SEVENTH YEAR OF SERVICE

RADIO ENGINEERING

Vol. VII AUGUST 1927 Number 8

A Review of Tuned Double Impedance Amplification

The last of the series of articles by Mr. Hiler which contains some new facts

A High Voltage Rectifier

Technical description of a new type gaseous conduction tube

Series Wiring

A general review on series filament connections in radio receivers

Equipment for Measuring Transformers

The first of a series of articles on special measuring equipment for inter-stage coupling devices

A Double Voltage "B" Eliminator

Special circuit for obtaining twice the usual voltage from a "B" eliminator

Servicing Equipment for the Radio Dealer

Covering the construction of a special tube tester and circuit driver

NEXT MONTH

The first description of a new, tuned power amplifier

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The Technical Magazine of the Radio Industry

IN CURRENT SUPPLY UNITS

Standard Vitrohm Resistor

"Vitrohm" is a trade name applied only to Ward Leonard products in which the resistive element is completely enclosed and permanently protected by a fused-on coating of vitreous enamel. These resistors have been manufactured without basic change for more than 35 years.

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Vitrohm Radio Resistors are more than a wire-wound tube which is coated with a "protective" covering. They embody the technical improvements and production skill of three decades' manufacture

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The technical story of Vitrohm Resistor superiority is short: Vitrohm Resistors consist of a porcelain tube upon which is wound resistance wire. This wire is then coated with and surrounded by fused-on vitreous enamel at high temperatures: an intimate bond is established between the enamel and the wire.

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During this process, all wire which is not perfect is destroyed. The very manufacturing processes through which these resistors pass is a test far more severe than any imposed upon them in service.

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MANUFACTURERS of radio receivers and power apparatus employing resistance are invited to use the research and engineering facilities of Ward Leonard Electric Co.

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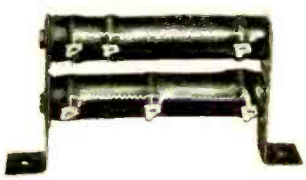
4 Inch Vitrohm Rheostat for Heavy Duty. Available up to 500 ohms, 11 steps

During the making of Vitrohm Resistors the resistance wire is subjected to an "ageing" process which guarantees permanence in value indefinitely.



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The question is frequently asked, "Why do you stick to wire? Is there not some method of producing a resistor which is less expensive and just as good for all practicable purposes?" The answer is *no*. For 35 years Ward Leonard has endeavored to find a better, a cheaper, method of producing resistance and it has not yet been found.

The Adjustat. 8 Values, 1 to 25000 ohms, 15 steps

The Vitrohm Resistor upon a dollar and cents basis is the most permanently accurate resistance element available today.

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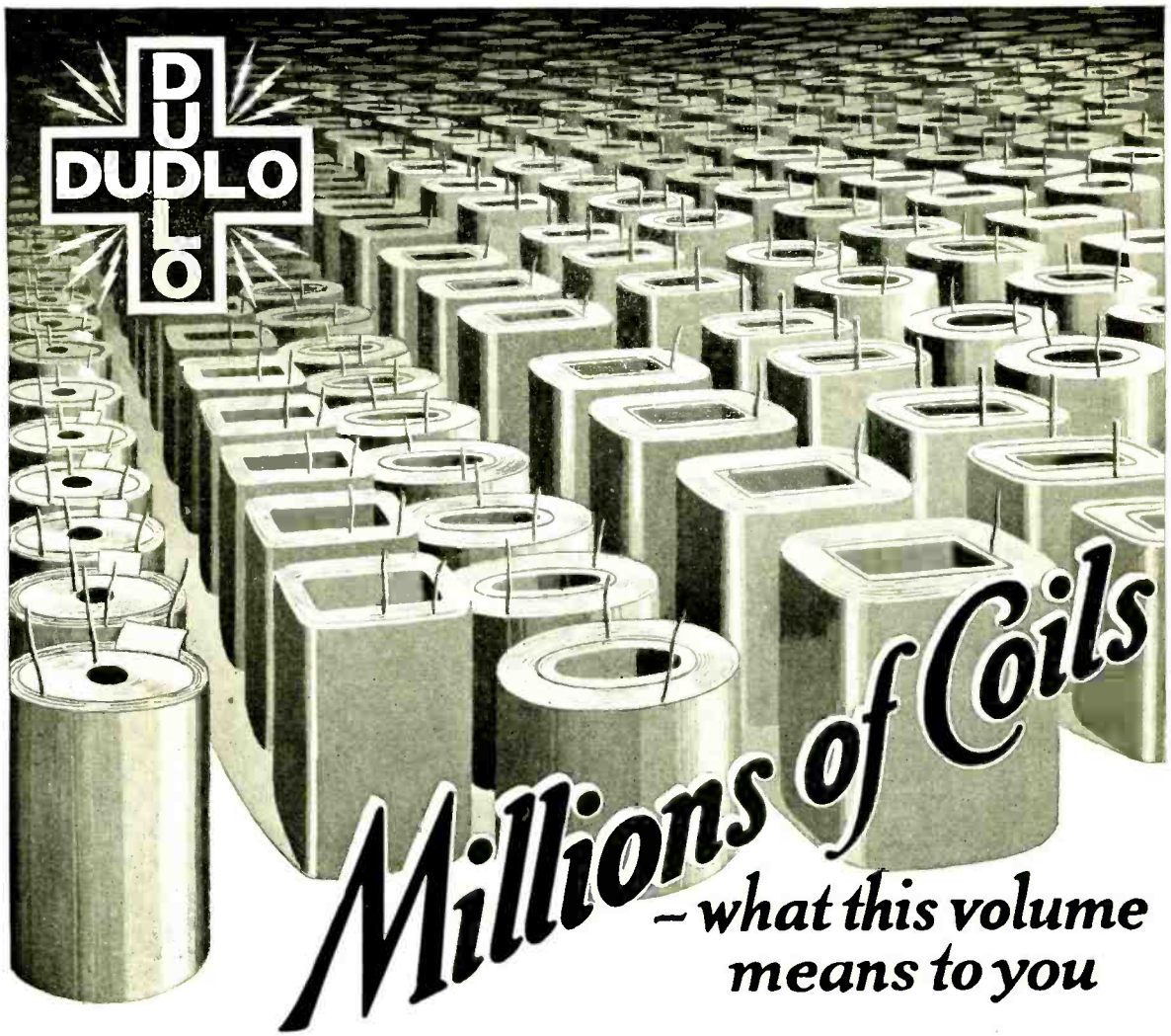

The fact that literally millions of coils are produced by Dudlo every season means not only that Dudlo is the world's headquarters for magnet wire and coils—but it has even greater significance.

This tremendous output automatically requires highly specialized manufacturing methods—impossible in smaller plants. It provides testing and inspection facilities that guarantee a more uniform product. It assures exact adherence to customers' specifications.

Such enormous volume also permits the maintenance of experimental laboratories that can be of great assistance to you in designing and developing more efficient coils for the products you make or sell.

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EDITORIAL

PARTS and set manufacturers are preparing their campaigns for the coming year. Both groups have computed, from the sales of last year, the present market trends and the psychological face of the ultimate consumer, the anticipated sales and are scaling their production accordingly.

Statistical reports indicate that the sale of complete sets is on the increase. Though statistics are inclined to be inaccurate, they are, nevertheless, sufficiently accurate to allow one to note which way the wind is blowing.

The very fact that there has been an increase in the sales of complete sets means but one thing: i. e. the parts manufacturers have lost some of their most important and greatly cherished consumer trade. It is true, of course, that a few parts manufacturers have benefited by this swing, through the sale of parts, in quantity, to a few set manufacturers.

Statistics likewise indicate that the parts business has been dropping off to some extent for the past two years. The figures are not comparative. This means that the consumer market for parts has been considerably weakened.

There is no problem attached to the present condition. The direct and immediate answer to the situation is the Professional Set Builder. He has introduced a new and very worthy proposition to the ultimate consumer. He has shown the radio fan how he can get exactly what he wants in the way of a radio, at a reasonable price and minus grief. He has originated the "custom built" set.

There are literally thousands of these men who are graduates of all manner of radio organizations. Men with ambition and initiative who are pushing the custom built set idea to the limit. They have come to be one of the most important factors in the radio field and with more assistance from the parts manufacturers they are capable of pushing parts sales up to a record peak. But they need the help of the manufacturers as much as the manufacturers need theirs. They have a fine idea, worthy from every viewpoint and one which, insofar as possibilities are concerned, is far better than the original "build your own" idea.

Even as conditions stand, sales figures show ever increasing returns from Professional Set Builders. Radio dealer establishments are not losing ground, but there is a less number of them. Those which continue have in their employ one or more Professional Set Builders.

The fact that these men have a very appealing proposition to offer the prospective customer; namely, a receiver built to exact requirements, equal if not superior to many factory built sets, practically fool-proof and backed by the right kind of service, it seems only logical that they will go a long way towards altering the opinions of the radio buyer.

The Professional Set Builder is handicapped in many respects and if he is to make the most out of the proposition he must have the confidence and cooperation of the manufacturer with whom he directly or indirectly deals. Many parts and kit manufacturers have already taken steps to form closer contact with these men, whether or not they buy direct or through a jobber.

RADIO ENGINEERING expects to work with both the Professional Set Builders and the parts manufacturers in putting the "custom built" idea over. A series of articles on the subject will start in our next issue.

Parts manufacturers have had fair weather and good sailing for some time. There is better sailing ahead and it won't require anything more than concentrated and cooperative action to make it very profitable.—M. L. MUHLEMAN, *Editor.*

RADIO ENGINEERING

The Technical Magazine of the Radio Industry

Edited by M. L. MUHLEMAN

Vol. VII. AUGUST 1927 No. 8

Seventh Year of Publication

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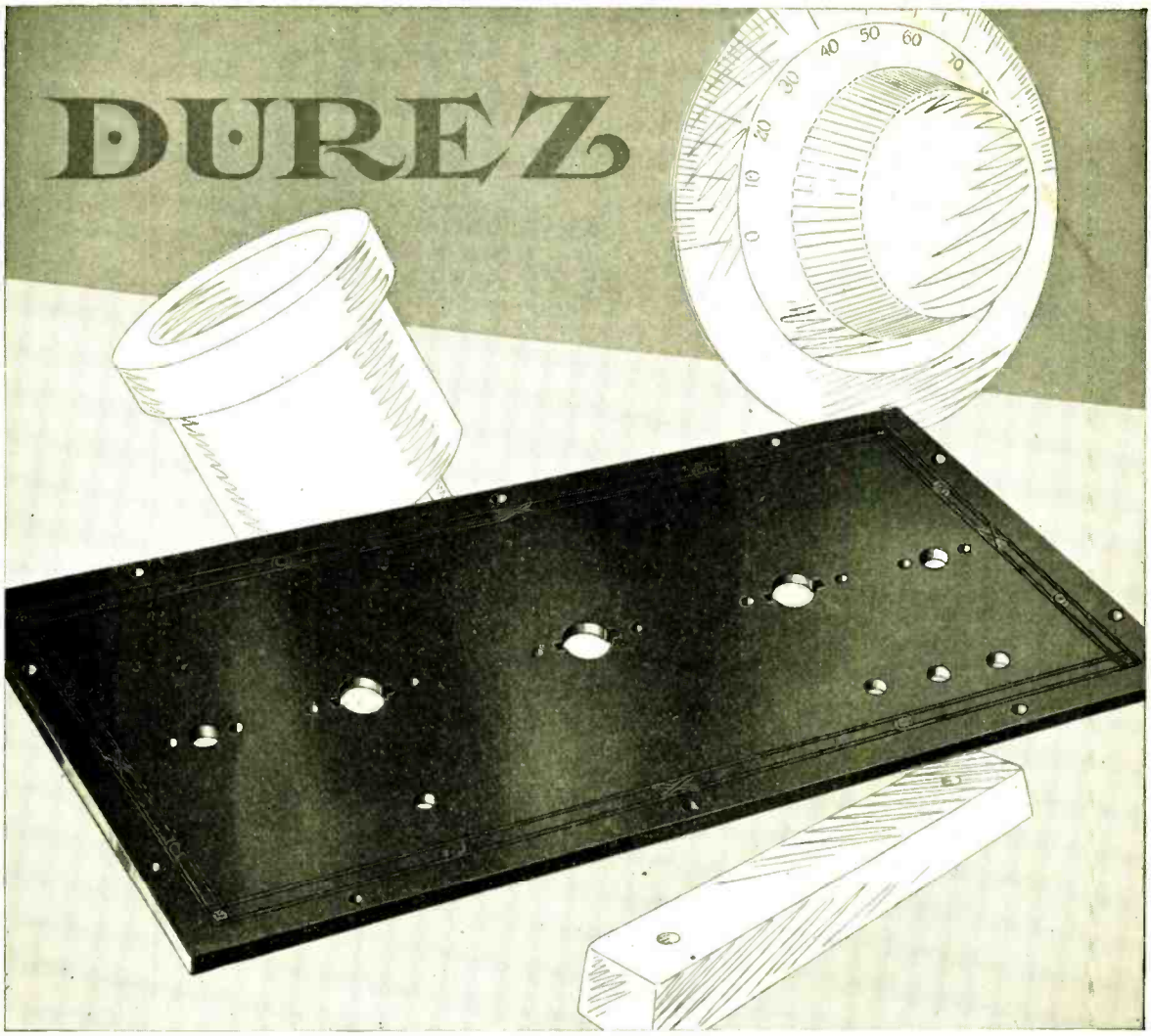

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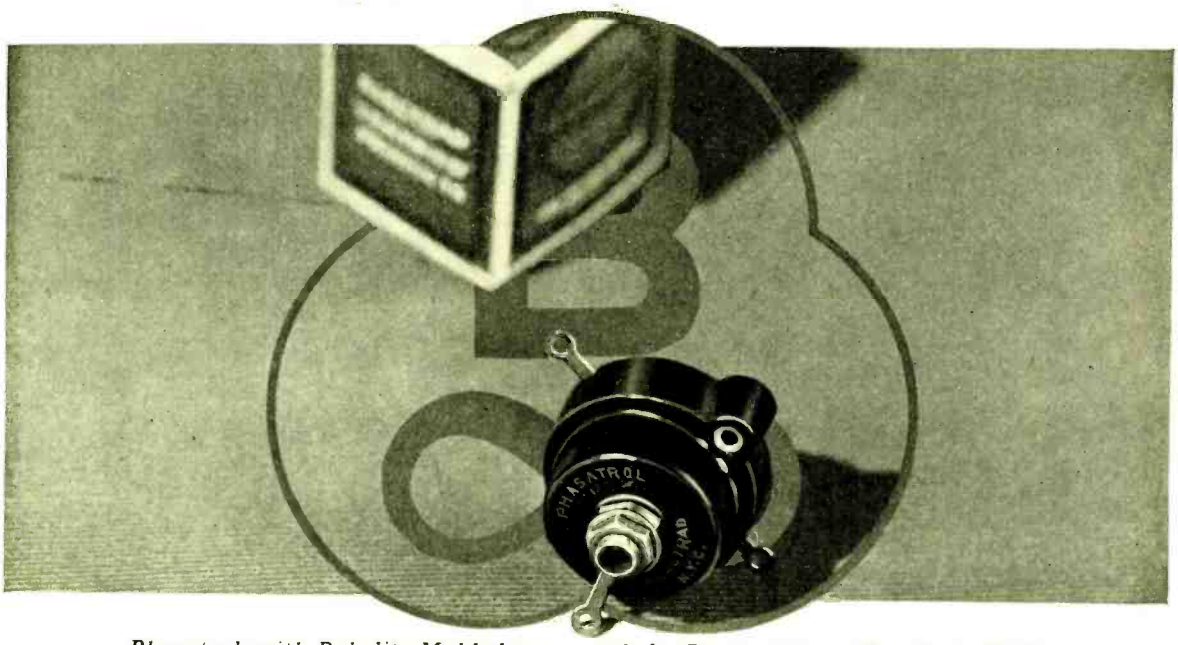

Phasatrol, with Bakelite Molded case; made by Electrad, Inc., New York, N. Y.

What more can one ask of Molded Insulation

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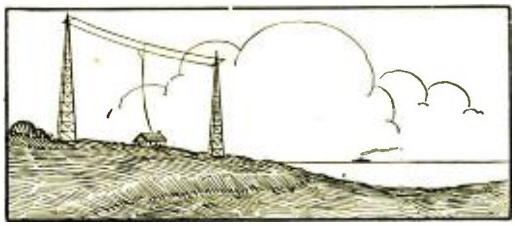


Vacuum Tubes, Their Manufacture and Application*

Some inside information on the vacuum tube family tree

By R. C. Robinson†

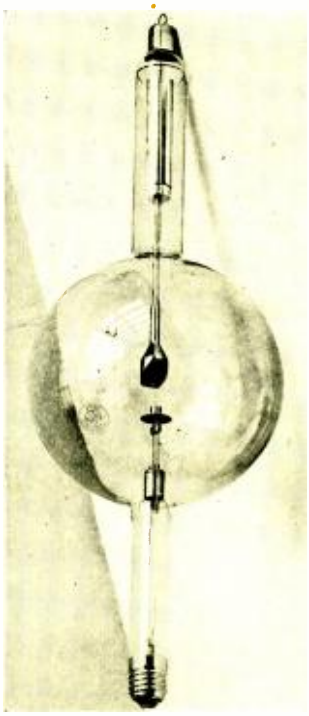
Part II

Special Glasses

Many special glasses have to be used in the tubes. The small ones are made from lead or lime glasses similar to those employed in incandescent lamps. X-ray tubes are constructed either from a lime glass which contains no lead, as lead in any form dissolved in the glass absorbs X-rays, or from a composite bulb, a part of which must contain no lead, while the remainder is made from glass which contains as high as 50 per cent lead oxide. This glass, if it is more than one-quarter inch thick, prevents all X-rays from passing through it and thus serves to protect the operator of the tube from X-rays. The higher power radio tubes are built of a glass of low expansion and high melting point, as it is less liable to crack under rapid changes of temperature and will stand higher temperatures without softening. This glass, known as G-702-P, is very similar to the well-known Pyrex glass, and has the added advantage that it will allow large sized tungsten wires to be sealed directly into it without the resulting seal cracking or leaking. A great amount of thought and work has been put on the glass problem to be sure that the best glass has been selected for each particular use and that it is handled in the best manner, as the success of the entire vacuum tube line depends on the reliability of the glass to metal seals and the glass bulbs.

X-Ray Tubes

The Coolidge X-ray tube was the first practical high vacuum tube which made use of thermionic emission. It was invented by Dr. W. D. Coolidge of the Research Laboratories of the General Electric Company, coincident with Langmuir's studies on the emission of electrons from hot bodies. Previous to 1913 the commercial X-ray tube had gas in it, and the cathode generally was an aluminum disc. The gas pressure changed during the operation of the tube, sometimes increasing and sometimes decreasing, so that one could never be sure of the penetration of the X-rays. The focal spot would also wander around on the target. This was bad for radiography, as it would make poor pictures. These faults were entirely eliminated with the hot cathode



A standard Coolidge X-ray tube

tube. One can always control the quantity and quality of the X-ray by the filament current and the voltage applied across the tube, and all tubes can be correspondingly controlled so they are alike.

The Coolidge Tubes

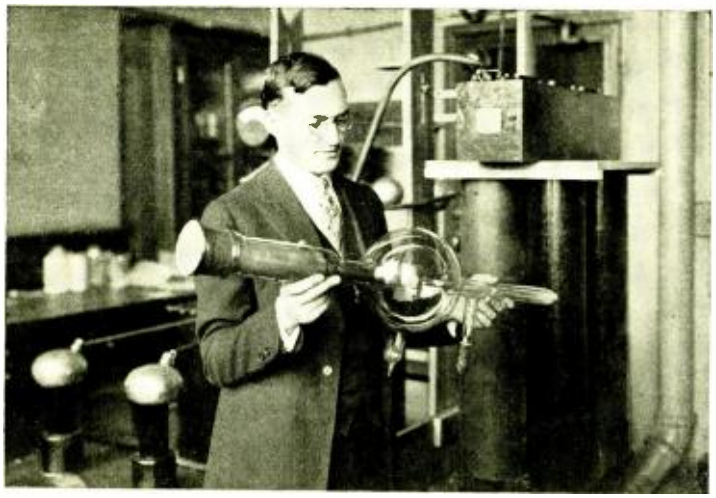
The original Coolidge tube had a tungsten filament mounted in a molybdenum focusing device as a cathode, mounted opposite an all tungsten anode. The electrodes were sealed into arms attached to a seven-inch glass bulb, the over-all length being sufficient to insulate the two electrodes from one another so that at least 100,000 volts could be applied to the tube. The very best possible vacuum was produced and maintained in the tube. It was manufactured in three designs so that it could carry approximately twenty, fifty, or eighty milliamperes at 100,000 volts continuously for periods of time long enough to make a good picture of any part of the human body. These tubes were designated as fine, medium and broad focus tubes, and were used for high-grade radiographic work (fine focus), stereoscopic work or treatment work (broad focus), or for all these classes of work (medium focus). This tube always had to be used with rectified current as the anode operated up to 1500 degrees C. and thus would emit electrons. The current under these circumstances could flow in either direction. For an X-ray tube to function properly, all of the X-rays must be produced at the anode.

