver.



The new Neutrowound electrified receiver.

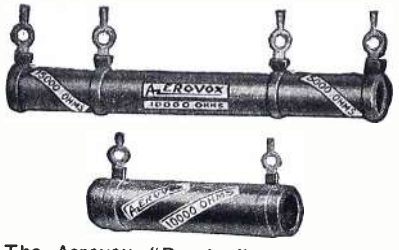
The receiver has two tumbler tuning dials which are so positioned that they can be operated with one finger.

A 171 type power tube can be used in the last audio stage in which case it is supplied with the necessary 180 volts "B" potential and 40½ volts "C" bias.

The "Allectric" receiver is 28½ inches long, 13 inches wide and 8½ inches high. The net weight is 35 pounds; the shipping weight 54 pounds. Complete instructions are included with every receiver leaving the factory.

Aerovox "Pyrohm" Resistance Units

The Aerovox Wireless Corporation of 70 Washington Street, Brooklyn, N. Y., have just announced a new line of resistance units to be marketed under the trade name of "Pyrohm." These units are of the wire-wound type and made of the best resistance wire obtainable, wound on a refractory tube and coated with special enamel which is fired on under intense heat.



The Aerovox "Pyrohm" wire wound resistance units.

Both types of units are shown in the illustration. The 2-inch length resistance will dissipate 20 watts and the 4-inch resistance will dissipate 40 watts.

The wire, the tube, and the enamel have the same co-efficient of expansion which allows the unit to be used under heavy loads without displacement or injury to the wire. The resistance value is permanent and will not change with use.

Resistance units of this type are of special value in use with "B" eliminators for voltage adjustment purposes. They are made in a number of different resistance values.

Sprague Tone Control

The Sprague Specialties Company of Quincy, Mass., have filled a long felt want by producing a Tone Control unit to be used in conjunction with all types of loud speakers so that the exact tone shading can be adjusted to suit the individual ear.

The New Sprague Tip Jack.

The Tone Control is mounted in a very small, molded insulation casing from which extends a phone cord. The Tone Control itself, comprises an adjustable condenser with a capacity range from 0 to .032 mfd. This capacity is controlled by a small knob on top of the casing.

When connected between the radio set and speaker it allows for accurate impedance matching.

The Sprague Specialties Company is also marketing a new type of Tip Jack. The nut, spring and soldering lug are riveted into one unit for easy assembly. The hexagon head tip receptacle is counter-bored and finished in highly polished nickle. Both units are multiple threaded, making quick and firm assembly. A double-action spring, made of spring-tempered phosphor bronze is attached in the same unit with the tinned, soft annealed soldering lug. The soldering lugs are provided either cupped or flat.

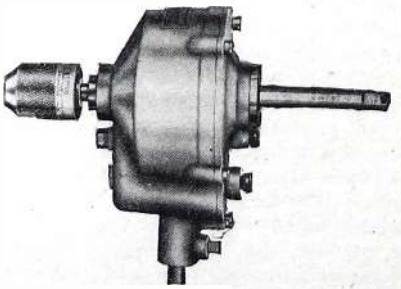
Pilotran Audio Transformer

In manufacturing the Pilot Audio Transformer, the Pilot Electric Manufacturing Company of Brooklyn, New York, has not only made the inner construction of the very finest materials, but has paid particular attention to the casing. The Pilotran case is moulded entirely of Bakelite which entirely eliminates any possibility of short circuits or leakage between terminals.

The Pilotran has been especially designed to give the maximum amplification factor on all frequencies without distortion and will easily handle the new power tubes in addition to all standard tubes. The Pilotran is made in two ratios, 3½ to 1 and 2 to 1 for use in the several audio stages.

Ettco High Speed Tapping Attachment

The Eastern Tube & Tool Co., 594 Johnson Avenue, Brooklyn, N. Y., are now making deliveries on the No. 2 new size Ettco High Speed Tapping Attachment. The range of this tool is from 0 to ⅜". This Tapping Attachment is designed for high speed sensitive tapping. There is no friction for the operator to set. It eliminates tap breakage, whatever the cause. In fact, a green operator can hit the bottom of a tapped hole without breaking the tap. The leather-lined cone clutch and cast iron driving cone have a smoothness of action and a slipping point which prevent tap breakage. The operator can enter or stop a tap at whatever speed is desired, regardless of the speed of the drill press, by the simple regulation of the press lever. If a tap sticks, the clutch slips; if it sticks backing out, the reverse cone slips. The reverse is twice as fast as the forward speed. By locking the threaded Morse shank in the tapper, left-hand threads can be tapped as readily as right



The Ettco electric driven, high speed tapping machine.