The World War necessitated that X-ray tubes be used as near the battle fields as possible. Consequently, Dr. Coolidge designed a tube which would rectify its own current and operate directly from a transformer. The X-ray outfit thus was simplified greatly. The principle of the tube was the same as in the earlier tubes, but the anode was a thin tungsten button cast into the end of a large copper rod. This copper carries the heat, produced by the electrons striking the tungsten, outside of the tube so that it can be radiated into the air. As long as the anode stays below the melting point of copper, the tube is its own rectifier.

Following these two general types of tubes several others have been designed for special purposes, such as for dental work; for work which demands an easily portable outfit; for therapeutic treatments, especially of

*From M. I. T. Technology Engineering News.

†Engineer, Vacuum Tube Dept., General Electric Company.



H. F. Tanis, Jr., holding one of the new Coolidge cathode ray tubes

cancer; for rapid picture taking, so that pictures can be made of the chest, for instance, without the "heart shadow" being blurred, etc. They are designed to operate on voltages from 40,000 to 250,000.

These tubes are so easily controlled that many uses other than those for the doctor and dentist have been discovered. They are used for sterilizing purposes, for detecting flaws in masses of metal, for studying the structure of the atom, and many other duties of general and scientific interest. They have practically superseded the gas tube throughout the entire world and have been of great benefit to the human race. Although all cancer cases cannot be cured by X-rays, it is used extensively for cancer treatment and in many cases is beneficial. In this country alone approximately 15,000 tubes a year are made.

Kenotrons

A kenotron is a vacuum device for rectifying alternating current. The word is derived from the Greek adjective *kenos*, meaning "empty" and suffix *tron*, singnifying an "instrument" or "appliance." Dr. Dushman, of the Research Laboratory of the General Electric Company, first designed and applied commercial kenotrons for use as rectifiers. His first tubes had tungsten or molybdenum plate or cylindrical anodes with a hot cathode tungsten filament. As described earlier, an X-ray tube is also a rectifier as long as the anode does not become too hot. All kenotrons, therefore, are designed so that the anodes do not become hot under the service where they must operate. Like an X-ray tube their vacuum must be as good as possible, and the tube must be long enough to withstand the operating voltage.

Uses for Kenotrons

Many different types are now made in order to have tubes satisfactory for various purposes. One of the principal uses for kenotrons is to rectify current for radio receiving and transmitting tubes. Here voltages up to 15,000 are used and power as high as 50 K. W. Tubes can rectify voltages even higher if needed. Examples of applications using higher voltages are cable testing, smoke precipitation, and and excitation for X-ray tubes. By the proper arrangement of tubes, 500,000 volt sets have been made, and even higher ones are being designed. With the use of these sets faults in transmission cables can be detected and located before the cable actually breaks down. Thus the cable can be repaired without interrupting the service.

The smoke elimination application is becoming even more valuable. The kenotron is employed to supply high direct voltage, direct current for the Cottrell process smoke precipitation. A chain or wire hanging in the center of the stack is connected to the negative end of the kenotron while the positive is joined to the chimney or to metal plates inside. When voltages high enough to make a corona are used the smoke and dust particles coagulate and collect on the electrodes, most of them going to the anode plate. This dust can then be periodically cleaned off the plate.

For X-ray tube excitation even higher voltage kenotrons are required, and tubes capable of rectifying 200,000 volts peak are being made. Their construction depends on the voltage and current required. For the higher voltages (over 100,000) it is desirable to have the electrodes opposite one another the same as the X-ray tubes, while for high currents (up to 250 milliamperes) the concentric arrangement of the electrodes seems best.

Pliotrons

Pliotrons are three element vacuum tubes used principally for radio transmission and reception. They range in size from the well known 199 dry cell receiving tube to the 100 K. W. transmitting tube. The circuits in which these tubes are used are varied and complicated, but they must be very carefully adjusted and regulated or the tubes will be ruined. They are used as amplifiers of small currents and voltages, detectors of small alternating current voltages, and generators of electric oscillation. In all of them the third element, the grid, is placed between the anode and cathode and is made of nickel, molybdenum or tungsten wires. The theory of its operation is simple. By impressing a negative or positive voltage on the grid the number of electrons reaching the plate can be greatly diminished or increased, and by this method small changes in grid voltage make large changes in the current flowing through the tube.

Hundreds of thousands of the small 199 and 201-A receiving tubes are made annually. The large demand has warranted the designing of special machinery for making them, and their manufacture, as carried on in the incandescent lamp factories, employs methods somewhat similar to those

A standard type photo-electric cell

used for lamp production. As the volume of the bulb is small and the electrodes are light, their exhaust is rapid and is made sure by the use of "getters".

Transmitting Tubes

The transmitting tubes range from 5 watts to 100 K. W. The 250 watt

size was the first large type and was the tube used aboard ship when President Wilson made his famous trip to Europe following the war, during which he kept in constant communication with this country. This is the tube originally used in broadcasting and operates with a 2000 volt plate circuit. The one and five kilowatt sizes are not in great demand, but the twenty kilowatt is now being used extensively in broadcasting. All but the latter have glass bulbs, while it has a copper water cooled anode attached to a glass insulation chamber. The one hundred kilowatt is similar to the twenty but is larger.

A few comparisons between the 199 tube and the 100 K. W. tube are interesting. The latter has eight feet of filament which weighs about two ounces, enough tugsten to make 750,000—199 filaments. The tube is five feet long compared to three inches for the 199. 225 amperes are used to heat the filament, while the 199 uses .06 ampere.

The exhaust of these larger tubes is very difficult and all known methods for getting the gases from the glass and elements are used, such as baking out in ovens, heating with high frequency currents, bombarding with direct currents, and oscillating. Wherever possible chemicals are also employed in the exhaust.

Special Uses

Besides their use for radio telephony and telegraphy three element tubes are used for signalling or talking over power lines (carrier current), for voltage and current regulation of generators, for power limiting devices, for manometers, to determine very low gas pressures, etc.

Four element tubes, keno-pliotrons, which rectify their own current, and so can derive their power from the ordinary A. C. power line, have been made and probably will find extensive use in the near future.

Other special vacuum tubes (dynatrons and pliodynatrons) have been designed, utilizing the negative resistance characteristics resulting from secondary emission, but have little commercial application at present.

Cathode-Ray Tube

The latest type high vacuum tube is one designed by Dr. Coolidge, and is called the Cathode Ray tube. In it the electrons from the hot cathode are focussed into a tubular anode. Their speed (voltages up to 350,000 volts have been applied between the anode and cathode) carries them through this tube so that they strike the end of the anode, which is of very thin metal preferably nickel (approximately .0005" thick). Most of them pass through this thin metal and enter the air. In a darkened room, at the higher voltages a discharge can be seen extending more than two feet from the end of the anode. Minerals placed in the path of the ray phosphoresce and fluoresce brilliantly and are very beautiful. Certain chemical reactions take place rapidly in the rays, such as the polymerization of acetylene. Bad burns will be made in an extremely short time if the ray is directed on flesh. These phenomena are being studied by Dr. Coolidge and many commercial applications are expected. As in all vacuum tubes, a very high vacuum must be maintained. The vacuum secured by regular methods is augumented by dipping a side tube attached to the bulb, and containing charcoal, into liquid air. The charcoal rapidly absorbs gases and creates the necessary high vacuum in the tube.

Photo Electric Cells

Photo electric cells do not depend on hot cathodes for their electron emission, but on the fact that the alkali metals under certain conditions give off electrons when light falls upon them. Their use is increasing rapidly for such work as signalling, sorting light from dark objects, transmissiou of pictures, etc. A standard type has a potassium hydride film deposited on the inside of an evacuated bulb, which serves as the cathode of a two element tube. Light falling on this cathode causes electrons to be given off, the amount varying with the intensity of the light. These flow to the anode when a voltage is applied between the anode and cathode. Currents up to 1.5 milliamperes can thus pass through the tube when approximately 250 volts are used. This current can be made to operate relays or can be amplified through pliotrons and thus is capable of performing various duties.

When one considers that all of the devices discussed, except the incandescent lamp, have been developed within the past fifteen years, and that all are the result of pure scientific research followed by intensive developmental engineering, one wonders what may be in store for us during the next score of years. The results so far obtained are stupendous monuments to the men who were farsighted enough to supply the facilities for this wonderful work.

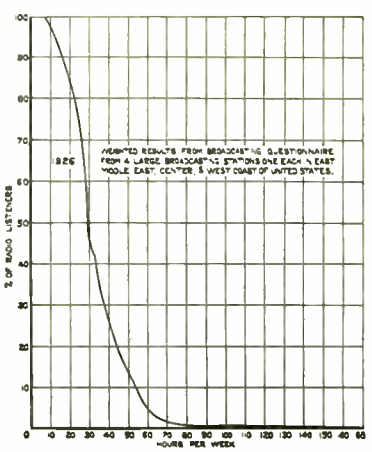
Time Study on Set Owners

Data on Number of Hours Per Week Sets Are in Use

RADIO Manufacturers have recently been holding a stop watch on the average radio user, in order to more properly design sets for the listeners' pleasure.

Time as an element which has to be considered in the production of power equipment for radio operation is really a vital factor, according to the Socket Power Committee of the Radio Division of the National Electrical Manufacturers Association, which has just issued information showing how long people listen to the radio in a given week.

The study, which is based on the per cent of listeners using radio receivers in excess of any given number of hours per week, shows that about 1/10 of a per cent of all radio listeners use a set in excess of 140 hours each week; 1 per cent use it in excess of 100 hours, 10 per cent in excess of 50 hours, 20 per cent in excess of 45 hours, 30 per cent in excess of 35 hours, 50 per cent in excess of 38, and 80 per cent in excess of 30 hours.



CURVE SHOWING PER CENT OF LISTENERS USING RADIO RECEIVERS IN EXCESS OF ANY GIVEN NUMBER OF HOURS PER WEEK.

SOCKET POWER COMMITTEE RADIO DIVISION NEMA FEB 1926

The study made by the NEMA Committee is shown in the accompanying curve made up from answers received from broadcasting areas in the east, mid-east, center and west coast of the United States.

The makers of batteries, tubes, charging units and like material are represented on the Socket Power Committee which made this study, and were interested in the collection of information to guide them in the proper design of material which would, when installed, adequately supply the set with sufficient power, with the minimum outlay of equipment, but with sufficient reserve capacity so that unusual use of the set might be made from time to time as required.

A New High Voltage Rectifier

Capable of supplying sufficient power for satisfactory operation of a 7½ Watt Transmitter

TWO new heavy duty, high voltage, gas filled rectifier tubes have recently been developed which have some very interesting characteristics. These tubes were designed primarily for Amateur transmission work.

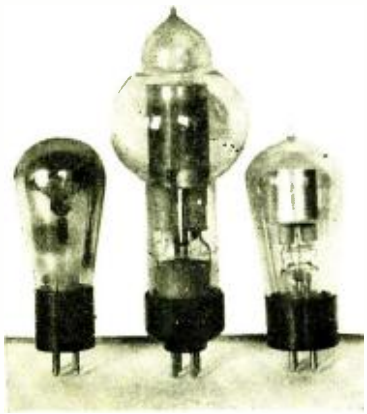


Fig. 1. The 300 mil. and the 90 mil. rectifier tubes contrasted with a 210 power tube

Photo, courtesy Manhattan Electrical Supply Co.

The larger tube delivers an output of 300 milliamperes at 500 volts in a full wave rectification circuit. The small tube, which is also a full wave rectifier, will deliver 90 milliamperes at 470 volts.

By operating four of these rectifiers in series it is possible to obtain sufficient voltage, namely 2000 volts, to operate the new type 852, 75 watt transmitting tube. By using two of these rectifiers in series one may obtain sufficient voltage to operate the 203-A. At the present time the manufacturer of these rectifiers is developing a half-wave rectifier capable of supplying 150 milliamperes at 1500 volts.

It is obvious that the large tube can be used in an "A-B-C" eliminator supplying a receiver using 201-A type tubes with the filaments connected in series. The small tube, with an output of 90 milliamperes has sufficient output to supply "A," "B," and "C" power for a receiver employing 199 tubes having their filaments similarly connected.

The useful life of both of these tubes is rated by the manufacturer at 2500 hours.

Fig. 1 shows the 90 mil. tube and the 300 mil. tube contrasted with a 210 power amplifier tube.

Fig. 2 shows the smooth regulation of the 90 mil. rectifier. From this curve it is seen that the regulation between the 40 mil. load and the 90 mil. load is not over 50 volts. The details of construction, whereby this high voltage and current may be obtained are clearly shown in Fig. 3. It is due to this type of construction that the life of the rectifier at such excessive drains, namely, 42 watts on the 90 mil. rectifier and 150 watts on the 300 mil. rectifier, is appreciably lengthened.

Theory of Operation

The principle employed in the operation of this type of rectifier is by no means simple, but is bound up with the respective mass of electrons and positive ions, as well as the relative sizes of the two electrodes. It must be remembered that in this class of tube, the electrodes are included in a bulb filled with some inert gas at a fixed pressure, and that when a potential difference is applied to the electrodes, the gas is ionized and the electrons, due to their smaller mass, will travel much more rapidly in the one direction than the positive ions travel in the other. Therefore, due to the sluggish action of the positive particles, there will be a preponderance of positive ions in the space between the electrodes. On the application of a voltage, which is alternating in character, between the electrodes, current will flow each half of the cycle in opposite directions, and the plate and point will alternately become anode and cathode. However, on account of the much greater area of the plate the greater current will flow when it is the positive terminal of the external circuit, hence a rectifying effect will be obtained, although it is to be noted that absolutely perfect rectification is not possible, but by careful design practically perfect rectification may be obtained. The rectification ratio, as may be termed the ratio of the mean current in one direction to that in the other, will thus be seen to be approximately the ratio of the respective electrode areas at any given pressure.

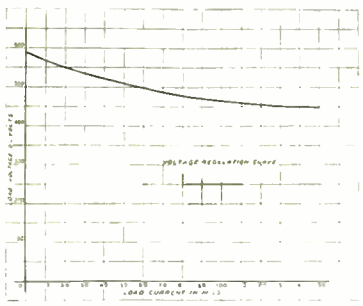


Fig. 2. Voltage regulation curve of the 90 mil. rectifier tube

This theory perhaps may be more clearly shown by referring to a half-wave rectifier of this type as in Fig. 4.

When the point electrode is negative a very large number of positive particles, coming from the ionized gas, attempt to reach the point electrode which being negative has a strong attraction for these positive particles. Due to its relatively small surface there is a terrific congestion or crowding of these particles around the point electrode and it is this congestion which forms the cloud or screen of positive particles around the point electrode which virtually effects the valve or shut-off action and prevents the migration of electrons from the point to the plate and allows current to flow in one direction only. (*This crowding of positive particles about the point electrode is analogous to a subway jam in which a great number of people are attempting to get on a train while others are getting off. Due to the overwhelming majority of people attempting to get on, very few succeed in getting off.*)

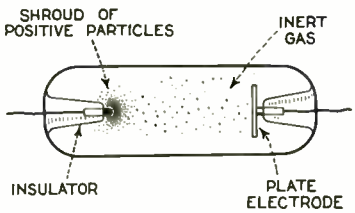


Fig. 4. Illustrating the operation of a gaseous conduction half-wave rectifier

The combat between the positive particles, and the negative particles which are attempting to leave the point electrode is shown clearly by the region of brilliant luminosity in the immediate vicinity of the point electrode. The heat of this combat may be

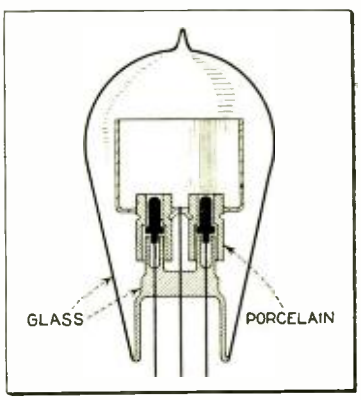


Fig. 3. Internal construction of the high voltage rectifier tube

judged by the brightness of this yellow glow.

During this period the potential drop takes place at a very short distance from the cathode (probably of the same order as the distance through which an electron must fall to produce ionization at the impressed voltage).

The Insulation

Fig. 5, A, shows an electrode with an insulator which is not recessed while B, C and D show the insulator with various degrees of recessing.

The type shown in A will safely stand about 150 volts and the type shown in B is good for approximately 250 volts while the type shown in C will safely stand 350 volts. D shows the type used in the present rectifiers and this type will safely stand 800 volts.

If the electrode is supported by an insulating platform or support as shown in A, this insulator is destroyed within a very short time if high potentials are used: this is true even when the insulator is made of quartz.

When the point electrode is protected by an annular porcelain cylinder, kept away from the electrode a distance beyond the border line of the positive screen, as shown in A of

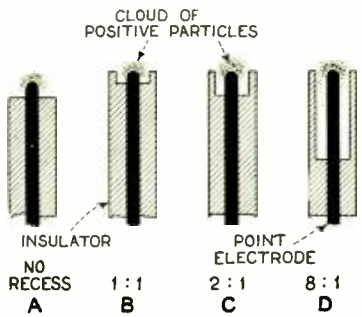


Fig. 5. Ratio of depth of recess in insulator to radial distance from cathode to insulator

Fig. 5, no destructive action takes place if the depth of the annular space thus formed surrounding the electrode be such that any positive particles which succeed in entering the space will be drawn into the electrode before arriving at the point where the electrode is in contact with the insulator. If the attraction of the electrode and the pressure in the bulb is fixed, this action is dependent on two factors, the width of the annular space and the velocity of the particle.

Analogy of Relative Attraction

Let us suppose that a small section of the annular space between the electrode and the insulator, such as shown in the shaded portion in the top sketch of Fig 6, be represented by a long narrow alley as shown in the lower sketch, one wall of which is made of highly magnetized iron and the other wall of brick. At one end of this long alley let us assume there is a man and at the other end there is a sharpshooter with a rifle which shoots an iron bullet.

It is a known fact that with a fixed charge in the cartridge, the bullet will travel a certain distance. Now let us suppose that the alley is of such a

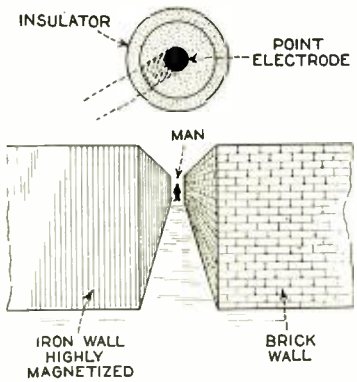


Fig. 6. Illustrated analogy of relative attraction as outlined below

length and the iron wall is so highly magnetized that before the bullet reaches the man it will be attracted to the iron wall and attach itself to it. In this way the sharpshooter may fire directly at the man at the other end of the alley who will be as sure of not being shot as if he were behind the iron wall.

Analagous to increasing the impressed voltage, let us assume that the cartridge is charged with a higher powered powder. If this is the case the man at the end of the alley will be shot before the bullet can be attracted to the iron wall. Therefore, we must increase the length of the alley so that the bullet will be attracted to the iron wall before the man is shot.

By the above analogy it can be seen that knowing the attractive power of the electrode for the positive particles, the depth of the recess may be determined for any desired voltage. It was in this manner that the ratio of the depth of recess to the width of the annular space between the cathode and the insulator was found to be 8:1 for this voltage. For higher voltages this ratio must be increased.

With a transformer secondary voltage of 850 volts each side of the center tap, the 90 mil. tube has been found capable of delivering 800 volts and 45 mils for a period in excess of its rating.

As this voltage is far in excess of any required by a radio broadcast receiver, this tube has been rated at 90 mils and 470 volts. This may be obtained by having a transformer secondary voltage of 900 volts or 450 volts each side of the center tap.

Think About R. F. Chokes

A Discourse on Their Function and Requirements

*By Bert E. Smith**

SOME years ago, with the idea of high reactance (or as high as could be gotten) over the whole broadcast band, somebody decided that R. F. chokes should be all inductance and no capacity. Which for the purpose in mind was very good but with the usual initiative of the designer of modern (?) radio equipment, everybody who has thought of R. F. chokes since then has stuck to the same old story, without ever exercising a brain cell on whether it was the right thing or not.

In the transmitter utilizing shunt feed, or the receiver of the same variety, the efficiency is *directly* proportionate to the efficiency of the choke. And as 90% of the present transmitters, and fully half the receivers, are shunt feed, it seems remarkable that communication is as good as it is amongst amateurs. Still, now and then we hear of a fellow with one flea power who is moving traffic where we can't get a peep back with 947 watts input. We should look at the choke with large gobs of suspicion dripping from our glance.

* *Allen D. Cardwell Mfg. Corp.*

Action of R. F. Choke

As a matter of fact, the actual mechanics of what goes on in an R. F. choke are not clearly understood by many experimenters. An R. F. choke does not choke: It offers *lower* resistance to the passage of R. F. current than a piece of straight wire.

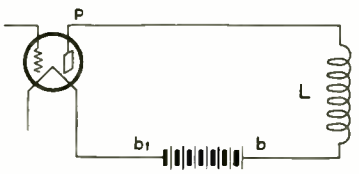


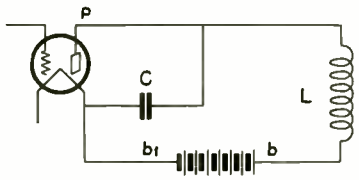
FIG. 1

Tracing the flow of radio frequency current

In Fig. 1 we have a tube which we will assume has a series of impulses at radio frequency being fed to the grid; a choke and batteries.