AN INFORMATION SERVICE

for

DEALERS
DISTRIBUTORS
MANUFACTURERS

RADIO ENGINEERING, in addition to covering comprehensively, each month, the technical and industrial developments as they apply to the *business* of Radio Manufacturing and Distributing, offers also a valuable information service to its subscribers.

A production manager wishes to learn about sources of supply.

A designer wishes some specialized information to help him meet a problem.

A dealer wishes technical information to help him in his selection of lines.

A professional set builder wants dope about a new circuit or system.

RADIO ENGINEERING usually has this information available at a moment's notice. If not, the information is obtained from the proper source and passed on to the person interested.

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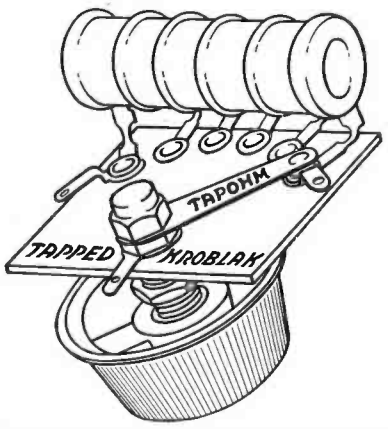
hand. An aluminum case and light alloy steel parts greatly reduce weight. This tapper can be applied to light drill presses. It is claimed, by the manufacturer, that on some work this tapping attachment will increase production from one hundred to five hundred per cent. The manufacturers state they will be very pleased to put them out on a ten-day trial basis.

The Mountford "Tapohm"

The C. E. Mountford Co., New York City, have announced the Mountford Tapohm. It is a tapped Kroblack wire wound resistance—designed especially for use in "B" Eliminators.

The Tapohm has a total resistance of approximately 30,000 ohms and will give nine variations in voltage.

The voltage range given by the Tapohm is regulated by two factors, namely: Total eliminator voltage (represented Vt) and the series fixed resistance.



The Mountford tapped resistance unit designed expressly for "B" eliminators.

With a voltage of 135 and A series resistor of 25,000 ohms the voltage delivered to the detector tube is as follows: 0-14-15-24-27-33-37-41-45-48. volts.

With 185 volts and 25,000 ohms, range is 0-20-22-33-36-43-47-52-57-60 volts.

If the eliminator voltage exceeds 200 volts the series resistor value should be 50,000 ohms.

New Loudspeaker

The Symphonic Sales Corporation, of 370 Seventh Avenue, New York City, are introducing to the trade a new type of loudspeaker—the Symphonic Globe Radio Loudspeaker.

This is a decidedly different speaker in both appearance and quality of tone. Its double purpose gives that additional value long needed in the loudspeaker field.

The Symphonic Globe Speaker has a remarkably fine tone—extreme clear speech and high musical quality. In the ball-shaped interior there is no vibration elsewhere than in the diaphragm of the powerful unit itself.

The Globe itself is an accurate full-sized library globe—an up-to-the-minute post-war map of the entire world.

This new speaker can be cleaned with a damp cloth. It is not fragile and therefore reduces the trouble of handling and shipping by wholesalers and dealers.

"A-B-C" Eliminator Transformers and Chokes

The introduction of the new Raytheon BA 350 MA tube has caused a wide-spread demand for an "A-B-C" eliminator. Dongan Electric Mfg. Co., Detroit, a pioneer in the development of transformers and chokes for "B" Power Tubes, now brings out Transformer No. 3591 and Double Choke No. 3584 for use with the new Raytheon tube. These Dongan parts are offering maximum operating efficiency with the new "A-B-C" eliminator tube.

Dongan builds Power Transformers in two types both for 201-A tubes. one having 700 volts center tap 300-400 mils, and 5 volts, ½ amperes center tap, and the other 750 volts center tap 300-400 mils with 5 volts, ½ amperes center tap and 4 volts, 5 amperes. The double chokes, inclosed in a metal case, are designed for 300-400 mils. The transformer also is built into an attractive metal case.

Ambassador Announces Two New Products

The Ambassador Sales Company, Inc., of 108 Greenwich Street, New York City, and 326 West Madison Street, Chicago, Ill., announce to the trade the Ambassador Tone Gates and the Ambassador Cone-Saver.