In this circuit an r. f. indicator at "p", "b" or "b1" will show that the circuit contains r. f., providing the impedance of "L" is low at that frequency. Now let us shunt "L" with a

condenser "C" as shown in Fig. 2. Our indicator will show that there is r. f. in the circuit of "C" but none at "b" or "b1". The natural assumption is that the choke has prevented the flow of r. f. through "L-b-b1," and diverted it through "C", but while this is the effect, what actually has taken place is quite different. The radio frequency passing through "p-L-b-b1" has induced an opposite, and approximately equal (depending upon the



- FIG. 2 -

The same as Fig. 1 but with the addition of a by-pass condenser

efficiency of "L") current in the circuit "L-b-b1-C." Inasmuch as "b" and "b1" are common to both, and the r. f. currents are equal and opposite, they balance each other and cannot be detected by the ordinary r. f. indicator, but they are there just the same. The action can be proved by the equivalent circuit in Fig. 3, where we have isolated our induced current, and r. f. will be found in all parts of the circuit, as nothing is common to both circuits.

If "L" has either too high an impedance, or no inductive reactance, to the radio frequency assumed, there will be a very small back e. m. f., or none at all, induced in "L" and flowing through "C."

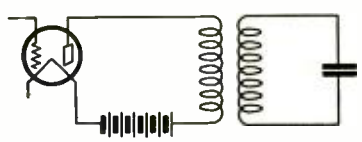
Impedance and Inductive Reactance

So, we have found out that in our r. f. choke, if we are to get the maximum r. f. through "C," we must have the *lowest* possible impedance to the frequency we desire to use, with the maximum *inductive reactance*. Now let us see how this can be obtained.

The formula for impedance is:

$$Z = \sqrt{R^2 + (\omega L - \frac{1}{\omega C})^2}$$

Therefore, if the proper values of capacity and inductance are used, the impedance is equal to the resistance only. As we want the maximum inductive reactance, the natural conclusion is to use pure inductance. However, as condensers can be made with



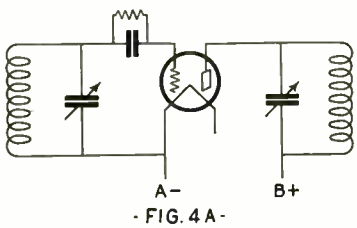
- FIG. 3 -

An equivalent circuit illustrative of the action in the circuit of Fig. 3.

far lower losses than coils, we may find ourselves better off if the capacity reaches an appreciable portion of the combination.

Another factor enters here also—the width of the band to be covered. The less resistance we have the more efficient the impedance becomes, and at the same time the frequency band over which it will operate narrows. Tests in a transmitter have shown that the ratio between an efficient and properly tuned impedance in the plate circuit and one of the broad type ordinarily used may frequently be very high, although the transmitter with the tuned impedance would oscillate only at the point to which it is set, while the outfit with the broad choke would oscillate all over the band. In a receiver it is, of course, desirable to use a choke with the flattest possible frequency resonance curve, but in a transmitter, which we hope to operate at only one wave length, the use of such a plate choke is often ill-advised.

The comparison between the two is most easily exemplified by reference to Fig. 4A. This shows an Armstrong tuned plate oscillator system, such as is frequently used in the so-called tuned plate, tuned grid circuit. Figure 4B shows the same circuit using an ordinary choke in the plate lead. If the broad choke were as efficient as



- FIG. 4 A -

Armstrong tuned plate, tuned grid oscillator circuit

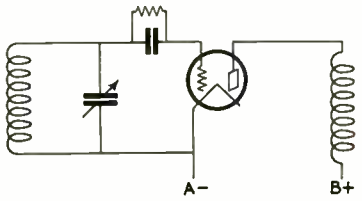
the tuned choke (for that is what it amounts to) the system shown in 4B would be far superior to that in 4A, because to change wave length we should only have to change our plate tuning, but unfortunately we cannot make the broadly tuned choke of enough efficiency to keep the tube in oscillation. (To divert for a moment; it will become quite apparent here that the maximum efficiency in a tuned plate transmitter will be obtained when a series feed is used. This is a fact, and the only reason for utilizing a shunt feed in this system is to keep from getting electrocuted on the plate condenser when tuning.)

For the same reason, if we are not keying in a grid leak circuit, we can usually get a little greater efficiency by shunting the grid leak around the grid condenser direct rather than returning it through an r. f. choke to the center tap.

In a Hartley circuit the usual purpose of the shunt feed is to keep the high voltage off the whole inductance, and as it is necessary to play with taps it certainly is a good thing to do with this circuit.

If a sharply tuned choke is used the plate blocking condenser must be reduced in value to the smallest possible figure, as otherwise, any variation of the capacity around the choke would cause a variation in the setting of the tuning condenser which makes the adjustment extremely difficult.

When this article was started, there was no intent to go into the applica-



- FIG. 4 B -

The same as Fig. 4-A but with an R.F. choke in the plate circuit

tions of chokes to various circuits, but what has leaked in, has been more or less illustrative of the fact that the r. f. choke is one of the most important pieces of apparatus used in station construction and its selection is worthy of at least as much thought as the tuning inductances and other instruments. In some cases the sharply tuned, highly efficient choke is by far the better, for other uses the inefficient, broadly tuned unit is more advantageous, but a bit of thought as to which is best may result in many miles more D. X.

300,000 Canadian Radio Owners

Canada ranks second to the United States in the per capita ownership of radio receiving sets, according to figures compiled by the Radio Branch of the Department of Marine and Fisheries. There is one radio to every thirty people in the Dominion, the department estimates, while Uncle Sam's record is one to every twenty inhabitants.

Radio sets in Canadian homes number 300,000, a bulletin of the department sets forth. Radios in the United States total 6,000,000. Ontario leads in radio ownership followed by the prairie provinces of Manitoba, Saskatchewan, and Alberta. Settlers in pioneer areas keep in touch with centers of population by radios which have banished the traditional isolation of farm life.

There are fifty-five commercial broadcasting stations in the Dominion, according to the bulletin. In addition, the government has established a chain of forty-eight coast stations on the Pacific, the Atlantic and the Great Lakes to provide communication facilities within 500 miles of the Canadian coast.

Series Filament Connections

A General Discourse on Re-Wiring Receivers for Light Socket Operation

*By V. T. Baird**

AT first glance series connection of filaments in a broadcast receiver appears to be surrounded by many difficulties; information on the subject is scarce, and somewhat vague, due to the fact that much of the work is still in the experimental stage. While this method has been used for years in some commercial sets and, to a limited extent, by users of direct current, it did not become really popular until the development of the high current rectifying tubes now being introduced. With the development of rectifying tubes capable of handling 300 to 400 milliamperes of current at high voltages, series connection of filaments came into its own and is growing more and more popular.

Admittedly, it makes much more of an appeal to the engineer who wishes to design a set to operate with direct current but it is equally useful where only alternating current is available.

Since the methods followed in either case are the same as far as the receiver itself is concerned and, as this article is not intended to deal with battery eliminators, no particular attention will be paid to the type of current supply to be used.

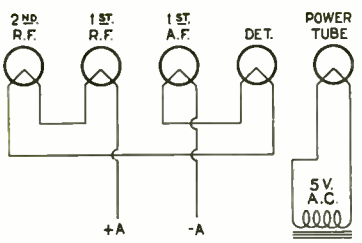
What might otherwise be a handicap to series connection of filaments is removed by the characteristics of the so-called power tubes. Tubes which require 500 milliamperes of current for their operation could not, of course, be placed in series with other tubes using only 250 milliamperes without a great deal of special wiring. However, due to the thermal inertia of the filaments of tubes of the 171 or the 112 type, they may be heated from a source of unrectified alternating current without any objectionable hum. Transformer manufacturers provide a special winding on the input or power transformer for use with such tubes.

When tubes of the 201-A type are used throughout, no special precautions need be taken except those necessary to suppress oscillations, unless seven or more such tubes are used in a series.

When tubes of the 199 type are used however, very careful design is necessary to avoid filament current overload due to the "B" battery return circuit.

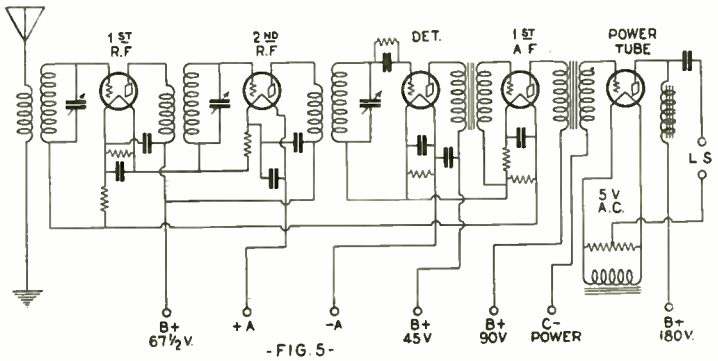
Any type set from the multi-tube superheterodyne to a simple 3 tube regenerative set may be series connected without special precaution. When the receiver is partially or entirely shielded, all the tuning elements must be carefully insulated from the shields to prevent short circuiting the filament line through them. This same condition holds when the tuning condensers are of the dual type, having a common rotor.

*Engineering Dept., Hammarlund Mfg. Co.



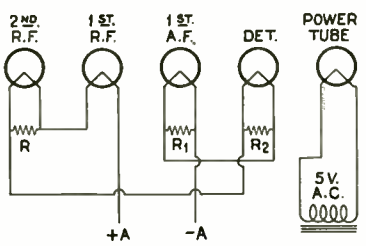
-FIG. 1-

The best manner in which to tie up the consecutive tubes in a series connection



-FIG. 5-

Complete, typical 5 tube T.R.F. receiver with series filament connection for operation from "A-B-C" eliminator



-FIG. 2-

The same as Fig. 1 but including the resistances for by-passing the plate current

Position of Tubes in the Series

The first and apparently easiest method for series connection that enters the mind is to simply connect all the tubes consecutively in series with the high potential leads at one end and the low at the other. There are, however, a number of objections to such a method. Grid biasing voltages are obtained by connecting the grid returns of each tube to some point in the filament line which is at a lower potential so that in the consecutive connection there will always be one tube for which a suitable "C" bias is not available.

Experience has also proven that there is less trouble from hum or ripples if the detector tube is placed on the negative end of the string, followed in turn by the next most sensitive tube, and so on. Fig. 1 shows the filament wiring diagram of a typical 5 tube tuned R. F. circuit built by the writer after many experiments. In this receiver the two R. F. tubes, the detector and the first A. F. tubes were wired in series and the 2nd A. F. tube energized by a separate source of raw alternating current from the power transformer.

The order of the tubes from the positive end of the string was as follows: 2nd R. F., 1st R.F., 1st A. F. Detector, and it was found that with a good filter system practically no hum could be heard, even with rather large variation of power factor on the input line. The current was adjusted by means of resistances in the filter circuit to 60 milliamperes, when 199 type tubes were used, and to 250 milliamperes when 201-A type tubes were used.

A receiver wired in this manner was found to be equally as sensitive as the same type receiver with the filaments wired in parallel and this circuit will be used to illustrate the points brought out.

Excess Current from "B" Batteries

A moment's study of the complete diagram in Fig. 5 will demonstrate the fact that the "B" voltage applied to the plate of each tube must return to the "B" battery through the fila-

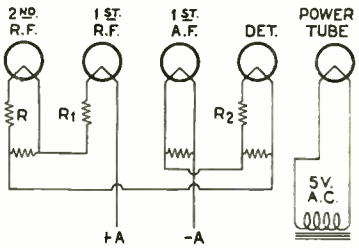
ments of each succeeding tube. Therefore, all filaments, except one, must carry the regular "A" current plus the "B" current, flowing in the circuit of all preceding tubes. In the ordinary 5 tube T. R. F. circuit the "B" current flowing averages between 15 and 30 milliamperes and if 199 tubes are used this excess would amount to from 25 to 50 per cent. overload on one of the filaments and would involve a dangerous overload in all but one of them. When 201-A tubes are used, this overload still exists but unless there are seven or more tubes in the series, it does not become serious enough to affect the operation of the receiver. This excess current can however, be by-passed through resistors placed across each filament.

The necessary value of these by-pass resistors may be computed by the law:

$$R = \frac{E}{I} \text{ or}$$

$$R = \text{by-pass resistors} = \frac{E = \text{filament voltage}}{I = \text{total excess current on filament}}$$

This calculation should be made for individual tubes in the string. Our original circuit now looks like that



- FIG. 3 -

Resistances (R, R_1, R_2) in the filament legs are used to obtain grid bias

shown in Fig. 2, R, R_1 and R_2 are the by-pass resistors.

No values are given here for the resistances as they are different for each tube and each type used as well as the "B" battery voltages used on each plate. The only safe way is to take a current reading for each tube and adjust the resistance to fit.

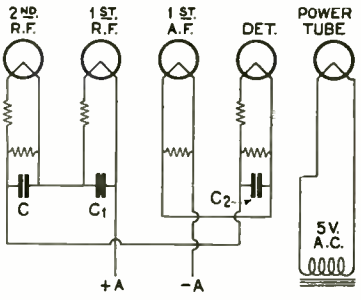
Grid Returns

The voltage drop across 199 tubes is 3 volts and across 201-A tubes, 5 volts, and if "C" biases are obtained by connecting the grid return to some point in the series which is lower in potential, it is readily seen that such a bias can only be obtained in multiples of either 3 or 5 volts. Since the obtainable "C" voltages are fixed, some method must be used to vary them in order to permit the tube to function at its highest point. This can be done by the introduction of either fixed or variable resistances in series with the filament, as shown in Fig. 3, and the grid return made to a point outside this resistance. The most convenient form of resistance for use at this point is an ordinary filament rheostat having a resistance of 60 ohms, if 199 tubes are used, and 20 ohms if 201-A tubes are used. They should be of such a size as to safely pass the entire filament current which is always somewhat greater than the rating of the tube.

Oscillation Control

The resistance of the series filaments becomes a common resistance in the plate current return circuit and this gives rise to two peculiar effects. First, a progressive drop in plate voltage, due to the resistance of the filaments through which it must pass. This however, is not of great importance since it can be easily remedied by placing a slightly higher plate voltage on each tube. The second effect is of much more importance and frequently causes some trouble. Such a resistance is very apt to cause oscillations in the radio frequency stages and often gives rise to low frequency oscillations in the audio frequency circuits.

The first may be either entirely removed or at least controlled by the use of properly placed fixed condensers across the "B" supply of the R. F. tubes, and the second, by providing a continuous path for the stray radio frequencies around all of the filaments. A condenser having a capacity of not less than .25 mfd. should be connected across each filament in the string, as shown in Fig. 4, and a fixed condenser of not less than .5 mfd. should be connected between the plate return of each radio frequency tuning coil and the negative end of the filament of the same tube.



- FIG. 4 -

The addition of by-pass condensers to prevent oscillation

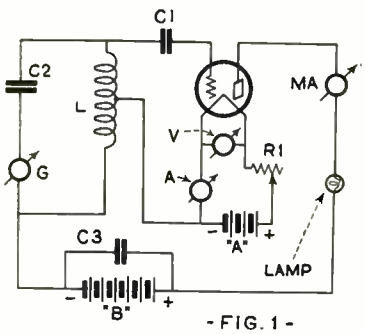
Fig. 5 shows the completed 5 tube tuned R. F. circuit with series filament connections, including the biasing resistances, the by-pass resistances and the by-pass condensers shunting each filament. The same general arrangement can be applied to most any receiver circuit.

The Radio Service Problem

Covering the construction and uses of a special tube tester and all-purpose oscillator—By J. Ray Blaich

Part III

IN the last article, if you will permit the writer a slight review, we covered the layout of the work bench, a source of power for the set under test, which included



- FIG. 1 -

Circuit diagram of the special tube tester for service work

a hook-up board and the necessary batteries, some tools were suggested and a circuit continuity tester and tube checker was shown. In other words then, we have proceeded with the test of the set through the "continuity test." Let us go on from that point but first we must consider some more apparatus that we expect to use in our next tests.

Tube Tester

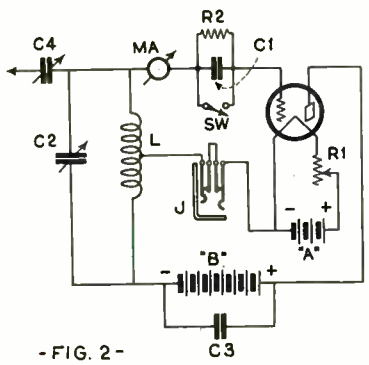
Our first consideration will be a tube tester that does the job very well and at the same time is very fast to work with especially where a large number of tubes are to be checked. The writer contends that all this "racket" about the plate impedance, mutual conductance, etc., that we hear so much about is not necessary in our work, hence the tube tester that we are about to consider does not tell you these things. What we want to know is whether the tube will work and if so, about how good. Referring to Fig. 1, you will notice that we have a simple Hartley oscillator with indicating meters in the various circuits. These meters will tell us very quickly the working qualities of the tube under test. For instance, the filament voltmeter tells us at a glance whether the filament is intact and also when the proper voltage for the particular tube under test is obtained. The filament ammeter tells us the condition of the filament as translated in terms

of filament draw. The lamp in the plate circuit will instantly pick out a short between the plate and filament and at the same time acts as a protective resistance for the delicate plate milliammeter. The thermo-galvanometer tells us how good the tube is working.

So that you will be well acquainted with the working of this tube tester we shall test a tube say of the 01-A type. The first step after the tube is inserted in the socket of the tester is to adjust the rheostat until the proper potential of five volts is indicated on the filament voltmeter. We should now have a reading of about ¼ ampere on the filament ammeter. The plate milliammeter will probably read around ten mils., while the galvanometer ought to register sixty or over. It is impossible for the writer to supply a chart giving the readings of the various tubes since the readings on the plate milliammeter and particularly those of the galvanometer will vary with the individual construction. When testing AC rectifier tubes you will, of course, get no reading on the galvanometer since there is no grid circuit. If a six volt storage battery is used the full six volts is applied to the filament of such tubes as the 16-B and the 210 type power tubes. It is also advisable to reduce the "B" battery to 67½ or 45 volts on these tubes as the galvanometer will read off scale otherwise.

Circuit Driver

Referring to Fig. 2, you will find the circuit diagram of an oscillator. It will at once be noticed that the fundamental circuit is identical to the one used before but with some apparatus added and minus all the meters used with the tube tester. This oscillator may be used as a generator of pure high frequency oscillations or as a modulated oscillator, at will, by merely opening or closing the switch in the grid circuit. The grid leak, when not short circuited, tends to modulate the high frequency oscillations and the tone of the modulated signal is dependent upon the value of the leak. A jack has been inserted in the grid return lead. This is used if voice modulation as obtained from an electrical pickup device, such as is used on the electric phonographs, is desired. Several such pickup devices are now obtainable and work very satisfactorily in the above-mentioned capacity. A grid milli-ammeter has been included also and acts as a resonance indicator as will be explained a little later. The branch lead containing C4 is merely a means of coupling the oscillator to circuits outside itself. These two units, the tube tester and the oscillator, can readily be combined into a single piece of apparatus without detracting from the working qualities of either separately. The oscillator can be used as a portable affair and very compact construction is possible by omitting the grid meter. A pair of head-phones may be plugged into the jack and a click will then indicate resonance.

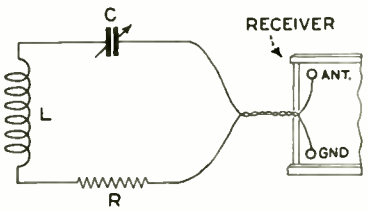


- FIG. 2 -

Circuit diagram of the oscillator or "circuit driver."

The apparatus needed to construct these two testers is:

L—50 turns No. 24 DCC wire on a 2½ inch form.



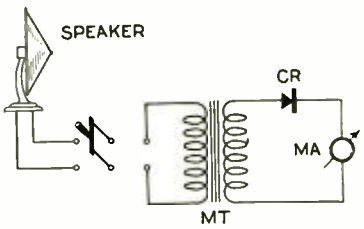
- FIG. 3 -

The dummy antenna, composed of the resistance R, the variable condenser C and the inductance L, connected up to a receiver

C1—.00025 mfd fixed condenser with grid leak mounting.
C2—.0005 mfd condenser, either fixed or variable, for the tube tester but variable for the oscillator.
C3—.5 mfd by-pass condenser.
C4—Midget condenser, about .00005 mfd.
R1—30 ohm rheostat.
R2—4 meg. grid leak.
SW—SPST jack switch (midget).
J—Double circuit jack.
G—Current squared thermo-galvanometer (115 MA).
V—0 to 6 D.C. voltmeter.
A—0 to 1.5 D.C. ammeter.
MA—(Grid) 0 to 1.5 D.C. milliammeter.
MA—(Plate) 0 to 50 D.C. milliammeter.
La—40 watt, 110 volt, Mazda lamp.
"A" battery, 6 volt storage.
"B" battery, 90 volts.

Special Tests

As was mentioned a little earlier, in the previous article we had proceeded through the "continuity test." That test was a check on everything except the leads from the variable condensers, the primary of the antenna coil and the secondary of the output transformer, if one is used. The test from the aerial to the ground binding posts on the set with a pair of phones in series with a battery will produce a click that indicates continuity. The same test across the output will prove



- FIG. 4 -

An output indicator. The switch arms connect to the output of the receiver under test

continuity there. If a phone jack is used in the output instead of binding posts don't leave the loudspeaker connected when making this test as the secondary of the output transformer might be "open" and still you would get the click through the loudspeaker windings. To test the connections from the variable condensers to the R.F. coils in the present day sets that carry total shielding is not easy unless you have an oscillator such as was just previously described. The condenser-to-coil test is as follows:

(1) Set oscillator into operation.