The Tone Gates are especially made impedances with windings impregnated with bees-wax and rosin as a resistance against temperature and atmospheric changes.

Normally, from two to three Tone Gates are used in a complete amplifier, making up three stages. It is claimed that an amplifier of this type will amplify all musical frequencies evenly without any notes being slighted or emphasized.

The Tone Gate units are designed to carry 25 milliamperes without overheating which permits the use of any power tube in the last stage.

A Tone Gate amplifier will operate with "B" eliminators without motor boating.

The Ambassador Cone-Saver is a special output unit to be used in connection with loud speakers. Used in conjunction with a 2 mfd. fixed condenser it prevents the direct battery current from flowing through the coil winding of the speaker thus protecting it from possible injury.

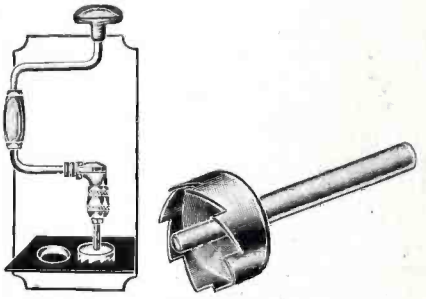
Centralab Tone Amplifier Which Can Be Attached to Any Set for Power Amplification

The Central Radio Laboratories of 16 Keefe Avenue, Milwaukee, Wis., are now marketing a single stage power amplifier which can be used in conjunction with any radio receiver. The Tone Amplifier is enclosed in an attractive, compact casing and is made in two models. Model 100 is designed for use with the CX-371 or UX-171 tubes and can be attached to any set operating from a storage battery. Model 200 is designed for use with UX-120 or CX-220 tubes and can be used only with dry cell operated sets.

Both models are so designed that no changes in the connections of the receiver are necessary in order to adapt it to this unit.

Stevens Panel Cutters

Stevens Walden-Worcester, Inc., of Worcester, Mass., are now marketing special panel cutters which can be used in connection with any type of brace or breast drill. They are very handy and efficient for cutting large size holes in radio panels. They are made in three sizes: ¾", 1" and 1½".


An efficient panel cutter for making bezel holes, etc. The cutters can be had in various sizes.

Where holes larger than 1½" are desired the type T-564 adjustable panel cutter can be used. This can be quickly adjusted from 1½ to 6 inches. The shank is 7/16th inch in diameter for convenient use in carpenter's brace or machine.

ONLY A LIMITED QUANTITY

The books listed below are available to Radio Engineering readers, at reduced rates while they last. All of these books have been published within the last two or three years. The material contained in them is entirely authentic and of considerable value to set builders.

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

Published monthly at New York, N. Y., for April 1, 1927.

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

Before me, a Notary in and for the State and county aforesaid, personally appeared B. S. Davis, who, having been duly sworn according to law, deposes and says that he is the Business Manager of RADIO ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24th, 1912, embodied in section 443, Postal Laws and Regulations to wit: 1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Radio Engineering Magazine, Inc., 52 Vanderbilt Avenue, New York; Editor, M. L. Muhleman, Bronxville, N. Y.; managing editor, M. L. Muhleman, Bronxville, N. Y.; Business Manager, B. S. Davis, Scarsdale, N. Y.; 2. That the owner is Radio Engineering Magazine, Inc., whose stockholders are: B. S. Davis, Scarsdale, N. Y.; Roy Atwood, Albany, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1% or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of this company but also in cases where a stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustees is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

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

Sworn to and subscribed before me this 30th day of April, 1927.
(Seal) JAS. WALKER, Notary Public.

Kings County.
Kings Co., Clerk's No. 390.
Kings Co., Registers No. 9100.
New York Co., Clerk's No. 159.
New York Co., Registers No. 9166.
Commission expires March 30, 1929.

Buyers Directory of Equipment and Apparatus

Addresses of companies listed below, can be found in their advertisements—see index on page 742.

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

ADAPTERS:
Bakelite Corp.
Carter Radio Co.

AERIALS, LAMPSOCKET:
Dubilier Condenser Corp.

AMMETERS
Jewell Elec. Inst. Co.

AMPLIFIERS, RESISTANCE:
Amsco Products. Inc.
Polymet Mfg. Co.

ARRESTERS, LIGHTNING:
Bakelite Corp.

BASES, VACUUM TUBE:
Bakelite Corp.
Zierick Machine Wks.

BATTERIES, DRY:
National Carbon Co.

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

BOXES, WOODEN PACKING
Tifft Bros.

BRACKETS, ANGLE:
Zierick Machine Wks.

BRACKETS, SUBPANEL:
Bruno Radio Corp.

BRASS:
Copper and Brass Research Ass'n.

CHOKES, AUDIO FREQUENCY
Irvington Varnish and Insulator Co.
National Co.

CHOKES, RADIO FREQUENCY:
Cardwell, Allen D., Mfg. Co.

CHOKES, B ELIMINATOR:
American Transformer Co.
Dongan Elec. Mfg. Co.
General Radio Co.
Irvington Varnish and Insulator Co.
Modern Elec. Mfg. Co.
National Co.
Thordarson Elec. Mfg. Co.

COILS, CHOKE:
Dudlo Mfg. Co.

COILS, IMPEDANCE:
Dudlo Mfg. Co.

COILS, INDUCTANCE:
Aero Products, Inc.
Bruno Radio Corp.
Hammarlund Mfg. Co.
Irvington Varnish and Insulator Co.
National Co.

COILS, MAGNET:
Dudlo Mfg. Co.
Irvington Varnish and Insulator Co.

COILS, RETARD:
Aero Products Co.
Hammarlund Mfg. Co.

COILS, SHORT WAVE:
Aero Products Co.
Hammarlund Mfg. Co.

COILS, TRANSFORMER
Dudlo Mfg. Co.
Irvington Varnish and Insulator Co.

CONDENSERS, BY-PASS:
Dubilier Condenser Corp.
Polymet Mfg. Corp.

CONDENSERS, FILTER:
Dubilier Condenser Corp.
Polymet Mfg. Co.

CONDENSERS, FIXED:
Aerovox Wireless Corp.
Dubilier Condenser Corp.
Electrad, Inc.
Polymet Mfg. Corp.

CONDENSERS, MIDGET:
Amsco Products. Inc.
Cardwell, Allen D. Mfg. Co.
Hammarlund Mfg. Co.

CONDENSERS, MULTIPLE:
Amsco Products. Inc.
Cardwell, Allen D. Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.
United Scientific Laboratories.

CONDENSERS, FIXED TRANSMITTING:
Dubilier Condenser Corp.

CONDENSERS, VARIABLE TRANSMITTING:
Cardwell, Allen D. Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.

CONDENSERS, VARIABLE:
Amsco Products. Inc.
Bruno Radio Corp.
Cardwell, Allen D. Mfg. Co.
General Radio Co.
Hammarlund Mfg. Co.
National Co.
United Scientific Laboratories
X-L Radio Laboratories.

CONNECTORS:
Saturn Mfg. & Sales Co.

CONTROLS, ILLUMINATED:
Martin-Copeland Co.
National Co.

COPPER:
Copper & Brass Research Ass'n.

CURRENT CONTROLS, AUTOMATIC:
Radiall Co.

DIALS:
American Hard Rubber Co.
Bakelite Corp.
Bruno Radio Corp.
Eby, H. H. Mfg. Co.
General Plastics, Inc.
Karas Electric Co.
Martin-Copeland Co.
Westerland Corp.

DIALS, VERNIER:
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National Co.

ELIMINATORS, B BATTERY:
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Dongan Elec. Mfg. Co.
Modern Electric Mfg. Co.
National Co.
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FOIL:
U. S. Foil Co.

GRID LEAKS:
Aerovox Wireless Co.
Amsco Products. Inc.
Dubilier Condenser Corp.
Electrad, Inc.
International Resistance Corp.
Lynch, Arthur H. Co.
Polymet Mfg. Corp.

HEAD SETS:
Bakelite Corp.

HORNS, MOLDED:
Bakelite Corp.

INDUCTANCES, TRANSMITTING:
Aero Products, Inc.

INSULATION, MOULDED:
Bakelite Corp.
General Plastics, Inc.

JACKS:
Carter Radio Co.
Electrad, Inc.
Rono Mfg. Co.
Saturn Mfg. & Sales Co.
Union Radio Co.

JACKS, TIP:
Carter Radio Co.
Union Radio Co.

KITS, RECEIVER:
Bruno Radio Corp.
Diamond of the Air.
Donle-Bristol Corp.
Equamatic System.
Karas Electric Co. (Equamatic)
United Scientific Laboratories. (Pierce-Aero)

KITS, SHORT WAVE:
Aero Products, Inc.

KITS, TESTING:
Jewell Elec. Inst. Co.

KITS, TRANSMITTING:
Aero Products, Inc.