(2) Close switch in grid circuit—with this switch open the grid MA will not give a reading.

(3) Disconnect all batteries from radio set—open the switches on power panel.

(4) Adjust tuning knobs on radio set to about half reading.

(5) Vary C2 on oscillator until a dip in grid MA is noted. This is an indication that condenser-to-coil continuity is OK.

(6) Duplicate the above procedure with each succeeding R.F. stage.

The coupling with the oscillator is made to the stator plates of the condenser. In the case of the shielded sets this connection can be made through the grid of the tube socket. A convenient means is to construct a plug from an old '99 tube base as described in conjunction with the continuity tester but only one connection is made and that is to the grid prong of the plug.

Now suppose we have one of these radio sets where two or more stages of R.F. are tuned simultaneously with one tuning control. These sets usually carry some means of compensating the main tuning condensers which in all probability will be a small variable condenser similar to a neutralizing condenser. To balance out one of these tandem tuning sets proceed as for testing the continuity from condenser to coil with the following exceptions:

(1) Start with the last stage in the tandem.

(2) Set oscillator at about 200 meters.

(3) Adjust tuning knob until dip is noted on grid MA.

(4) Don't change the wavelength of the oscillator nor the position of the tuning knob on the radio set.

(5) Proceed to proceeding stage in tandem.

(6) Adjust compensator until maximum dip is noted on grid MA—these two circuits are then "in step."

(7) Repeat the procedure until all the stages in the tandem are covered.

(8) Don't disturb the setting of the oscillator or the radio set tuning knob during the procedure. The accuracy of the balance depends on this.

(9) When all the stages have been checked, repeat the balancing at about 500 meters making whatever slight readjustment is necessary. Only very slight readjustment, if any, should be necessary.

To neutralize a Neutrodyne, place set in operation and couple the oscillator loosely thereto—that is, by placing the oscillator about three feet or more from the radio set. A "three legged" tube (with the filament positive prong removed) is used to replace the regular tube in the first R.F. stage. The neutralizing condenser is adjusted for minimum signal. A modulated signal from the oscillator is used for neutralizing. When the point of minimum or no signal is reached that particular stage is neutralized. Proceed with each succeeding stage until the entire set has been neutralized. During the neutralizing process the radio set should be connected to either a regular aerial and ground or a dummy antenna.

Dummy Antenna

A very convenient dummy antenna, Fig. 3, for shop use is made up of about ten turns of No. 18 DCC wire (bell wire is OK) on a 2½ or 3 inch form in series with a .0005 mfd. variable condenser (so as to be able to change the size of the antenna) and 25 ohm fixed resistance which is all connected to the aerial and ground posts of the radio set through a short length of flexible, twisted lamp cord. This dummy antenna should remain in a fixed position on the shop bench. The reason for this will be explained a little later.

Up to the present we have ascertained that the continuity of the set is OK, that it is neutralized and that it is balanced, if a tandem tuning set. We have yet to determine if it will deliver a goodly signal to the loud speaker. Fig. 4 represents the circuit diagram of an output indicating instrument. It is made up of the following:

DPDT switch,
Modulation transformer (MT),
Carborundum crystal detector (Cr),
0 to 1 D.C. milli-ammeter.

The modulation transformer is a 1:1 transformer used merely to keep the battery current out of the meter circuit. The crystal detector rectifies the pulsating current so that it can be read on the D.C. meter. To use the output indicating meter, start up the oscillator with a modulated signal. Place the oscillator about a foot from the dummy antenna coil. Tune in the oscillator signal on the loud speaker. Switch from loud speaker to output meter and note reading. To tell you just how much reading you get on the meter is impossible but suppose that a five tube set causes a deflection of 0.3 MA with the oscillator meters reading "such and such" and the coupling between the oscillator and the dummy antenna coil at "so much" a 6, 7 or 8 tube set should cause correspondingly greater deflection under like conditions. You will have to establish your own standards by putting a few sets that you know to be "up to snuff" on test and noting the readings on these sets. The preliminaries are the hardest but well worth the trouble in case of operation and time saved in future tests. The output meter will tell you things that your ears do not even know are going on. It is for this reason that the writer has endeavored to make all indications visual rather than audible because they are more reliable.

Conclusion

With the conclusion of this last test a fairly thorough diagnosis of the radio set has been performed and should show up all ordinary radio set ailments.

In conclusion the writer hopes that he has demonstrated by word and picture the statement in the first of these articles to the effect that money making in radio service work lies in the use of scientific methods for diagnosing radio troubles rather than the "hunt and poke" method. The method is the thing. With the method outlined a relatively inexperienced man can be trained in a short time to perform the "routine tests" namely continuity, balance, neutralization and output. The initial cost of this installation will soon be more than offset and a smoothly operating service department turning out work that is right and making profits will be the result.

Definite Standards for Resistor Units

R. M. A. Standards Covering Dimensions and Methods of Testing and Marking

THE Fixed Resistance Unit Committee, of the R. M. A., with Francis H. Ehle as Chairman, is composed of Arthur H. Lynch, J. J. Dunleavy, David Siegel, H. L. Bradley, and Arthur Moss. At the preliminary meeting held some time ago in Chicago, a definite groundwork was laid, although there are several details still remaining to be worked out so that the standards may be complete and comprehensive.

To begin with, it is understood that the Rheostat (filament) and the Resistance Unit Committee meet jointly to obtain the full co-operation of the two committees, but that the scope of the Resistance Unit Committee be confined to standards pertaining to fixed resistance units, and that of the Rheostat Committee to variable resistor devices, each committee to submit its own report.

It has been recommended as standard practice that if spring clips of any type are used for the purpose of holding or securing resistance units, these clips be 1-13/16 inches apart at the point of contact. A subcommittee has been appointed and instructed to submit at the next standards meeting its recommendations pertaining to the overall dimensions of resistance units commonly known as the Grid Resistor type.

Resistance Value Markings

One measure adopted is that Fixed Resistor Units be marked with their resistance value from 100,000 ohms upwards, using the decimal system in megohms, and that all resistance values below 100,000 ohms be marked with their correct reading in ohms. Furthermore, it has been recommended that fixed resistor manufacturers adopt a commercial list of resistance ranges as follows:

500, 1000, 2000, 3000, 4000, 5000, 7500, 10,000, 25,000, 50,000, 75,000 ohms, and .1, .25, .5, 1., 1.5, 2., 2.5, 3., 3.5, 4., 5., 6., 7., 8., 9., 10 megohms, and that this list of ranges be specified in their trade and consumer literature.

It has also been recommended that manufacturers of resistor units adopt, as an approved practice, a method of indicating, on shipping containers or by means of printed slips, the voltage at which the resistor units were tested.

Furthermore, it was adopted that one, consisting of the chairman, be appointed for the purpose of securing the co-operation and opinion of the U. S. Bureau of Standards with regard to the best method of measuring resistance units of various ranges, and that a report covering these recommendations be furnished to the committee before the next meeting for its full consideration.

Equipment For Measuring Inter-stage Coupling Devices

Covering the theory and construction of a Laboratory Driver

*By E. W. D'Arcy**

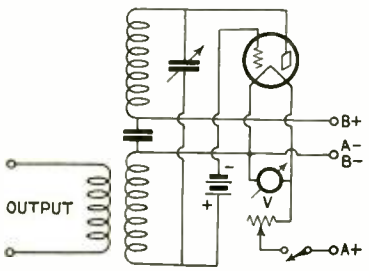
Part I

The subject of equipment for measuring transformers is quite a large contract to fill in just one article, therefore this subject will be covered by Mr. D'Arcy in a group of three articles.

The second article will cover voltage amplification bridges for measuring transformer amplification, and a much newer phase of testing transformers which we will call rejectance. This article will also include design, theory of operation, construction, and an outline on vacuum tube voltmeters.

The third and last article will be an instructional article explaining the adaption of the bridge to general laboratory measurements, or uses to which service departments or repair men can put the equipment.—EDITOR.

THERE has been very little information on equipment for testing transformers. In fact, it is almost impossible to obtain information on how to make this equipment. The requirements for equipment of this type, in order for the measurements to be of any use, are very rigid, and in measuring equipment in the past, as a rule, this equipment has been very unstable and unreliable. The readings of voltage amplification were not reliable, and

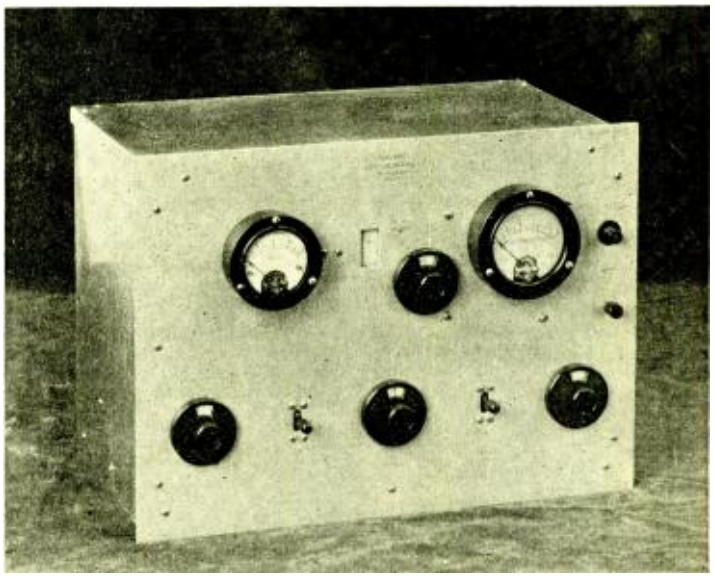


- FIG. 1 -

The Meissner oscillator circuit

the driver circuit changed its frequency with any variation in batteries and load conditions.

In equipment of this type it is also very necessary, owing to the sensitivity of the measurements and the minuteness of the input voltage used, to have all the equipment very thoroughly shielded, which includes the batteries and all connecting wires. This assures the operator that the transformer under test is not picking up any energy from the driver outside of what it is supposed to. This would not be the case if the equipment were not shielded.



The complete circuit driver, constructed by the author. The case is made entirely of aluminum so as to shield the components

Driver Circuits for Laboratory Measurements

The driver, or vacuum tube oscillator, has a great many uses in the laboratory. It can be used for measuring resistances of condensers and inductances, in the calibration of wave meters, in measurements of capacity, for testing out radio frequency transformers, for drawing amplification curves on audio frequency transformers, and they also can be used, although in a much more limited field, in the testing and balancing of lines in broadcasting stations. The driver, in order to be most useful, should cover all frequencies from 25 cycles up to approximately 1,500 kilocycles.

Circuits for Drivers

The greatest problem in a laboratory driver has been the elimination of harmonics and the ability to regulate the output of the driver without varying the frequency; also the isolation of the driver circuit itself from any of the equipment to which it is connected. To clearly understand the circuit which is universally used in laboratory drivers we will analyze the circuits in Figs. 1, 2 and 3.

Meissner Circuit

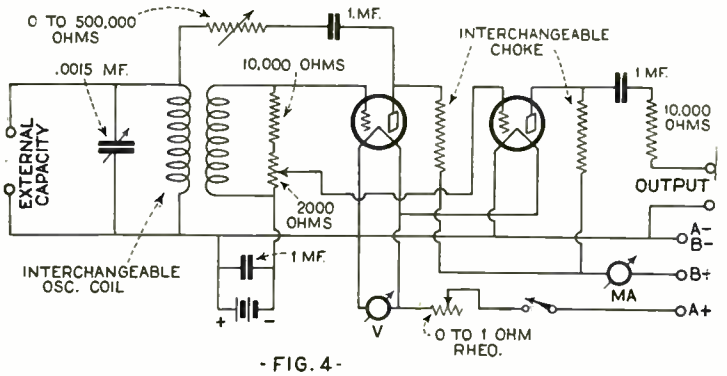
In the circuit in Fig. 1 we have a loosely coupled coil, coupling the measuring equipment to the driver circuit. The oscillator proper consists of a Meissner circuit, which means that the inductance is a split affair with a condenser across the entire inductance, half of the inductance being in the grid circuit and the other half in the plate circuit.

This is the style of oscillator used quite extensively in superheterodynes. This circuit, on account of its inability to control the feed-back from the plate circuit to the necessary amount to just actuate the grid and keep the tube oscillating, is impossible for use as a laboratory driver. This is due to an overloading of the grid circuit, thus causing a number of harmonics in its emitted wave. It also has an inductive pick-up and this inductive pick-up does not allow for regulation of output without varying the load conditions on the driver.

Inductive Circuit

In Fig. 2 we have a driver circuit of a little better design from the standpoint of feed-back. Undoubtedly, the plate coil could be made to give a

* *Engineer—Dar-Mac Laboratories.*



- FIG. 4 -

The schematic diagram of the driver circuit employed in the unit described

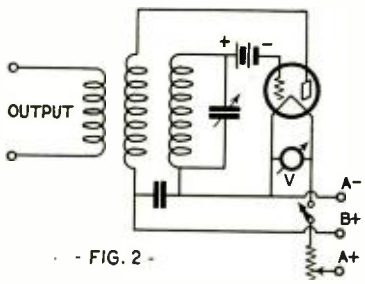
much purer wave form at the frequency to which the plate coil was adjusted by varying the number of turns in it so that the feed-back could be decreased to the correct actuating grid voltage. This, of course, makes this type of driver a very inflexible sort of affair in regards to varying its frequency and keeping the wave form pure. Also, we still have the inductive pick-up with all its disadvantages. However, it is a little bit better on account of the fact that we now can use a standard, efficient variable condenser, with the ability to place the rotary plates at a ground potential.

Shunt Feed Circuit

In Fig. 3 we have a much better arrangement for a laboratory driver. We find the condenser, of course, tuning the grid coil as in our other diagram. A little different system of feed-back is used, however. A shunt feed battery system is used, which allows the use of a variable resistance in the plate circuit to reduce the feed-back to the best operating position. This resistance allows the reduction of the feed-back voltage to the grid, thus preventing overloading, and acting as a harmonic purifier. Connected directly to the plate we have a condenser, a resistance and a voltage divider. This allows regulation with very little change in the frequency caused by external load conditions. As much better as this circuit is to the other ones there is still room for improvement; namely, we still have a little bit of trouble with frequency variation on account of variations in load. Of course, this trouble is much less than in the inductive systems of pick-up. We also find that varying the feed-back resistance varies the frequencies to a marked degree. Thus, this circuit, which is much better than the others, still is not the ideal insofar as the laboratory driver goes.

Untuned Grid Circuit Driver

In Fig. 4 we have a driver circuit that is best suited to the requirements of laboratory usage. In this circuit the grid coil is untuned and has a high resistance voltage divider connected across it, the center arm of the divider going to the grid of an amplifier tube. The grid circuit of the amplifier tube remains practically constant in its characteristics, thus eliminating any effect upon the driver circuit by varying load conditions and at the same time amplifies the output of the driver circuit up to a workable point, thus allowing the use of a large feed-back resistance. This purifies the wave form much more than if



- FIG. 2 -

Inductive oscillator circuit with tuned grid coil and inductive feed at output

we did not have the amplifier tube to gain the signal strength. In the plate circuit of both tubes we find that the battery power is fed through resistances. This system of battery feed is used in preference to a choke coil system because of the fact that, while it has one frequency to which it responds most efficiently, at the same time the variation of impedance with frequency is, to all workable purposes, constant and since we do not need a large power output from this driver for measuring transformer characteristics, it is not necessary for us to use a choke coil system. This resistance arrangement, however, is arranged on plugs. This allows making the driver flexible in regards to its frequency as it is impossible to use the resistance arrangement below 1000 meters. We also find in this driver that where in the driver circuit in Fig. 3 we had difficulty with keeping the frequency constant while varying the feed-back resistance, we no longer have this difficulty to a marked extent.

This is the driver that is now used in most laboratories. It is the most stable sort of arrangement and allows a variation of the output without varying the frequency. Also, by reason of the last amplifier tube incorporated, it allows the feed-back to be reduced to such an extent that harmonics are practically eliminated, which is as close as we can come to the ideal. The driver requires a battery voltage for 112 power tubes of between 350 and 400 volts. The current that these tubes take makes it necessary to use resistances that will carry it without heating.

Construction

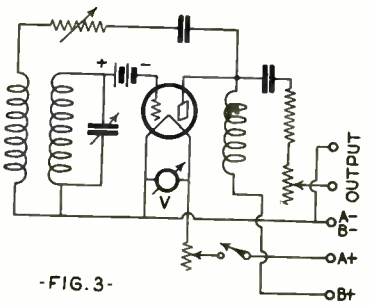
There are many different ways of constructing oscillator drivers. In lieu of this fact and the number of special purposes to which they are put, we will describe a driver made by the writer. This driver is made entirely of metal, the shielding making the case. While it is somewhat more difficult to work aluminum 3/16 of an inch thick, at the same time it is necessary in order to use precision condensers. The oscillator cabinet is arranged to fit over a metal battery box. This insures short battery leads, and due to the fact that the batteries are shielded, eliminates any trouble from pick-up by them. The condenser used is a standard laboratory condenser made by a well-known eastern manufacturer. The indicating system on this condenser consists of a celluloid scale, with a small lamp behind it to facilitate readings. The shaft on which the worm gear is mounted has a sub-scale with 100 divisions on it. This gives an accuracy of reading to one part in ten thousand.

Connected in parallel with this precision condenser, through a cam-switch arrangement, we have three .007 mfd. condensers. This provides for a reasonable variation in frequency without changing the oscillator inductance.

On the front of the panel are two large binding posts for the use of an external condenser bank. This is necessary in using the driver as an audio frequency oscillator.

The feed-back resistance is a 0 to 500,000 variable resistance.

The milli-ammeter has a scale reading of 0 to 5 milliamperes. This meter reads the space current of the oscillator tube and tells whether or not it is operating.



- FIG. 3 -

An oscillator with a shunt feed battery system

Reviewing Tuned Double Impedance Amplification

*A Resumé of the Theory and Applications as Outlined in the Past Articles—By E. E. Hiler**

In recapitulating, Mr. Hiler has presented a number of new facts and also some valuable information regarding the general application of the system.

This article concludes the series on tuned double impedance amplification. However, Mr. Hiler is favoring us with an article on a new development along similar lines. This will appear in the September issue.—EDITOR.

THE need for feeding to the loud speaker more volume on frequencies in the range starting about an octave below middle "C" on the piano and down to the lowest note of the organ, can really not be appreciated unless you have experimented with tuned double impedance and by a quick switching arrangement compared it with other forms of audio amplification. After once hearing this you will not need to study the curves of speakers to know that even the best cones fall off sharply below 200 cycles and that it takes a tremendous amount of boosting of these frequencies before they really come back to normal.

It is true that with large cones more "lows" are available but usually this means that the range which is covered *at all* is widened or that the point where the "drop" begins is a few notes lower on the scale. This is particularly true of the new "power cones" (electro-dynamic) that have lately appeared on the market.

We can classify speakers today into three groups. The cones of all types having a range which starts very low but does not climb up to normal before 150 or 200 cycles; the exponential horn types which do not start so low but climb up quickly to normal at about 100 to 150 cycles, and the old type horns which do not start as low as either of the above and which take even longer to reach normal. Some of the horns we used to think were excellent never reached normal until they got up to 1000 cycles.

*Hiler Audio Corporation.

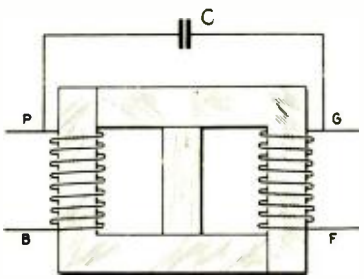


Fig. 1. Details of the tuned double impedance unit

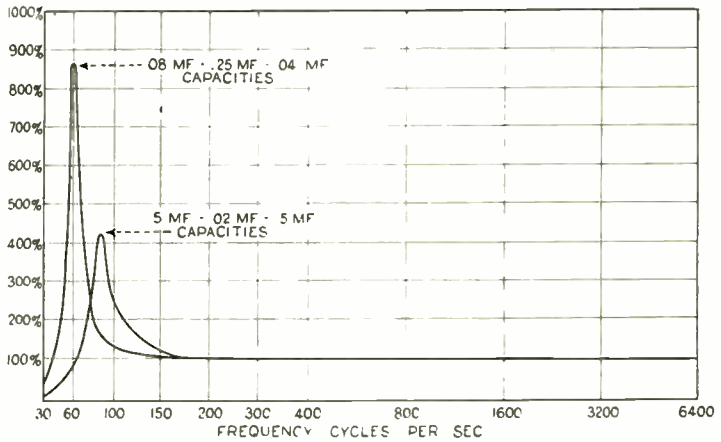


Fig. 4. Two frequency characteristic curves of a three stage tuned double impedance amplifier, using different values of coupling condensers

Calculation of Factors

The tuned double impedance circuit and units are illustrated in Figs. 1 and 2 and the impedance relations are shown in Fig. 3. Believe it or not Fig. 3 is the same circuit as Fig. 1. The important formulae to remember in connection with the circuit are two in number.

$$\frac{E_2}{E} = \frac{Z_1}{Z} \times \frac{Z_3}{Z_2} \qquad (1)$$

$$F = \frac{159.236}{\sqrt{L} \times \sqrt{C}} \qquad (2)$$

(F = resonant frequency; L = grid choke; C = mfd. in coupling condenser)

If you have read the first article in this series you will known how to arrive at the value of impedance Z_1 (the total external impedance). This is the impedance which will compel you to review your analytical geometry and trigonometry. We can promise you that if you figure Z_1 once you will never forget your "analyt" or "trig" again.