KNOBS:
Bakelite Corp.

LACQUER:
Egyptian Lacquer Co.

LABORATORIES:
Electrical Testing Labs.

LOCK WASHERS:
Shakeproof Lock Washer Co.

LOOPS:
Deutschmann, Tobe, Co.

LUGS:
Shakeproof Lock Washer Co.
Zierick Machine Wks.

MAGNETS, SPEAKER:
Bullens, D. K. Co.

METERS:
Jewell Elec. Inst. Co.

PACKING MATERIALS:
Tifft Bros.

PANELS, COMPOSITION:
American Hard Rubber Co.
Bakelite Corp.

PANELS, METAL:
Crowe Nameplate Co.

PAPER, CONE SPEAKER:
Seymour Co.

PLUGS:
Bakelite Corp.
Carter Radio Co.
Polymet Mfg. Co.
Saturn Mfg. & Sales Co.

POTENTIOMETERS:
Amsco Products, Inc.
Carter Radio Co.
Electrad, Inc.
Federal Radio Corp.
United Scientific Laboratories.

RESISTANCES, FIXED:
Aerovox Wireless Co.
Amsco Products, Inc.
Carter Radio Co.
Electrad, Inc.
International Resistance Corp.
Lynch, Arthur H. Co.
Polymet Mfg. Corp.

RESISTANCES, VARIABLE:
American Mechanical Labs.
Amsco Products, Inc.
Carter Radio Co.
Central Radio Labs.
Electrad, Inc.
Federal Radio Corp.
International Resistance Corp.
Polymet Mfg. Corp.

RHEOSTATS:
Amsco Products, Inc.
Carter Radio Co.
General Radio Co.
Polymet Mfg. Corp.
United Scientific Laboratories.

SETS, RECEIVING:
United Scientific Laboratories.

SHIELDING, METAL:
Copper and Brass Research Assn.
Crowe Nameplate Co.
Zierick Machine Wks.

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Bakelite Corp.
Eby, H. H. Mfg. Co.
General Radio Co.
Saturn Mfg. & Sales Co.

SOLDER:
Chicago Solder Co. (Kester).

SPEAKERS:
Amplion Corp. of America.

STAMPINGS, METAL:
Zierick Machine Wks.

STRIPS, BINDING POST:
X-L Radio Laboratories.

SUBPANELS:
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Bakelite Co.

SWITCHES
Carter Radio Co.
Saturn Mfg. & Sales Co.

TAPPERS:
Eastern Tube & Tool Co., Inc.

TESTING INSTRUMENTS:
Jewell Elec. Inst. Co.

TESTING KITS:
Jewell Elec. Inst. Co.

TESTING LABORATORIES:
Electrical Testing Labs.

TOOLS:
Eastern Tube & Tool Co., Inc.

TRANSFORMERS, AUDIO:
American Transformer Co.
Dongan Elec. Mfg. Co.
Federal Radio Corp.
General Radio Co.
Hiler Audio Co.
Modern Elec. Mfg. Co.
Thordarson Elec. Mfg. Co.
Walker, Geo. W. Co.

TRANSFORMERS, B-ELIMINATOR:
Dongan Elec. Mfg. Co.
General Radio Co.
Hiler Audio Co.

TRANSFORMERS, FILAMENT HEATING:
Dongan Elec. Mfg. Co.

TRANSFORMERS, OUTPUT:
Dongan Elec. Mfg. Co.

TRANSFORMERS, POWER:
American Transformer Co.
Dongan Elec. Mfg. Co.
General Radio Co.
Hiler Audio Co.
National Co.
Thordarson Elec. Mfg. Co.

TRANSFORMERS, R. F., TUNED:
Cardwell, Allen D. Mfg. Co.

TRANSFORMERS, R. F., UNTUNED:
Dubilier Condenser Corp.

TUBES:
Donle-Bristol Corp.

UNITS, SPEAKER:
Amplion Corp. of America.

VARNISH INSULATING:
Irvington Varnish and Insulator Co.

VOLTMETERS:
Jewell Elec. Inst. Co.

WASHERS:
Shakeproof Lock Washer Co.

WIRE, ANTENNA
Dudlo Mfg. Corp.
Roebling, J. A., Sons, Co.

WIRE, BARE COPPER:
Dudlo Mfg. Co.
Roebling, J. A., Sons, Co.

WIRE, COTTON COVERED:
Dudlo Mfg. Corp.