Here is a peculiar thing. One set manufacturer took a tuned double impedance unit and tried to measure the rising characteristic curve by using the same method that he had always used for measuring transformer curves, i.e., used two tubes with the unit connected between them. The result was that he failed to find any rising curve at all but only a dropping off and a slight bump. The right way to measure the results obtained in a set is to take an overall measurement of the amplifier with three stages working from a common "B" supply, for then the presence of audio frequency regeneration works wonders with the curve and gives the grid chokes the characteristics of high phase angle "iron." The same thing applies to transformers, only the curve rises up at the wrong place. This subject of audio frequency regeneration was covered in detail in the May issue of RADIO ENGINEERING.

Measurement of Inductance

We have also had a lot of fun measuring inductances so as to know exactly the value to put down in formula (2) above. The effect of the hysterisis and eddy current losses must be considered when measuring inductance.

One simple way is to have a known frequency of A.C. current of known voltage pass through the inductance to be measured in series with which is a condenser and sensitive A.C. milliammeter. Vary the condenser until the milliammeter reads maximum current. By substituting the value of the condenser (mfd) and the frequency used in formula (2) the value of the inductance will be found. And by substituting the value of this maximum current and the known voltage in ohm's law the "effective resistance" will be found. If it is desired to measure the inductance with D.C. flowing at the same time,

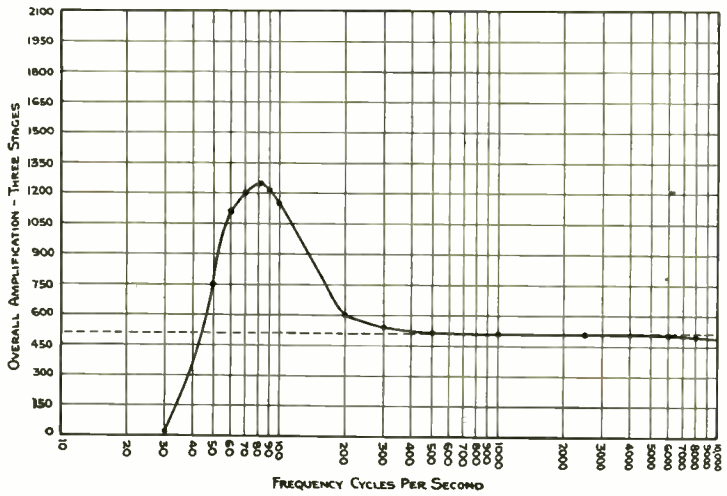


Fig. 5. Another frequency characteristic curve obtained from the amplifier when using .08 mfd., .04 mfd. and .03 mfd. coupling condensers and 25,000 and 50,000 ohm resistances in the second and third stages respectively

take two inductances identically the same and connect them in series, with a battery between them. Consider the mid-point of the battery as one end of a single coil and the other end of the two coils being common to each will be considered as the other end of a single coil. Then the measurements are made as before and the calculations take into consideration the fact that the two coils are in parallel.

Comparative Characteristic Curves

In Figs. 4 and 5 are given some curves for different combinations of capacities and we call particular attention to the one using the standard combination of .5 mfd., .02 mfd., and .5 mfd. without resistances. This is a good all around combination for all purposes as it strikes a happy medium between the three classes of speakers mentioned above.

The object of the original calculations on double impedance was to obtain the rising characteristic curve and after this was done the tests showed that it "worked" but one thing was overlooked in the calculations and that was the unexpected, positive elimination of "motor-boating." This added feature was thrown in for good measure and was the result, as we now know it, of the steep curve below the musical frequencies. It was down where the parallel reasonance of the "B" eliminator causes excessive feedback producing oscillations known as "fluttering" or "motor-boating."

If we should ever have loud speakers which would require the resonant frequency to be as low as 25 cycles it would be necessary to shunt the "B" eliminator with additional capacity to lower the parallel resonant frequency of said eliminator to prevent oscillation of the resonant frequency of the amplifier, or somewheres between the two resonant frequencies.

Controlling Resonant Peaks

The heights of resonant peaks can be adjusted by the insertion of resistances in series with the grid chokes but if the standard units marketed are turned around in order to try various combinations of condensers, it is best to place these resistances next to the free end of the coil as otherwise the condenser already inside of the unit will spoil the effect, to a large degree, of the added resistance. Another way to control the resonant peaks is by means of a potentiometer connected across the "A" battery with the mid-tap connected to the filament end of the grid choke.

Amplitude Distortion

We have seen in a previous article how important it is to consider amplitude distortion as well as frequency

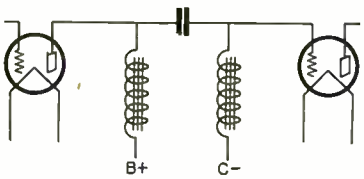


Fig. 2. Schematic diagram of a single stage tuned double impedance amplifier

distortion. The explanation of amplitude distortion involves the "loop characteristic" of a tube. It is caused by the fact that a tube varies in its efficiency with the amount of plate voltage actually between the plate and filament and the amplitude of the signal changes this voltage drop. The cure for it is to use large "external impedances" so that most of the voltage change will be across the "external impedance" where it belongs.

Amplitude distortion is also caused by the grid swinging positive with resulting grid current and consequent lowering of internal grid to filament effective resistance. A tedious and careful calculation of the amplification with varying values of effective grid to filament resistance shows a very interesting fact. *WITH TRANSFORMERS OR ANY FORM OF TURN-RATIO IT IS NOT PERMISSIBLE TO DRAW GRID CURRENT* but with double impedance the *amplification is hardly affected at all until the grid to filament resistance drops about 50,000 ohms.*

Constant Resistance Structure

We have now reached the last tube in the set and find that here the problem of making the external impedance large at all frequencies is not such an easy way of eliminating amplitude distortion. One way was suggested in the July issue of Radio Engineering which told of a constant resistance structure used in telephone transmission work. This method is inexpensive but has certain limitations and therefore is only a partial cure of loop characteristics in the last tube, unless carefully handled. If loud speaker impedances were higher it would be easier, but they too have limitations at the present time which make it impractical to increase their impedance greatly, (say 50 times what they are now). If we could use much higher plate voltages on the last tube we would be lowering our internal impedance which would help to cut down amplitude distortion and we would also be changing the proportion between the A. C. voltage change of the signal and the constant potential of the "B" supply. Both of these factors put off the point when loop characteristics affect the signal. The old reliable push-pull arrangement for the last tube in a set for the express purpose of balancing out the amplitude distortion of one tube by means of the amplitude distortion of the other tube (180° out of phase) is perhaps the ideal means for working into a low impedance speaker and a new combination of tuned double impedance push-pull arrangement where the last two tubes do not have to be the same size or carry the same voltage, has been developed by the writer. One amplifier built along these lines had a 201-A with 135 volts on the plate balanced against a 50 watt tube with 1200 volts on the plate. This new circuit arrangement will be described in the September issue of Radio Engineering.

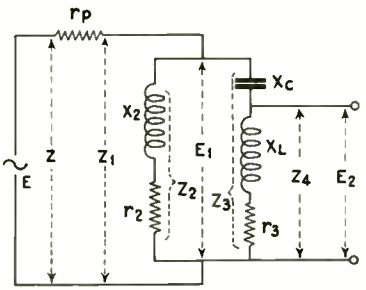


Fig. 3. Illustrating the electrical properties of a single stage tuned double impedance amplifier

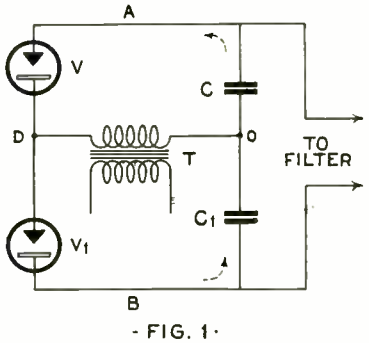
A Unique High Voltage "B" Eliminator

A Power Unit, Using Standard Parts, Which Supplies Double the Usual Voltage

PRACTICALLY any form of "B" eliminator can be altered, at small expense, so as to supply at the output, twice the normal voltage. Thus, if the eliminator employed has a maximum output of 200 volts, the potential can be increased to 400 volts, and a 210 power tube accomidated. "B" eliminators designed to supply sufficient voltage for a 210 tube can also be improved upon in the same manner as far better results can be obtained if a much higher voltage is used, to compensate for the sub-normal voltage at the output of the eliminator when on full load which often falls as low as 200 volts. Correspondingly higher voltages can be obtained, at low cost, by using two power transformers, with their secondaries connected in series and in conjunction with the circuit arrangement to be outlined and thereby sufficient voltage obtained for the operation of a 50 watt tube.

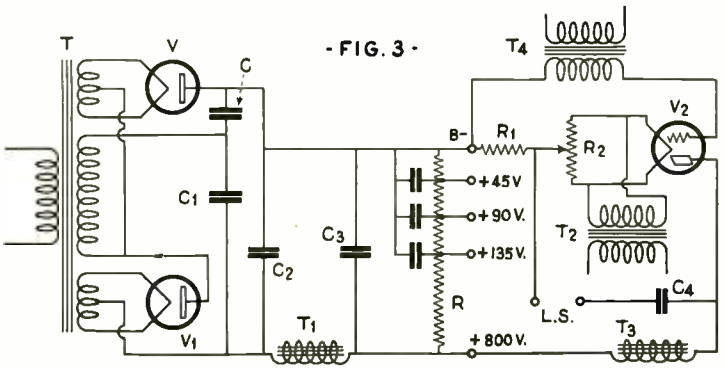
The circuit for doubling voltage in a rectifier arrangement or "B" eliminator is by no means new. The idea is comparatively simple and the results are entirely satisfactory.

The transformer is tied up with two half wave rectifiers as shown in Fig. 1. Quoting from Van der Bijl's "Thermionic Vacuum Tube:" when the transformer voltage is such that D is at a positive potential with respect to O, an electron current will flow in the direction of the arrow through the tube V, thus charging the condenser C such that A is positive with respect to O. But during this half period no current will flow through the tube V_1 in circuit DB. During the next half cycle current flows only through V_1—DB, charging B negatively with respect to O. The potential difference between A and B (if the condensers did not discharge themselves) would therefore be twice the transformer



- FIG. 1 -

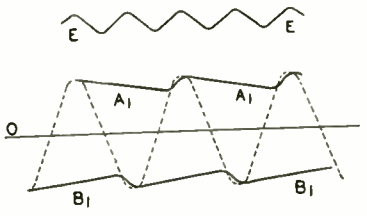
Diagram illustrating the operation of the double voltage eliminator



- FIG. 3 -

Schematic diagram of double voltage eliminator and 210 power amplifier. The grid biasing resistance R, might well be variable

voltage. What actually happens is that the one condenser discharges through the load while the other is being charged. Hence if the broken line (Fig. 2) represents the potential of the point D with respect to O, the curves A_1A_1 and B_1B_1 will represent the potentials of A and B respectively



- FIG. 2 -

The output voltage of both rectifiers (represented by A_1 and B_1) combine to make E which is double the voltage and frequency of the transformer output

with regard to O. The potential difference between A and B is therefore obtained by adding the curves A_1 and B_1 and is given by EE. Thus, although the condensers are charged only in alternate half periods, the voltage fluctuation in the circuit leading to the filter is double the frequency of the impressed voltage, while the mean voltage on the filter is approximately twice the impressed voltage.

The complete arrangement for a double voltage "B" eliminator, tied up with a 210 power tube, is shown in Fig. 3. T is a standard "B" eliminator power transformer while V and V_1 are two half wave rectifier tubes. The condensers C and C_1, which are instrumental in doubling the voltage, have a capacity of 2 mfd. each. The voltage rating on these condensers need not be very high.

The filter network is composed of the capacities C 2 and C 3 and the impedance T-1. T-1 can be an ordinary type of impedance designed for eliminators, operating from a 60 cycle line.

It has been pointed out that the voltage impressed upon the filter network is twice the frequency of the line voltage which would be 120 cycles, and since the impedance T-1 will have twice the reactance at this frequency and the capacities C-2 and C-3 will have one-half the reactance at this frequency, the efficiency of the filter network will be approximately four times as great as the network employed in the usual eliminator.

Due to the fact that the potential is doubled, capacities C-2 and C-3 must either be two 1 mfd. condensers with a voltage rating of 800 or 1000 volts, or each capacity composed of four 1 mfd. low voltage condensers connected in series-parallel.

The resistance R which is tapped for providing the necessary voltages for the radio frequency, detector and audio frequency tubes in the receiver, should have a total value in the vicinity of 82,000 ohms or twice the usual resistance value, since the voltage has been doubled. The usual by-pass condensers are shown connected from each voltage tap to the "B" negative lead. The resistance R-1 which is employed for obtaining the necessary voltage drop to provide a bias on the grid of the 210 power tube V-2 should have a value of about 1,000 ohms. The resistance R-2 can either be two fixed resistances of equal value connected in series or one resistance with a center tap. The total value should be about 2,000 ohms.

It will be noted that the two filament windings of the transformer T are employed for lighting the filaments of the half-wave rectifier tubes, consequently, it is necessary to employ a separate transformer (T-2) for lighting the filament of the 210 power

tube. This can be a toy transformer, such as sold for operating toy electric trains.

C4 is the capacity and T3 is the impedance forming the output filter. The loud speaker is connected to the posts marked L. S.

It is understood, of course, that though the output of this eliminator is twice the voltage and twice the frequency of that at the secondary terminals of T, the current output is no greater than if but one rectifier tube was employed. However, with a maximum potential of 800 volts sufficient current is available for the operation of the 210 tube without the voltage dropping below the normal value.

Vacuum-Tube Synchronizer

A New Use for Radio Tubes

VACUUM tubes, developed primarily in the field of radio, have now been applied in an entirely different field—that of a vacuum-tube synchroscope for indicating whether or not electric generating machines are properly timed in their operation. The apparatus gives a direct indication of whether incoming machines are running too fast or too slow, and shows the difference in speed without any time lag.

The first installation of this new type of equipment was made by the *General Electric Company* at the Menands substation of the *Adirondack Power and Light Corporation*, near Albany, N. Y.

Tubes Operate Synchroscope

The vacuum-tube synchronizing equipment provides the usual "fast," "slow," and "synchronism" indications without the use of instrument potential transformers. Potential from the lines to be synchronized is obtained from a capacitance transformer, and is amplified by means of vacuum tubes until sufficient power is obtained to operate a synchroscope.

Standard oil-filled bushings of transformers, oil circuit breakers or other apparatus can be replaced by a modified bushing with capacitance transformer for furnishing potential to the vacuum tube apparatus. Where such bushings are not in use, the capacitance transformer can be supplied in a separate tank which can be installed either outdoors or indoors. The voltage obtained in this way is in phase with the line-to-neutral voltage of the system. A capacitance transformer must be provided at each point where a potential transformer would be necessary if transformers were used for synchronizing.

The potential obtained from the capacitance transformer is impressed on the grid-filament circuit of a vacuum tube and amplified. This tube should not be more than 50 feet from the transformer. This low-power amplifier is built into a weatherproof housing for outdoor mounting. One such amplifier is required for each bus and line to be synchronized. The low-power outdoor amplifiers require a five-wire multi-conductor cable with 500-volt insulation between the amplifier and the substation where the high power amplifiers are installed.

Station Equipment

The station equipment consists of a tube and control unit, a motor-generator set, and the synchroscope. The tube and control unit consists of two 50-watt amplifying tubes and their associated equipment. These tubes will amplify the energy received from the low-power amplifiers sufficiently to operate the indicating synchroscope. The high-power amplifying equipment will take care of any number of synchronizing points at one substation. Proper switching means are provided to take care of a number of circuits where this is necessary.

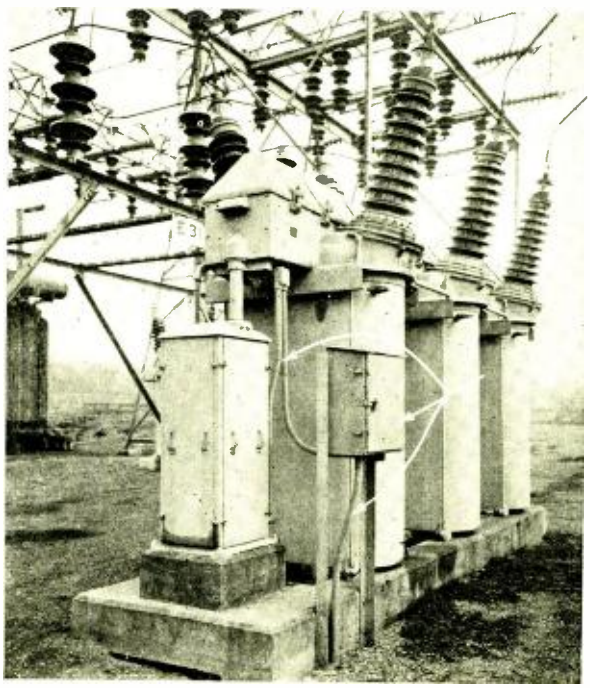
Where synchronizing potential of the proper phase relation from potential transformers is available from one side of the line, this potential may be applied to one winding of the synchroscope and tube equipment used to supply potential to the other winding. In such a case, the synchronizing potential from the potential transformer must be in phase with the leg voltage of the high potential circuit.

Generating Equipment

The motor-generator set consists of a driving-motor a filament alternator, a bias generator, and a high-voltage double-commutator generator. The driving motor requires approximately 1000 watts and operates from the station battery, or, with a different type of motor, alternating-current can be used. The filament alternator supplies the filament excitation for all the tubes. The bias generator supplies bias potential for all the tubes and excitation for the high-voltage generator, which supplies direct-current at 500 and 1000 volts for the plate supply of the amplifiers.

The insertion of the synchronizing plug starts the motor-generator set, which lights the tube filaments and supplies all necessary power. The synchroscope operation is the same as if potential transformers were being used. Where there are several lines to be synchronized, the connections are alternately transferred to the indoor unit or power amplifier so that only one indoor unit is required.

The tubes for high-power amplification and the accompanying transformers, grid bias, resistors, voltmeters, fuses, generator-field rheostats, motor starter and power switch are mounted on the indoor panel, which can be placed in any convenient location in the station.



Vacuum tube synchroscope installation at the Menands Substation, Adirondack Power & Light Corp., showing outdoor unit and leads from capacitance transformers. Arrows indicate outdoor unit and leads

The Evolution of Power Supply for Radio Receivers*

By Dr. A. N. Goldsmith

AS IS well known, the amount of power received by the average radio set, even for a fairly acceptable signal, is very small in terms of everyday power levels in the electrical industry. In fact, it can be measured in hundred-millionths of a watt and as capable, in itself, of producing only very little trifling acoustic effects. Nevertheless, one of the present requirements for most radio receivers is not merely weak loud speaker operation, but such loud speaker operation as will produce sounds of very considerable intensity, quite capable of giving a fair illusion of the presence of the original musician or speaker. Using loud speakers of the efficiency available today, this requires a practically undistorted electrical input to the loud speaker of the order of tenths of a watt of power or even more.

So that, among the various other functions (such as selecting the desired signal to the exclusion of all others), the receiving set must be capable in the instance mentioned of producing a power amplification running into the millions or even the billions. The only physical agency commercially available at the present time for this purpose of so greatly amplifying minute quantities of power is the vacuum tube. And the requirements of its operation are therefore of the utmost importance to the radio designer and must, in considerable measure, control the development of the radio industry. Previous examination of vacuum tube circuits discloses the necessity for two sources of power, together with a third source of *voltage* (rather than power, under normal operation). These have been called respectively the filament, plate, and grid supply. The function of the filament or "A" supply is to heat the negative element or "cathode" of the tube (generally called the filament), causing it to emit a cloud of tiny electrical charges, or electrons as they are called. The purpose of the plate or "B" supply is to propel a stream of electrons across the space between the filament and the plate within the tube (by means of electrical phenomena which we need not consider in detail in this discussion) and to continue this electrical current flow through the outside plate circuit, from some portion of which the useful output of the vacuum tube may be withdrawn. The object of the grid or "C" voltage is to maintain the grid member between the filament and plate in such condition that a certain average electric current in the plate circuit will exist, the variations of which will occur in a convenient manner suitable for the proper operation of the vacuum tube system considered as a whole.

It will be noted that "A" supply actually has nothing to do *directly* with the input or output of the tube, but is really an indispensable auxiliary permitting the operation of the tube. It is the foundation of the structure of vacuum tube amplification, but not the structure itself. The "B" supply, on the other hand, is very definitely a part of the output circuit of the tube and its elimination is not conceivable in such devices, with due regard for the law of the conservation of energy. The "C" supply furnishes little or no power to the vacuum tube circuit but is a control means, whereby satisfactory operation of the vacuum tube system is secured.

The nature of the "A" supply depends to a considerable extent upon the design of the vacuum tube. In the majority of vacuum tubes used up to the present time satisfactory operation could be obtained in radio receiving sets only when a steady or direct current was available for the "A" supply. This, however, is not a necessary condition since heating effects (which are the real purpose of the "A" supply) are quite as readily obtained through alternating current as through direct current. The difficulty in using alternating current for "A" supply in most receiving sets with standard tubes has not been that the set failed to operate under such conditions but that its operation was accompanied by a more or less disagreeable hum or buzzing note produced by the loud speaker in addition to the desired program. The source of this hum lies in no single effect and need not be analyzed in this brief discussion. However, there are various means whereby alternating current may be transformed into direct current for the "A" supply, and also other methods of tube construction which enable the desired electron stream to be produced in the tube when raw alternating current is fed either into the filament or into a special heater which, in turn, raises the temperature of that tube element which is the equivalent of the filament.

The nature of the "B" supply is much more definite. Since it supplies the usuable output of the tube, it must initially be a smooth or steady direct current, "producing silence," so to speak, in the loud speaker when no signal is being received, and varying only with the incoming music or speech and in correspondence therewith.

The "C" voltage similarly must be a steady and constant voltage. The foregoing considerations show us definitely the nature of the problem which we face in developing a power supply for radio receiving sets.

In order to present the principal possibilities in the way of power supply for the vacuum tubes in receiving sets, as at present known, in compact form, a chart has been prepared listing seven arbitrarily chosen types of power supply for vacuum tubes in a fairly reasonable order.

In the following chart, certain terms are used:

A "Storage Battery" may be with or without a storage battery charging device.

A "Trickle Charge" is a device which charges a storage battery at a rate much lower than its normal discharge rate but for longer periods of charge than discharge; as for example, a charge during

Type	"A" Supply	"B" Supply	Field of Use
1	Dry Battery	Dry Battery	Portable; general where simple set is desired and also where no power supply is available.
2	Storage Battery	Dry Battery	General where no power supply is available.
3	Storage Battery	Rectifier	General where A. C. socket power supply is available.
4	Trickle Charger	Dry Battery	General where A. C. socket power supply is available.
5	Trickle Charger	Rectifier	General where A. C. socket power supply is available.
6	Rectifier	Rectifier	General where A. C. socket power supply is available.
7	Alternating Current Tube	Rectifier	General where A. C. socket power supply is available.

*Courtesy of R.M.A. News.

the entire time that the receiving set is not in use.

A "Rectifier" includes the associated smoothing filters whereby the alternating current input, after rectification, is smoothed into steady current.

An "Alternating Current Tube" is a vacuum tube, the hot element of which is heated directly or indirectly by alternating current introduced within the glass envelope of the tube. It may be heated either by passing the raw alternating current directly through the filament or by passing the alternating current through a heater element which, in turn, heats the electron-emitting element.

Relative to the preceding chart, the following comments are pertinent. In the first place, this chart is not intended to convey any implications as to the relative merits of the various types of receivers, their order being chosen merely for electrical reasons. Furthermore, it is not intended to be a complete list of all possible combinations of "A" and "B" supply devices, but is merely a list of certain of the more usual types. It will be noted also, that the "C" voltage is not mentioned since this is frequently obtainable directly or indirectly from the "A" or "B" circuit or by a comparatively simple auxiliary device. Furthermore, in listing the various forms of socket power devices, only those suitable for use with alternating current input have been considered. It is recognized that in a certain small percentage of cases in the United States only direct current is available from the lighting circuits for socket power operation of receiving sets. The problem of its utilization is somewhat similar to the problem of operation from alternating current and need not be given special consideration at this time. For a similar reason, the use of motor-generator sets (with suitably associated filter circuits) for converting the lighting circuit power into a form suitable for use as "A" and "B" supply (or even into alternating current when only direct current is available in the lighting circuit) has not been considered since the use of rotating machinery is not a direct solution of the main problem of socket power operation and is perhaps applicable only in certain cases.

In studying the preceding chart, it is well to keep in mind that the "B" supply is always direct current. So that, in the last analysis, all vacuum tube plate circuits at the present time are steady direct current circuits.

The term "Rectifier" in the above chart necessarily covers a wide variety of quite dissimilar devices. It includes such forms as the vacuum tube, certain types of gas-filled rectifiers, electrolytic rectifiers, and may even be a vacuum tube functioning in the receiving set itself (as, for example, the case where the plate current of a final audio frequency power amplifier tube is used to feed the filaments of the preceding tubes of the receiver).

It will be noted that we may either feed alternating current directly into the vacuum tube for the "A" supply and get rid of whatever hum might result by suitable tube and circuit arrangements, or we can feed rectified alternating current (that is, direct current) into the tube for the "A" supply. This latter method, which is used in some of the earliest and best socket-power operated receivers, gives very satisfactory and thoroughly acceptable quietness of operation. It is perhaps the most powerful and effective method of socket power operation in cases where the very highest standards of tonal reproduction (fidelity) are demanded.

It is customary in certain forms of publicity to refer to a receiver as "Electrified" when it falls under any of the above types except types 1, 2 and 4. The term "Electrified Receiver" is not a particularly attractive one in some respects since every receiver is, after all, operated by electricity and therefore "electrified." Types 3 and 5 are clearly intermediate between types 1, 2 and 4, on the one hand, and types 6 and 7 on the other hand. They should probably be given a distinctive designation, such as receivers with "partial socket power operation." Types 6 and 7, on the other hand, are more definitely "socket power operated" and with increasing closeness to direct connection with the lighting circuit in the order that they are given.

It is believed that charts such as the above which are submitted purely in the hope of clarifying present practice and stimulating a correct classification of power supply for receivers, may lead to the development of a consensus of opinion relative to proper methods of describing such power supply methods to the public, in order that the prospective purchaser may have a clear idea of that which he is about to buy.

Leaving the subject of classification of power supply devices for vacuum tubes, we may next consider a few questions connected with the design and performance of socket power devices operating from alternating current lighting circuits.

The first question is encountered whenever we touch a lighting circuit, and involves the requirements of the Underwriters. As is well known, the Underwriters' Rules prescribe a number of definite practices on 110-volt circuits. Similarly precise rules have not yet been developed to cover socket power devices in all the types previously mentioned. Boiled down, however, the requirements of the Underwriters simply spell safety to the user and the elimination of any undue hazard. It is not believed that these requirements are or will be any source of trouble to qualified electrical manufacturers who are willing to study the situation carefully. They are mentioned merely with the thought that they should not be overlooked and thereby lead to the sale of devices which might detract from the present excellent reputation of radio equipment as a thoroughly safe device to have in the home.

A second and more basic matter which is encountered in the development of A. C. socket power operated receivers, is "hum elimination." Alternating current may be classified as nothing but hum and, when used in connection with highly amplifying and sensitive devices, such as high-grade radio receivers, it is but natural that the "fangs of the serpent" should occasionally be visible (or perhaps we should say audible). In this connection, it should be remembered that high-grade radio receivers (including the audio frequency amplifier and loud speaker) are definitely responsive to frequencies as low as the principal harmonics of a 60-cycle alternating current (120 cycles, 180 cycles, etc.); and are sometimes even responsive to the fundamental frequency of 60 cycles itself. It is necessary that these frequencies be reproduced by the receiver in order that orchestral music and speech may be properly re-created in the home; but this very requirement makes the elimination of hum a matter for careful study in any receiving set which gives a reasonably satisfactory audio frequency response at the lower frequencies. Then, too, there are various shapes of wave form of alternating current supplied commercially, some with exaggerated harmonics, and it is more difficult to utilize these effectively. Conditions of the supply lines and ground connections affect the elimination of hum as do a number of electrical features in the design and construction of the receiving set. Rectifying devices also differ considerably in the wave form of the rectified current and the ease with which it can be smoothed out or filtered to the necessary extent.

A third matter which arises whenever radio receivers are operated with vacuum tube power supply obtained directly or indirectly from lighting lines is "silence of the line." A lighting or power circuit may not be altogether "electrically silent" but is sometimes subject to transient disturbances arising from the operation of electrical devices connected to these lines. For example, commutators of motors may spark, switching contacts may arc, and other abrupt current changes may cause transient effects on the power lines. Radio receivers are built so as to respond with great readiness to extremely small amounts of radio frequency power, and these may well be present in lighting lines as a reasonable result of normal operating conditions for devices connected to the lines. This being the case, means should be provided to keep these disturbances out of the radio receiver or, at least, from producing objectionable noises in the loud speaker.

A fourth matter which arises in connection with the use of lighting

circuits as a source of power for vacuum tubes is "voltage regulation." If a user of electricity is located near the end of a fairly long supply line, it is likely that the voltage supply at times of heaviest load, for example mid-evening, will be lower than the voltage supply at times of light load, for example, in the late morning. Accordingly, the power supply to the filament of the vacuum tubes may be high during a talk on "baking a tasty cake" addressed to the housewife at 10:30 in the morning, but may be low during a vigorous and energetic description of a prize-fight for the championship broadcast at 8:30 o'clock in the evening. This, of course, is all wrong not only from the point of view of the fitness of things but because the life of the vacuum tubes is threatened through overload during the housewife's hour, and the operation of the set is unduly feeble during the prize-fight.

Certain requirements are therefore presented alike to the lighting supply company and the designer of the radio receiver. The lighting company (which is benefitting from the use of power by the radio listener) is called upon to maintain as reasonably constant a voltage at the consumer's residence as feasible and, conversely, the radio designer should devise his circuits so that tube life and receiver performance will not be unduly affected by normal variations in the supply voltage of the lighting circuit. A number of other minor questions might be mentioned but it is believed that the preceding brief summary of some outstanding features indicates sufficiently the general nature of socket power operation. Socket power operation is destined to add greatly to the convenience of radio reception in many cases, and should be welcomed alike by the public, the engineer, and the manufacturer.

Guiding Airplanes by Radio

Series of short wave transmitters form guiding channel

RADIO, which daily is being called upon for new uses, may eventually be utilized by airplanes, instead of compasses, for through the invention of C. Francis Jenkins, of Washington, D. C., it is believed that radio will become a guiding force for aviators, enabling them to fly across the country by means of air marks instead of land marks.

What Mr. Jenkins has done is to develop a radio guiding channel which will make it possible for aviators to keep on a definite course, irrespective of weather or topographical conditions. The invention is receiving the consideration of some of the leading commercial aviation executives in the country preliminary to the adoption of the plan.

Its importance to radio experts is the fact that while there has been talk of guiding ships by radio no consideration in this respect hitherto has been given the airplane. The two plans differ in that under the plan considered for ships the radio would act not only as the guide but also as the controlling force, the ships being operated by radio from the land. The radio guiding channel, however, has a different function. Its primary purpose is to provide a path through the air so that an airplane will be moving on a road, even though invisible, just as the automobile or the steam engine moves on a road.

Series of Transmitters Used

The radio guiding channel calls for the installation of a series of radio transmitting stations at intervals of twenty-five miles over any given course. These make use of short wave lengths and low power. By the use of vertical antennae, of a height and separation bringing them one-half a wave length apart, the waves are radiated in one direction. The use of the low power limits the force radiated by one station to approximately forty miles. The location of the stations causes this directional radiation of waves to overlap somewhat.

An airplane traversing this route will be equipped with a receiving device which uses the power from this radio-energized channel to light a small indicator lamp on the instrument board of the plane. By noting the intensity of this lamp the aviator is able to determine whether he is keeping in the channel. If he gets off the course the light from the little bulb becomes dimmer. The light becomes stronger as he returns to the course. The constant transmission of radio waves from these stations along the radio channel makes it unnecessary for the airman to know the course which he is flying.

"The radio guiding channel," Mr. Jenkins says in explaining it, "is especially suited to commercial or government uses, such as the air mail, where flying must go on through rain, fog, snow and sleet. The present system of beacon lights along the air mail courses serve their purpose well for night flying in clear weather, but when storms come and fog lowers, these are blotted out to a large degree. Then is when the radio channel guide will be most helpful."

Advantages

The advantages of the radio guiding channel include the ability to change the direction of the course, so as to take the airplane through mountain passes or other rough ground. Another important advantage is that the channel will serve many planes traveling in either direction at the same time, the opposing planes flying at different levels. Along with this is the simplicity and automatic character of the transmitting and receiving devices.

This might be compared with the submarine cable which is used to guide ships coming into New York in a fog, through the use of which ships' officers are able to determine whether they are in the proper channel.

The area covered by the radio waves is sufficiently high that the aviator may fly far above cities and thus miss objects which might cause the plane to crash.

Other Developments

Other inventions by Mr. Jenkins for the improvement of aeronautics include a launching runway which will enable a plane to get into the air in a second's time; a propeller-reversing device which permits a plane to be stopped in twice its own length on landing; and a landing altimeter, which will keep an aviator constantly informed as to the distance of his ship from the ground when weather conditions would prevent him from seeing the landing field.

The altimeter also is of interest to radio experts because it involves the use of radio devices. Use is made of the known velocity of sound, and the measurement of time, which is taken for sound to travel to earth and back furnishes the key to the guiding dial of the altimeter.

The device, which occupies but little space in the plane, consists of a tiny motor which serves two purposes. It actuates a sound producing mechanism, through which the sound is sent to the earth; it also operates a wheel spinning just behind the ground glass dial of the altimeter on the instrument board of the plane. The dial is graduated, and so calibrated that as the echoes of the sounds reach a microphone attached to the plane, lamps are lighted back of the dial. The frequency of the sounds and the resultant echoes caught by the microphone are transformed into flashes of light. These flashes of light, appearing at various points on the dial—according to the length of time between echoes—furnish the guiding marks which tell the aviator whether the plane is five hundred or fifty feet above the ground. From these he can determine when he is close enough to slow his plane to landing speed.

During the experimental period for the development of the landing altimeter, Mr. Jenkins and his co-workers applied the device to an automobile which was driven through a forest road. In each test the sounds echoing from the trees, houses, etc., by the roadside marked the distances on the dial.

Methods of Governing Voltage Output

An outline of the systems used in general practice—and a preferred method

*By H. G. Richter**

THERE are a number of specific methods of controlling the output voltages of a "B" eliminator or power unit which have been employed for some time. There is no justification in a statement that any one of the existing methods is preferable to all others any more than there is justification in a declaration that the opinion of one man should hold forth in contradiction to the opinions of others.

There are two fundamental systems for controlling the output voltages of a "B" power unit and both systems have their advantages and disadvantages.

The first general method employed consisted of one or more variable resistances, each connected in series with the high voltage line and bypassed, by fixed condensers, to the low voltage side of the line. Obviously, with this arrangement there are two or more separate paths for current flow.

The second method, and the one most commonly employed today, consists of a single, tapped resistance shunted across the output of the filter circuit. This potentiometer arrangement, with taps at predetermined places on the resistance, provides two or more fixed voltages. With this arrangement there is a direct load across the output of the eliminator and the output of the filter circuit flows through all of the resistance at periods of no load.

Limitations

Now, as to the advantages and disadvantages of the two systems. A number of variable resistances offer the advantage of individual voltage adjustment for the tube or tubes they are in series with. This may or may not be considered as a desirable feature since a change in the voltage for one series of tubes may likewise alter the actual voltage on the plates of the other tubes, due to an increase or decrease in the load, as the case may be. Still, if a rectifier tube, which is capable of supplying sufficient current to the receiver for all purposes, is employed in the eliminator, a change in load on one series of tubes will not materially affect the actual voltage impressed on the plates of the other tubes. In other words, if the rectifier tube is capable of maintaining a fairly constant output voltage with varying loads and the line voltage at the input of the eliminator remains fairly constant, the change in voltage at all of the taps on the output of the eliminator, due to a readjustment of one or more of the variable resistances, will not be appreciable.

With the potentiometer method, or tapped fixed resistance shunted across the output of the filter circuit there is less actual chance of a change of voltage at the various taps with a varying load. Of course, a momentary heavy current drain, due, say to the functioning of the power tube in amplifying a low frequency note, will change the voltage drop throughout the entire tapped resistance, but again, this drop will not be very great if the rectifier tube is capable of maintaining a fairly constant voltage under heavy load.

With this arrangement there is the disadvantage that it is impossible to adjust individually the voltage at each tap and this disadvantage is increased by the fact that a miscalculation in the current drain of the receiver or a miscalculation in the formula for determining the resistance required to drop the voltage a given degree with a certain current flow may result in too high or too low a voltage impressed on the various tubes in the receiver. As a matter of fact, even though the necessary calculations are made it is next to impossible to determine what the voltage is at each tap without the use of a high resistance voltmeter.

The only alternative in this case is to employ a variable power resister connected in series with one side of the primary winding of the power transformer. This variable resistance will accomplish two things. First, its adjustment will make up for any change in the line voltage and thus allow for a constant voltage at the output of the filter circuit. Secondly, assuming a constant line voltage, it makes provision for adjusting the total output voltage of the filter circuit most desirable for the operation of the receiver. However, the use of such a resistance is advisable only in the case that the rectifier tube is of the gaseous conduction type.

There is another point that should be mentioned regarding the two systems just outlined. It is obvious that when employing the variable resistance arrangement that there is no constant load at all times on the output of the eliminator. When employing the potentiometer method however, there is a constant load and this helps to maintain a limit above which the voltage cannot rise and to some extent acts as a voltage regulator when the load on the eliminator varies.

It is seen that both systems have their advantages and disadvantages and that it is very difficult to decide which method to employ. If economy were the main factor the potentiometer system would be the best, since only one tapped resistance is required and the number of by-pass condensers is cut to a minimum.

New Voltage Control System

The author wishes to present a new method of controlling the voltages at the output of a "B" power unit which has all of the advantages, but practically none of the disadvantages, of the two systems outlined. This system is not based on a new principle but rather on a new type of resistor which heretofore was not at all practical from the manufacturing standpoint.

We have pointed out the obvious advantages of the variable resistance method which allows for individual voltage adjustment and of the fixed potentiometer method which does not allow for individual adjustment. The new system is of the potentiometer type but instead of having a number of fixed taps it employs one or more "voltage feelers." What we have is really a high resistance shunted across the output of the filter circuit and movable contact arms ranged along limited portions of the resistance. Thus, it is possible to individually adjust the voltage at each tap and do so without changing the voltage at any of the other taps, by moving one of the contact arms to a different section of the resistance where the voltage drop is either greater or less. The output of the filter still flows through the entire resistance, at no load, and provides the advantages heretofore outlined in connection with the fixed potentiometer arrangement. The number of by-pass condensers required is cut to a minimum.

Details of New Unit

The system, of course, is very simple but it has been impossible to carry it out in practice heretofore because no high resistance, power potentiometers were available. That they are available now is due to a new manufacturing process and in order to indicate the practicability of these high resistance potentiometers and their particular adaption to "B" power units it might be well to describe their construction.

It is basically a wire wound resistance but it is obvious that the usual high resistance of this type requires exceptionally fine wire to get the total resistance within a small space and that this wire would snap if a contact arm were run over it. It was for this reason that a new design had to be

* *Chief Engineer, Electrad, Inc.*

developed. Instead of the usual method, nichrome wire is closely wound on an asbestos cord having an enameled covered, copper core. This resistance element in turn is wound on a threaded isolantite tube. Since the fine resistance wire is wound twice before the unit is complete it is seen that each turn of the wire, as it is on the asbestos cord, is parallel to the axis of the tube and consequently a contact arm scribing an arc from one end of the tube to the other will not strike the fine wire at right angles but nearly parallel to the turns as they are on the asbestos cord. Thus, the contact arm slides evenly over the fine turns and can not snap them.

As the resistance wire is wound openly around the tube, the full length of the bare wire is exposed for the dissipation of heat directly into the air. Since there is no iron or zinc in the wire itself it can not rust or oxidize. The contact arm moving across the turns of wire gives fine regulation with as many points of control as there are turns.

These variable potentiometers are made in ranges from 0 to 2,000 ohms up to 0 to 50,000 ohms. If it is found by calculation that a maximum of say 50,000 ohms is required at the output to obtain the necessary voltage drop and it is desired to have two variable voltage controls, then two of the 25,000 ohm units can be connected in series. These units are rated at 25 watts which is sufficient for practically all purposes.

Code of Ethics

Adopted by the Radio Manufacturers' Association, June 17, 1927

EXPERIENCE has shown that a formal statement of principles embodying correct standards for business relations are essential to the development, and orderly conduct of every industry. The R. M. A., recognizing its responsibility to the radio industry and to the public has, therefore, adopted as a rule and guide for the conduct of its members, the following code of ethics:

1. Statistics

Knowledge—thorough and specific—and unceasing study of the facts and forces affecting this industry are essential to lasting individual success, and the members of this association should co-operate in the collection and dissemination of facts relating to the industry, for the benefit of all.

2. Standards

The standardization of parts, manufacturing methods, terminology, rating and types are of great assistance to the industry and to the public and the members of this association pledge themselves to make all reasonable efforts toward this end, provided, however, that attempts to standardize should not be pressed to such a point as to discourage or limit the development of the industry.

3. Mutual Relations

Recognizing that the Radio industry will benefit by the existence of harmonious and friendly relations between its members, no member of this association shall make statements or take action calculated to injure, directly or indirectly, the business reputation, product, or personal standing of a competitor.

4. Duty to the Public

The nature of the radio industry is such that there is a well-defined duty and obligation to the public. Their interest demands that the members of this association use every honorable means to uphold the dignity and honor of this industry, to raise its standards, and to extend its usefulness.

5. Piracy of Design

A company gaining an advantage by reason of superiority in designing skill, electrical or mechanical, is under no obligation to share such advantage with other companies. Such a company cannot, however, expect to retain exclusive use and benefit of unpatentable features of construction; but specific construction and designs of one company should not be appropriated by its competitors.

6. Piracy of Appearance

The duplication in color, description or designation of product or package which would tend to deceive the buyer or the public, that in purchasing the imitation they were getting the original article, is a form of unfair competition which this association condemns in the strongest terms.

7. Production Costs

Realizing that only through exact knowledge of the cost of production can the manufacturer sell on a fair margin of profit, this association specifically urges every member to adopt an intelligent check on their business operations, and to know accurately the cost of management, production, and distribution of their product. This association distinctly leaves to the determination of each member, however, all questions of selling prices, labor, hours, and wages, and avows its position in such matters to be that of the strictest observance of the law.