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INDEX OF ADVERTISERS

Williams Press, Inc., New York—Albany

An Invitation

TO RADIO / DEALERS / JOBBERS / DISTRIBUTORS

FIRST RADIO TRADE SHOW

RADIO MANUFACTURERS ASSOCIATION

RMA

The Radio Manufacturers' Association

invites all dealers, jobbers and distributors to attend the First Annual Radio Trade Show to be held in conjunction with the Third Annual R M A Convention at the Hotel Stevens, Chicago, June 13-17th inclusive.

Herbert H. Frost

Chairman Show Committee
Radio Manufacturers' Association.

PROGRAM

R. M. A. Annual Convention and Trade Show, June 13 to 17 Incl.

MONDAY — JUNE 13

10:00 a. m.— Registration of Delegates, Alternates, Visiting Dealers and Jobbers.
2:00 p. m.— Opening of the Trade Show. First Showing of new 1928 lines.

TUESDAY — JUNE 14
Flag Day—150th Anniversary of Stars and Stripes

10:00 a. m.— R. M. A. General Open meeting. President's address — Arthur T. Haugh. Addresses by Mr. Fred Woods, Hon. Frank B. Scott and Maj. H. H. Frost.
(Dealers and Jobbers invited.)
2:00 p. m. to 6:00 p. m.— Trade Show open.
8:00 p. m.— Meeting of all Jobber and Dealer Associations. Mr. Harold J. Wrape, Pres. of the Federated Radio Trades Association, presiding. Address by Maj. H. H. Frost on Merchandising; Hon. Richard Lawrence and Hon. Frank B. Scott.
(Dealers and Jobbers invited.)

WEDNESDAY — JUNE 15

10:00 a. m.— Closed R. M. A. meeting; election of officers and transaction of general business. Open meeting, Federated Radio Trades Association.
(Dealers and Jobbers invited.)
12:20 p. m.— Luncheon and meeting of radio industry's Banquet Committee.
2:00 p. m. to 10:00 p. m.— Trade Show open — Chicago's Trade Day.

THURSDAY — JUNE 16

10:00 a. m.— Open Technical meeting, engineering divisions — Mr. H. B. Richmond directing.
(Dealers and Jobbers invited.)
10:00 a. m. to 6:00 p. m.— Trade Show open.
7:30 p. m.— Annual R. M. A. Banquet — Introduction of new officers — Address by M. H. Ayelsworth — Paul B. Klugh toastmaster.

FRIDAY — JUNE 17

10:00 a. m.— R. M. A. Closed meeting. Committee Reports. Appointments of new Committees. Completion of unfinished business. Closed meeting of the Federated Radio Trades Association.
2:00 p. m. to 10:00 p.m.— Trade Show open.

Radio's First Exclusive Trade Show will be held under the auspices of the Radio Manufacturers' Association and under the management of G. Clayton Irwin, Jr., General Manager of the Radio World's Fair and the Chicago Radio Show.

All available exhibition space has been sold and the radio industry's leading manufacturers will be represented with all that is new, reliable and practical for the 1927–28 season. Many meetings of interest to the trade have also been planned.

Admission to dealers, jobbers and distributors only. Invitations will be mailed to the trade individually about May 1st. If you do not receive your invitation, admission will be granted upon presentation of proper credentials.

Radio Manufacturers' Association Trade Show
Times Building, New York City

Space for this advertisement donated by Radio Engineering; copy and layout donated by Paul S. Weil, Albert Frank & Co.

CLAROSTAT

NEWS for Engineers, Technicians, Manufacturers!

A WORD of CAUTION!

Certain unscrupulous manufacturers are imitating CLAROSTAT. Every genuine CLAROSTAT has the name stamped on the case.

DURING the season just coming to a close, as in past seasons, CLAROSTAT has justly earned the title of "the greatest variable resistor."

It has come through the most rigid and exacting resistor tests and requirements with flying colors. In the outstanding socket power units—in leading circuits and receivers—CLAROSTAT functioned silently, smoothly, efficiently.

We have kept pace and in the next issue of this publication we shall announce complete details of four new types of CLAROSTAT—a type for every resistor requirement: the Midget, Standard, Heavy Duty and Power Type.

AMERICAN MECHANICAL LABORATORIES, Inc.
285 North 6th St., Brooklyn, N. Y.

Manufacturers of Socket Power Units or Receivers, Engineers and Technicians are invited to discuss their resistor problems with us.

See the Clarostat Exhibit at Booth 136-A at the R. M. A. Show