8. Advertising

Advertising should at all times be fair and honest. It is not discreditable to become enthusiastic in print, but to criticize a competitor, directly or indirectly, in a paid advertisement or to convey to the public your opinion of your competitor or his products, or to include statements in advertising which through actual misrepresentation, through ambiguity or through incompleteness are likely to be misleading to the public is unjust to competitors, and should not be permitted.

9. Subsidizing Buyers' Representatives

We are opposed to any manufacturer offering in any way special compensation of any type or kind as an inducement to the individual who acts as buyer for his employer.

10. Jobbers' Catalogues

We discountenance the furnishing by the manufacturer of inserts for jobbers' trade catalogues without charging for same at full cost, or the making of any allowance upon the part of manufacturers to the jobber for illustrating the manufacturers' goods in such catalogues.

11. Cash Discounts

A cash discount is given in return for payment within a specified time after shipment. The terms given should be adhered to or the transaction ceases to be of the nature intended.

12. Returned Goods

We recommend the following as standard practice with reference to return of goods where orders have been correctly filled:

A. The customer should be required to obtain consent of the manufacturer before returning such goods for credit.

B. The goods thus returned may be credited subject to a service and rehandling charge including the shipping expense.

C. Such returned goods may be sold as new goods, if in salable condition.

13. Guarantees

We disprove of any unreasonable guarantee, believing such to be detrimental to the manufacturer and to the industry. Apparatus should be guaranteed free from defects in material and workmanship, for a reasonable time, but this should not apply to apparatus which has been subjected to misuse, neglect, or accident. Defective material should be repaired or replaced at the option of the manufacturer upon the return of the same, transportation charges prepaid.

14. Unethical Acts

(a) Formal complaint:

Should any member of the Radio Manufacturers Association believe that a serious unethical act has been com-

mitted against him by another member of this Association the procedure to be adopted by the complainant in entering his complaint shall be to file with the Executive Secretary a written statement duly sworn to, specifying the cause of complaint.

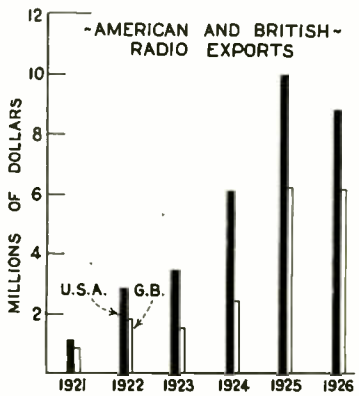
The Executive Secretary shall thereupon refer such complaint to the Fair Trade Practice Committee who shall review the charges that have been made, and if they are of sufficient gravity in their judgment to warrant such action, they shall cause to be served upon the accused member, a certified copy of the charges with a written notice that a period of fourteen days will be allowed in which to file with the Fair Trade Practice Committee their answer to the charges in the complaint.

The complainant shall submit for the consideration of the Fair Trade Practice Committee, all evidence he shall have in his possession and likewise the accused member upon receipt of his notice from the Fair Trade Practice Committee shall prepare all the evidence at his disposal and submit it in the form of the sworn affidavit.

If the Fair Trade Practice Committee shall find probable guilt the case shall be referred to the Board of Directors with a report of their findings for careful consideration and appropriate action.

(b) Informal complaint:

1. The complaining member may communicate, either verbally or in writing, to one or more members of the Fair Trade Practice Committee, stating his complaint in full, and submitting whatever evidence he may have.
2. If the complainant so requests, the Fair Trade Practice Committee must not reveal the name of the complainant to the party complained of. In the event of a report by an unnamed complainant, it shall be incumbent upon the Fair Trade Practice Committee and all of the members thereon as individuals to not reveal to any one outside of the Fair Trade Practice Committee, any of the facts or anything about the complainant so long as the complainant remains anonymous.
3. The Fair Trade Practice Committee, as such, or one or more of its members, will then advise the member against whom the complaint is made, of the nature of the complaint, and will give the accused full opportunity to present its side of the case.
4. The Fair Trade Practice Committee, or a member of the Committee, will then report back to the complainant. The complainant may then prefer formal complaint, if such action is warranted in his judgment, or he may do nothing further.
5. The Fair Trade Practice Committee may make formal complaint itself, if the original complainant does not care to do so, and if in the judgment of the Fair Trade Practice Committee such formal complaint should be made.



Comparative chart of American and British radio exports. It will be noted that British exports took a much greater jump in 1925 than American exports. Also, U. S. exports show a proportionately greater slump in 1926.

U. S. and British Radio Export Trade

Purchases have declined but export trade is means for relieving summer sales slump

DO international markets for radio show signs of reaching the saturation point? U. S. exports during 1926 showed a falling off of roughly ten per cent from the previous year's total, and it is noteworthy that this is the first occasion since the commencement of the broadcasting era when our exports in this line have failed to show a steady increase upon the previous year's quota. From data just released, Great Britain's radio exports for 1926 have also shown a decrease. The overseas sales of radio of both countries during the past few years have been as follows:

Year	U. S.	Gt. B.
1921	$1,010,891	$753,074
1922	2,897,799	1,827,368
1923	$3,448,112	$1,455,756
1924	6,030,914	2,256,666
1925	9,903,787	6,255,282
1926	8,794,453	6,131,962

Before 1924, British tube exports were so insignificant that they were not reported separately in government figures, but were included with other products, and it is probable that their figures might be increased by about 10 per cent on this account for the years 1921-1924 inclusive.

Race for World Leadership

For some years past, British radio manufacturers have been straining every effort in the task of disputing world leadership of radio exporting nations with the United States, and in the struggle for premier position that country now takes second ranking. Germany is still a considerable way behind, but her manufacturers are animated with the single desire to follow the lead of the U. S. until they reach the goal of world domination in radio.

Accurate statistics are of great value to the exporter to show what lies before him in the world's markets, and in the increasing volume of data upon radio conditions the statistics of the Bureau of Foreign and Domestic Commerce take first place. Nothing on the same lines has yet been undertaken in Britain, while the position which Germany has held in the markets of the world in the past is reflected to some extent by the fact that there is as yet no separate classification of radio in their official returns, and that these are only just about to be reported separately. Figures from every country where radios are licensed show that in every single instance there was a satisfactory increase in the number of users during 1926, and in the opinion of observers located in Europe, it is the efforts made by Germany to secure increasing trade in all markets rather than any decrease in foreign buying which is the cause of the decline in both American and British exports last year.

By reason of an earlier start in the business, the United States has for some years been keeping the best supplied radio store for all nations, but it is only to be expected that the huge sales should arouse the emulation of rival traders, and others are now beginning to realize that in foreign sales there lies the remedy for the bugaboo of the "summer slump." It is undoubtedly increased competition rather than decline in buying which accounts for the sudden drop in the national sales curve.

Constructional Developments

The Gomez Super-Reflex Receiver

THE Gomez Super-Reflex Receiver described in the September issue of *Radio News* is quite a change from the usual run of circuits. Though reflexing takes place, the receiver is more easily classified as a super-regenerator. The variation frequency employed to give the super-regenerative effect is produced by the windings of the transformer T-1. The condenser, C-1 tends to control the variation frequency as well as the tendency of the tube V-1 towards oscillation at radio frequencies.

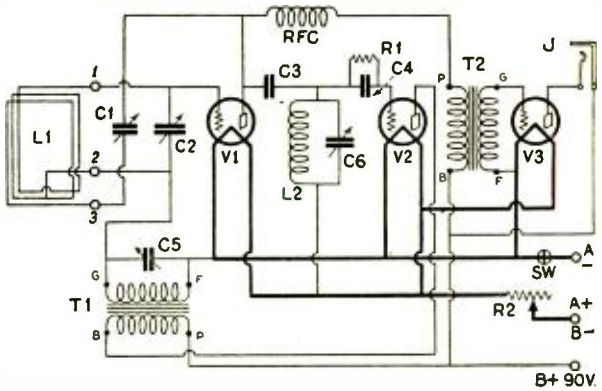
Theory of Operation

In order to allow the passage of the radio-frequency current, the 5-mmf. condenser C5, is used in shunt with the secondary of the audio-frequency transformer T1. The radio-frequency current passes through the condenser C3 to the coil L2 of the detector grid circuit and, after having been rectified, the signal passes through the transformer T1 to the grid of the first tube V1 whose plate is connected in series with the radio-frequency choke coil RFC, whence it goes to the audio-frequency amplifier T2 and V3.

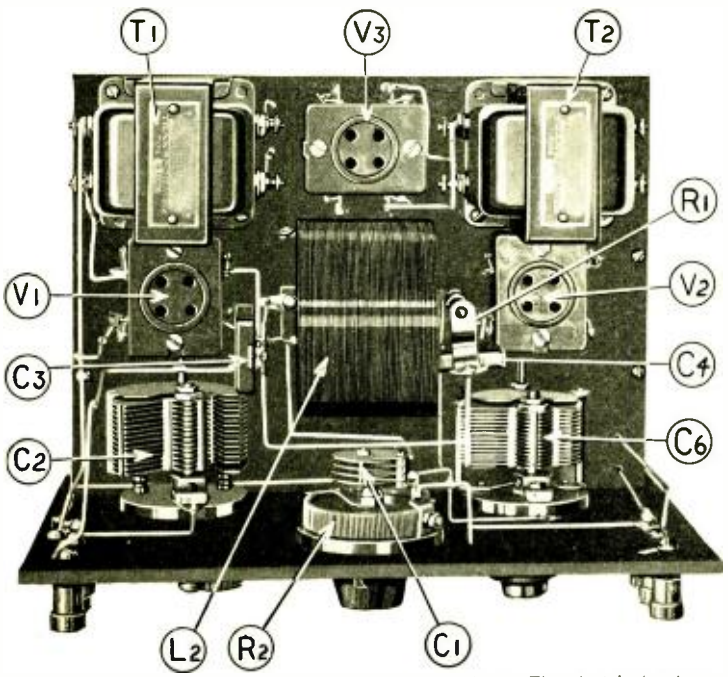
The energy picked up by one side of the loop goes to the grid of the first tube, the other half of the loop being used to neutralize the internal capacity of the tube, and to control the regenerative action of the latter. It might seem that this is an ordinary reflex circuit, but such is not the case. It is really a super-regenerator. The super-regeneration effect is obtained by the imposition of the super-audio oscillations, produced by the windings of the transformer, on the grid of the first tube.

The first tube really does three things. In the first place it amplifies the incoming frequency; secondly, it acts to a slight extent as a reflex audio amplifier; and, thirdly, it is an audio-frequency oscillator. It seems that the Rice system of neutralization is indicated here; but the Gomez circuit is distinctly different from Rice's.

The neutralizing condenser, when once set, need not be changed except on the longer wavelengths, variations being obtained by use of the impedance-coupling system between the radio-frequency tube and the detector.



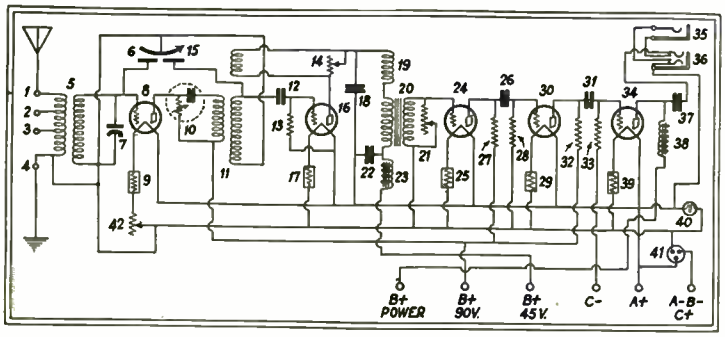
Circuit diagram of the Gomez Super-reflex. Regeneration in the circuit of tube V_1 is controlled by the variable condenser C_1. This handles both the radio and audio frequency feedback.



Top view of the completed Gomez Super-Reflex receiver. The electrical values of the instruments are given in the list of parts

List of Parts

C2, C6 — 2 Variable condensers, .00045 mfd. (29 plates).
C1 — 1 Midget variable condenser, .000025 mfd.
T1, T2 — 2 A. F. transformers, max. ratio 3 to 1.
R2 — 1 Rheostat, 6 ohms.
C4 — 1 Fixed condenser, .00025 mfd.
C3 — 1 Fixed condenser, .001 mfd.
R1 — 1 Grid leak, 2 megs.
RFC — 1 R. F. choke, 85 M. H.
J — 1 Single circuit jack.
SW — 1 Filament switch.
C5 — 1 Variable condenser; adjustable, 1.8 to 20 mmfd.
L2 — 1 Special coil, 60 turns, space wound.
L1 — 1 Loop antenna, 24 turns, center tapped.
V1, V2 — 2 Vacuum tubes, 201-A type.
V3 — 1 Vacuum tube, 112 type.
3 Sockets.
6 Binding posts.
2 Dials.
1 Panel, 7″ x 10″ x 3/16″
2 Brackets.
1 Cabinet, 7″ x 10″ x 9½″—inside.



Schematic diagram of the "Find-All" Five. This is similar in many respects to the Roberts' circuit

The "Find-All" Five

The "Find-All" Five receiver, developed by H. G. Cisin, M. E., of the *Allied Engineering Institute*, New York City, is based upon the well-known and time-tried Roberts circuit. This circuit, originated by Dr. Walter Van Braam Roberts, has undergone a process of evolution. Because of its intrinsic value, the Roberts circuit has been a subject of investigation and experimentation on the part of numerous radio engineers. Refinements, modifications and improvements have been added to the fundamental circuit and the result is the receiver described herewith.

The fundamental circuit consists of a single stage of tuned, neutralized radio frequency amplification and a regenerative detector. The audio amplifier consists of one stage of transformer coupled amplification and two stages of resistance coupled amplification.

Instead of using the older methods of neutralization which calls for rather difficult adjustments and often give uncertain results a device called phasatrol is used to prevent any tendency toward radio frequency oscillation or distortion.

The detector circuit is of conventional type, regeneration being secured through the use of a fixed condenser and a tickler coil. The addition of regeneration materially increases the amplification and gives added selectivity to the set. Regeneration is controlled by means of a variable resistance shunted across the tickler coil. The coupling of the tickler coil may be changed, a knob being provided to rotate the coil.

The Power Amplifier

The 171 type power tube is recommended for use in the last stage of this receiver because of the fact that it is capable of delivering plenty of undistorted power to the loud speaker. A tone filter is provided to protect the loud speaker and also to give improved tone quality. If a high-mu tube is used in the second stage, the lead from the 0.5 meg. resistor should go to the negative C 1½ instead of direct to negative "A", as shown in the diagram.

LIST OF PARTS FOR THE "FIND-ALL" FIVE

1—Panel, 7" x 21" x 3/16", crackle finish.
1—Sub-panel, 7" x 21" x 3/16", crackle finish.
2—Brackets.
1—10 Ohm rheostat (42)
1—Pilot switch (41)
4—5 V. ¼ amp. self adjusting rheostats (9, 17, 25, 29)
1—5 V. ½ amp. self adjusting rheostat for power tube (39)
2—.0005 mfd. variable condensers (6, 15)
1—32 mmfd. (9-plate) midget condenser (7)
1—Antenna coupler (5)
1—Coupler coil (11)
1—Phasatrol (10)
1—Variable resistance (21)
1—Variable resistance (14)
1—.00025 By-pass grid condenser (12)
1—.001 R. F. Choke by-pass condenser (18)
2—.015 coupling condensers 26, 31)
5—Cushion sockets, UX type.
4—201-A vacuum tubes (8, 16, 24, 30)
the program from the Radio Industries Banquet, beginning at nine oclock, New
1—171 type power tube (34)
1—2 meg. resistor (13)
1—0.5 meg. resistor (28)
1—0.25 meg. resistor (33)
2—0.1 meg. resistors (27, 32)
1—Single circuit jack (35)
1—Double circuit jack (36)
1—Vernier dial, with panel light (40)
1—A. F. Transformer (20)
1—Filter choke (38)
2—2-mfd. fixed condensers (22, 37)
5—Resistor mountings, single type.
1—Plug for loud speaker.
1—Cable complete with connector plug and mounting.
1—Automatic power control.
1—R. F. Choke (19)
1—Audio Choke (23)
4—Binding posts (1, 2, 3, 4)
2—Rolls wire.
1—Can of solder (rosin core)

Note: Numbers in parentheses after each part refer to corresponding numbers used to mark parts on diagram.

National Radio Day

The Radio Industries Banquet Committee realizing the tremendous public interest in the program broadcast from the Radio Industries Banquet in New York City each year, has authorized the designation of Wednesday, September 21, 1927, as NATIONAL RADIO DAY.

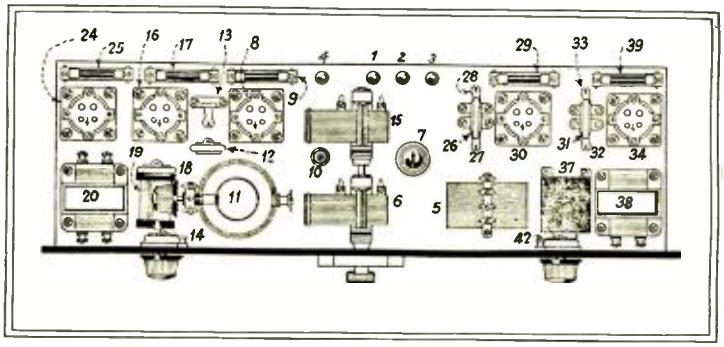
In line with activities in previous years, broadcasters all over the country will carry the broadcasting of the program from the Radio Industries Banquet, beginning at 9 o'clock, New York time, on Wednesday evening, while some others will carry the program beginning at an earlier hour.

Last year, in five cities, local associations of radio men staged local Industries Banquets, broadcasting their local programs up to the time the New York program began to go over the local station, thus linking up the two programs most effectively.

In the plans for the 1927 banquet, the committee is urging that more local associations endeavor to arrange such tie-up banquets and programs. Broadcasters assisting in such work will be giving a great deal of assistance to the industry as a whole.

It is also the aim of the Banquet Committee that broadcasters in general, shall endorse the National Radio Day movement and designate their programs on Wednesday, September 21st, as National Radio Day Programs, endeavoring to give the listeners an especial treat that day, if possible.

The Committee for the Radio Industries Banquet is interested in anything broadcasters are doing to help in the publicity for Radio Day, as well as the efforts of broadcasters to secure additional publicity.



Constructional layout of the "Find All" Five receiver. Note that the variable condensers are in tandem, making a single tuning control

NEWS OF THE INDUSTRY

Electrodyne Elects New Officers

At a recent meeting of the Board of Directors of the Electrodyne Company, Inc., the following were elected as officers for the coming year: Harold Hymans, president and general manager; Andrew H. Gombos, vice-president and in charge of production; George Szarnyassi, secretary and treasurer.

Wm. Engles Becomes Arborphone Sales Promotion Manager

To handle the new Merchandising and Advertising plan on Arborphone, Precision Products Company has employed William Ingles, formerly of Radio Retailing and Thomas A. Edison, Inc.

Mr. Ingles will be responsible for Arborphone advertising and Sales Promotional work, and will work with jobbers and dealers on the new merchandising plan.

Arborphone Obtains Loftin-White License

Precision Products Company have announced that they have been licensed under Loftin-White patents. Of the seven sets in the new Arborphone line, four will use the Loftin-White Circuit. These four will be known as models 25, 253, 252 and 255 DeLuxe. The latter is a combination power radio and phonograph.

Arborphone is the only complete set now licensed by Loftin-White.

Murdock Licensed by R. C. A.

Announcement is made by D. R. W. Murdock, Treasurer of the Wm. J. Murdock Company, that the Murdock Company has signed a license agreement with the Radio Corporation of America which gives the manufacturers of Murdock Radio full right to manufacture under one hundred and forty or more radio patents held and controlled by the Radio Corporation of America, the General Electric Co., the Westinghouse Electric & Mfg. Co., and the American Telephone & Telegraph Co.

NEMA Meetings

The Policies Division of the National Electrical Manufacturers Association will meet at Association Island, N. Y., on September 1st, 2nd and 3rd. The Apparatus Division is to meet on October 24th to 27th at Briarcliff, N. Y.

Browning-Drake Corp. Move Into New Quarters

The Browning-Drake Corporation of Brighton, Massachusetts, has just announced its removal to larger quarters across the river in Cambridge. Considerably greater floor space will be available for increased production during the coming season. Professor Browning has also announced recently the termination of his connection with the National Company, formerly of Cambridge. Henceforth all of his research will be devoted to the Browning-Drake Corporation.

To Travel for Splitdorf

James Keller Beach, formerly of the Hassler Texas Co., of Dallas, has joined Splitdorf Radio Corporation as an executive representative traveling out of the Chicago branch. His territory covers: Oklahoma, Kansas, Arkansas, Louisiana, with headquarters at Dallas. Mr. Beach is well known in the radio field as an aggressive worker and he has a large following.

International Resistance Co. Appoint New Sales Representative

"The International Resistance Company, Philadelphia, announce the appointment of Mr. B. J. Fitzner, 159 E. Elizabeth Street, Detroit, Mich., as their sales representative. Mr. Fitzner is quite well known in northern Ohio and the state of Michigan, and has been active in radio for a number of years."

New Samson Bulletin

The Samson Electric Co. are distributing an interesting new technical bulletin relating to the proper uses of Samson radio and audio choke coils in various of the popular circuits used by the set-builder during the last two years.

Samson engineers chose 17 circuits and carefully analyzed them to determine where radio and audio chokes could be inserted to isolate stages, prevent feedbacks, direct the various frequencies into the proper channels and aid neutralizing.

International Resistance Co. Moves

The International Resistance Company, manufacturers of the Durham Metalized Resistors, announce the change of address from the Perry Bldg., Philadelphia, to their new address 2½ South 20th Street.

Buckingham Announcement

Buckingham Radio Corporation of Chicago announce the election of Mr. F. J. Kolb of Monroe, Wisconsin, to the office of Secretary and Treasurer. Mr. Kolb a former radio dealer and manufacturer will take active part in the administration and operation of the company's affairs.

Cleveland's Third Annual Radio Show

Cleveland's Third Annual Radio Show has been scheduled for November 8th to 13th inclusive and will be produced under the backing of the newly organized Radio Trade Association of Northern Ohio. Headquarters for the Association have been established at the office of its managing director, Mr. Herbert Buckman, at 5005 Euclid Avenue, Cleveland, Ohio.

Freshman Company Adjusts Patent with R. C. A.

Following many other radio manufacturing concerns, the Charles Freshman Company have completed arrangements with the Radio Corporation of America for the right to use all of the radio patents that they own and control pertaining to the particular radio circuits manufactured by the Chas. Freshman Company. This includes licenses under the patents held by the Companies comprising the Radio Corporation of America.

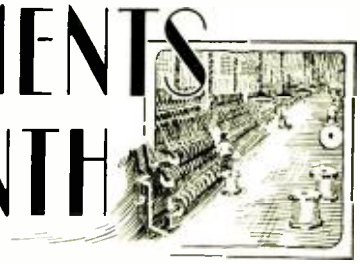
New Freed-Eisemann Distributors

The Telephone Maintenance Company, 123-5 So. Wells St., Chicago, Ill. has just been appointed Freed-Eisemann distributor in Chicago and surrounding territory.

The North American Auto Supply Company, of 4608 Prospect Ave., Cleveland, Ohio, has just been appointed Freed-Eisemann distributor for Cleveland and surrounding territory.

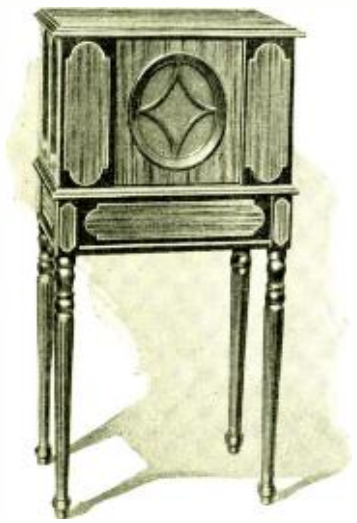
The Green Joyce Company of Columbus, Ohio, has just been appointed Freed-Eisemann distributor for Columbus and surrounding territory.

NEW DEVELOPMENTS OF THE MONTH



R. C. A. Model 104 Loud Speaker for Direct Current Operation

The Radio Corporation of America has developed a model 104 Loudspeaker which will operate on direct current and will furnish the necessary "A," "B" and "C" current supply for Radiolas 25 and 28. It will also supply "B" voltages for practically all other radio receivers. The external appearance of the DC 104 Loudspeaker is exactly similar to the AC type. Although the same cone with its accompanying operating



The R.C.A. direct current power speaker

mechanism is employed, a DC power amplifier has been substituted for the AC rectifier-power-amplifier unit. In the DC model four 171 tubes are connected in a multiple push-pull circuit to give the same output as a 210 tube used by the A. C. type. Particular attention has been paid to the elimination of line noises through the use of special filter arrangements and adjustable resistance which can be easily regulated, allowing the DC 104 Loudspeaker to be operated from power sources of from 105 to 125 volts DC.

"Har-Field" Heavy Duty Resistors

The new type "Har-Field" heavy duty wire wound resistors manufactured by Hardwick, Field, Inc., 215 Emmet Street, Newark, New Jersey, are suitable for use in all circuits of "B" eliminators and power amplifiers.

"Har-Field" fixed resistance unit

The manufacturer claims accuracy and permanence of ohmic value.

A special feature of the "Har-Field" resistor is the especially processed cement covering used. Not only is it extremely durable, but due to its rough surface, the heat is better dissipated.

They are available in various values ranging from 750 ohms to 50,000 ohms. Tapped resistors may be obtained to meet the individual needs and specifications of manufacturers and experimenters.

Hammarlund Radio Frequency Choke Coils

The Hammarlund Mfg. Company, Inc., of 424 West 33rd St., New York City, announced two types of radio frequency choke coils as an addition to their line of products.

A specially developed method of winding, and impregnation with low dielectric compound produces a coil of a minimum distributed capacity and extremely high impedance to currents at radio frequencies, states the manufacturer. Due to the resistance of the coils and the method of winding, there is no point within the broad-

The new Hammarlund radio frequency choke

cast band at which they become self resonant and their action is the same throughout this range of frequencies. After winding and impregnating, the coils are mounted in a moulded and polished bakelite case. Soldering lugs and binding post connections are provided at the bottom of the case as well as screw holes for mounting the coil on a panel.

The case is 1½ inches in diameter by 1¾ inches high, and the coil is made in two values of inductance for the broadcast band. R. F. C. No. 85 has an inductance of 85 millihenrys, a capacity of three mmfds, and a resistance of 215 ohms. R. F. C. No. 250 has an inductance of 250 millihenrys, a capacity of two mmfds, and a resistance of 420 ohms.

New Grebe Cone Speaker

A twenty inch cone shaped in a twenty degree angle, having a motor equipped with short, light weight driving rods, a new type of armature, known as the "Butterfly" ar-

The Grebe cone speaker

mature, an unusually large permanent magnet, which offers a high magnetic flux, are a few of the new features in the Type 20-20 cone type loud speaker being manufactured by A. H. Grebe & Co., Inc., Richmond Hill, N. Y.

The manufacturer states that the "Butterfly" armature, made of silicon

steel, results in a decreased magnetic saturation. Laminated silicon steel pole pieces, reduce eddy current losses; and by the use of large size wire with heavy insulation chances of a short or possible grounding are eliminated.

The short, light-weight, driving rods transmit the high and low frequencies to the cone with minimum loss, avoiding "whip" or side play, usually so wasteful of high frequencies.

Use of a detachable base makes this speaker readily adaptable to either table or wall. The speaker is well balanced, and due to the greater weight being concentrated in the base, will not tip over.

Grebe Socket Power Unit

A socket power unit supplying "B" and "C" voltages sufficient to operate standard radio receiving sets of from five to seven tubes, including the 171 type power amplifier, is a recent contribution to the radio market by A. H. Grebe & Co., Inc., Richmond Hill, N. Y.

By the use of a special resistance and condenser circuits all chance of the production of a "growl" or "motor

The new Grebe socket power unit

boating" interference in the receiver is eliminated, states the manufacturer.

Resistances employed for dividing the voltage are of the full metallic wire wound variety.

A cable with six differently colored leads makes available the following voltages:

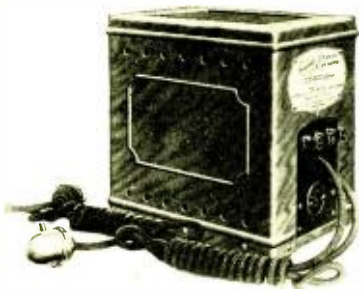
180 volts for the power tube; 90 volts for intermediate audio and radio frequency stages; 22 volts for the detector; 40 and 4 volts for the negative "C" battery voltages and one common lead which is the terminal for the "C" plus, "A" and "B" minus.

Construction of the Socket Power is such that any variation in the line voltage will not affect the balance of the output voltages. (i. e. any rise in "B" voltage, due to line voltage variation, will result in an equally proportioned rise in the "C" potential.)

The unit is enclosed in a hexagonally shaped container, having an attractive marble finish. Inside this container a small well is provided for the Raytheon tube socket. This socket is completely insulated from accidental contact when inserting the tube.

General Instrument Corp. Announces New "A" Eliminator

The General Instrument Company of 477 Broadway, New York City, have placed on the market an "A" Eliminator known as the "Permanent 'A.'"



The General Instrument "Permanent A" eliminator

This instrument provides power sufficient for operating ten tubes and runs direct from any 110 volt—60 cycle A. C. line. According to the manufacturer it consumes only 50 to 60 watts at maximum load.

This power unit does not use a storage battery in connection with a trickle charger, but consists of a transformer, a 2½ ampere Raytheon cartridge rectifier and a filter network. The secondary of the transformer is equipped with taps so that the power can be regulated at will and at the same time permit the unit to be operated successfully with various line voltages which exist in commercial practice.

"Permanent 'A'" is 8¾" high, 6" wide and 8½" long, and weighs approximately 21 pounds.

Wallace Electric Hand-Saw

The J. D. Wallace & Company of 134 South California Avenue, Chicago, Ill., are marketing a new type of electric hand-saw, shown in the illustration, which is principally adaptable to the cutting of wood for cabinets as well as moulded panel material etc.

The Wallace electric hand-saw is so designed that the motor can not be overloaded by putting in a larger saw blade than the power unit is intended to handle. A universal type of motor makes it possible to use the hand saw at either alternating or direct current, any frequency. Maximum efficiency has been secured by connecting the motor direct to the saw spindle.

Many manufacturers are adopting this hand saw in their shipping rooms for opening crates, making new boxes and reclaiming old stock. Further details on this saw can be obtained from the J. D. Wallace & Company.

New Willard Combination Power Unit

This newest Willard product is primarily a combination of the Willard "A" power and its "B" power supply, with an automatic control to change from charger to current supply and vice versa as the radio set switch is thrown on or off.

The unit itself is compactly assembled in a metal case finished in moss brown crystalline lacquer. The dimensions are such as to make the combination unit easily adaptable to any standard cabinet. It is 14¾ inches long, 11⅛ inches wide and 9¾ inches high.

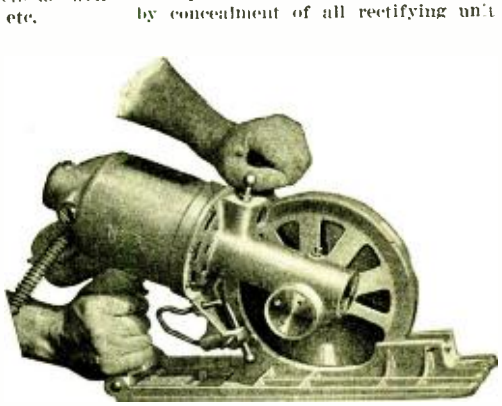
A new electrolytic rectifier increases the plate potential to 180 volts at forty milliamperes. Since few receivers nowadays draw more than forty milliamperes and most of them considerably less, this means that the power tubes of the 171 type may be

The Willard "A" and "B" socket power unit

operated at full efficiency. Also a 135 volt tap makes the 112 tube equally available.

There is no place on the entire "A" and "B" unit where contact may be made with any current greater than the harmless six volts supplied by the "A" battery.

In part this has been accomplished by concealment of all rectifying unit



The Wallace electric hand saw

connections under a moulded bakelite cover, and in part by using special binding posts of the spring type which have no exposed surfaces.

A rheostat governs the detector voltage with a variation of from 15 to 50 volts with amplifier voltage ranging from 45 to 110 volts. There are also 67½ volt and 90 volt taps as well as two power taps of 135 and 180 volts.

The "A" portion of the unit is essentially the same as the separate Willard "A" unit, consisting of a Willard 40 ampere-hour glass case six volt battery with threaded rubber insulation and gravity indicating balls. In conjunction with the "A" battery is a charging unit of the 2 ampere type, with either ½ ampere hour rate as a trickle charge or a booster rate of 2 amperes available.

For the convenience of the user, should he desire to shut off the house current to the power unit and the radio set, there is attached a snap switch to the cord, between the unit and the base plug.

New Polymet Metal Grid Leak and Resistance

Among the various items which the Polymet Manufacturing Corporation, 599 Broadway, New York City, have added to their line is a new type of Grid Leak and Resistor known as Poly Pure Metal Power Grid.

The new Polymet metal resistor

These new Grid Leaks and Resistors differ from any others on the market in that they are not metallized but pure metal, states the manufacturer.

This type construction permits a very high current carrying capacity and dissipates two and one-half watts to the square inch.

Poly Power Grids are made in various values ranging from 5,000 to 100,000 ohms, and ¼ to 10 megohms.

New Amsco Power Resistors With Optimum Temperature Coefficient

Considerable research and experimentation covering a period of three years has developed the new Amsco Metaloid power resistor especially designed for radio power devices. A unique feature of this resistor is the careful selection of the optimum negative temperature coefficient. A slight negative temperature coefficient is most desirable in eliminator circuits where it results in an improved regulation curve. The drop in resistance value as the current increases tends to counteract the augmented drop in the rectifier proper. Thus the voltages at the various output posts on the eliminator remain more constant at different loads. The regulation curve is less steep. The temperature coefficient of the Amsco Metaloid is .0008 per degree C. A higher temperature coefficient than this is not desirable.

Metaloid power resistors are made in wattages from one to sixty, for panel

Amsco tapped power resistor

and baseboard mounting. The two and five watt sizes can also be had for plug-in mounting, facilitating a change in resistors when this convenience is desirable. The resistor element itself is formed to an Isolantite base, and is absolutely permanent and noiseless.

Metaloid resistors can be obtained in the usual values, from 250 ohms to 10 megohms, tapped or untapped.

Amsco has also added a medium range power variable resistor to their line of fixed units, designed for securing the correct "C" bias to amplifying tubes.

The variable resistors take the form of a potentiometer, and are supplied with both single and double arms. The total resistance is two thousand ohms, wound with a special alloy wire. The winding will pass sixty-five milliamperes without undue heating.

The single and double units are known respectively as the Monostat and Duostat. The two arms of the Duostat are controlled by super imposed knobs operating through concentric shafts. The Duostat makes it possible to secure two variable "C" potentials. The optimum "C" bias is obtained by simple adjustment, at which point it is possible to output the highest undistorted volume from an amplifier. Both types mount in the space required for a single rheostat.

(The manufacturers have prepared a booklet on the uses of variable and fixed resistors in radio receiving circuits and eliminators, which can be secured from Amsco Products Inc., 416 Broome Street, New York City, for twenty-five cents.)

New Amsco Resistor Coupler

In response to the demand created by the new high mu tubes, Amsco Products Inc., of New York has added a resistor coupler to their line of resistance coupled amplifying apparatus particularly adapted to the requirements of these new tubes.

The new tubes have an amplification constant in the vicinity of 30, which renders comparatively unstable circuits in which they are employed. Amplifiers using these tubes have a greater tendency to motorboat than with the usual mu-7 tubes. This tendency, however, can be satisfactorily counteracted by the use of properly designed resister couplers.

Amsco now makes two types of resistor couplers, the RC1 for the 201-A type of tube, and the RC2 for the high mu tubes.

Kodel "Kuprox" Rectifier

The "Kuprox" rectifier manufactured by the Kodel Radio Corp. of Cincinnati, Ohio, is a new development in the radio and electrical field and has a number of interesting characteristics.

Kuprox, the active metallic element in the rectifier, is the result of considerable research work in connection with X-ray equipment.

Kuprox is a dry metallic element in which the atoms have been made

The Kodel "Kuprox" rectifier unit

to pass current in one direction only. It is a discovery of Professor S. J. Allen, of the Post Graduate College, of the University of Cincinnati.

A number of discs of this material which are clamped together, form a rectifier unit which can be adapted to practically all types of existing battery chargers and power units. The accompanying illustration shows one form of Kuprox rectifier which can be substituted in place of other type rectifiers. In operation this new rectifier element is absolutely noiseless and being perfectly dry, requires no care or upkeep.

Freshman Power Speaker

The Charles Freshman Company have developed, and are now offering for sale a combination high quality amplifier and loud speaker, housed in a small mahogany table. The combination called the Freshman "Power Speaker" is designed for use with any

type of radio set, having one stage of audio frequency amplification or the equivalent. The amplifier in the Power Speaker takes the place of the second stage of audio frequency in the radio set, thus eliminating the source of 90% of the distortion. The amplifier requires no batteries, it obtains its power directly from the 110 volt 60 cycle house lighting system. As an amplifier tube the R. C. A. UX 210 is used, as a rectifier the R. C. A. UX 216. Full voltage for proper amplification is supplied the power tube, the result being clear, pure reproduction at any volume.

The cone speaker supplied with the Power Speaker is of the diaphragm type, the unit being one capable of properly handling the great volume and fine quality available from the amplifier. In brief, the Power Speaker is a complete audio frequency amplifier unit and reproducer, capable of the best in quality reproduction at any volume.

New Exide "A" and "B" Socket Power Unit

A new development of the "A" and "B" socket power principle is announced by The Electric Storage Battery Company, manufacturers of Exide batteries and power units.

The new Exide "A" and "B" socket power unit

This latest development consists of an automatic charging method at high and low rates for the storage "A" battery and a system of electrolytic rectification for the "B" power supply.

The automatic charging feature insures rapid replacement in the "A" battery of current used in the operation of the set.

Full automatic control of both the "A" and "B" power is at the set switch. An especially designed automatic relay master control switch makes possible this feature of performance. Two rheostats provide separate regulation of the "B" detector and the "B" amplifier voltages, to suit the requirements of the individual radio receiver. The voltage range of the detector is from 20 to 45 volts and that of the amplifier from 60 to 100 volts. This is in addition to the power tube voltages which are 135 and 180 volts, respectively.

One of the features of the new power unit is the manner in which the battery is charged. As soon as the set switch is turned off, the battery is automatically recharged at a high rate until it comes up to approximately full charge. When this point is reached, the rate is automatically reduced to a trickle charge of a quarter ampere or less at which rate it continues until the set is again operated. This system of charging insures the battery being kept up to a fully charged condition at all times.

On the front of the unit is an instrument panel containing a charge rate indicator and two rheostat dials. A glance at the ammeter and one can tell immediately whether the battery is being charged at the high or the low rate.

Windows have been placed on the front and sides of the unit to permit observation of the pilot balls on the middle cell and the height of the electrolyte of all cells on the "A" battery and "B" rectifier.

The new "A" and "B" unit is being manufactured in addition to the Exide "A" power units.

Ehlert Speaker Consoles

The Ehlert Radio Furniture Company of 2468 Lincoln Avenue, Chicago, Ill., have placed upon the market, two new types of speaker consoles. These consoles will house all the accessories such as storage battery, charger, "B" eliminator, and will also accommodate cone speakers up to 21½" high. Arrangements are made whereby the speaker can be mounted on the door on the front of the console, so that when this is opened the speaker swings out with the door, leaving easy access to the battery compartment.

The No. 2250 Super-Excellent Speaker Console has a top 20 x 31", stands 32" high, has battery and speaker compartment 14½" deep and 26¾" long, will take table cabinet with panel up to 26" long.

Ehlert Speaker Console

The No. 2650 Super-Excellent Speaker Console has a top 20 x 37", stands 32" high, has battery and speaker compartment 14½" deep and 32¾" long, will take table cabinet with panel up to 30" long.

New Valley "A" Power Unit

The Valley "A" Socket Power eliminates the wet storage battery. It requires no charging and connects directly to the house lighting circuit. It will operate the radio set and all other accessories from one switch. According to the manufacturer, it provides power for any radio regardless of size.

The new Valley "A" Power which employs a Raytheon cartridge rectifier

This Unit employs a stout metal Raytheon Cartridge that is free from delicate filaments. It is a new principle of "A" Socket Power and delivers permanent, steady, uniform current.

Provision has been made in the Valley "A" Power Unit for use of an additional Raytheon Cartridge when operating sets of seven tubes and larger. This Power Unit is made by the Valley Electric Company of St. Louis.

"Perryohm" Resistors

The new "Perryohm" Resistor is manufactured by the Perry Wire Works, Yonkers, N. Y. This unit is made by winding resistance wire upon or around a heat resisting porcelain tube and, after winding, the whole is coated with an enamel-like composition which also is heat-resisting. A special heating and firing process prepares the unit to withstand heat and cold, which do not affect either wire or coating. Heat developed in operation passes through the outside coated surface into the air.

The "Perryohm" is now available for the "A," "B" and "C" current-supply units, power-amplifiers, trickle charger circuits, power packs, plate-supply units, resistor kits, "B" eliminators and also for use with the "Raytheon" B-H rectifier.

CUSTOM SET BUILDING

Radio sets, "made to the measure" of local conditions, are assuming greater importance than ever before. Thousands of set-building organizations and individuals are now functioning to supply the public with custom-built receivers adapted to individual requirements.

Beginning with the September issue, *Radio Engineering* will cover this phase of radio activity from A to Z. How to start and operate a custom-set building establishment—how to contact with and *sell* the consumer—testing, installation, servicing, etc.

In conjunction with this material, literally scores of different construction sets, amplifying systems and power supply systems will be reviewed and described.

Readers of *Radio Engineering* are invited to send in the name or names of technical men, professional set builders, service men, students, etc., who will be interested in this material. We will be glad to send sample copies of the magazine to anyone recommended by our present readers.

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Mountford Kroblak Tapped Resistors

The C. E. Mountford Company of 32 Sullivan Street, New York City, have placed upon the market a series of tapped resistor units ranging in resistance value from 100 to 50,000 ohms and in continuous duty capacities of 10, 20, 35, 50 and 75 watts. These resistors can also be supplied to manufacturers, tapped according to their specifications. Their main field is in connection with "B" eliminators and special power units.

Mountford "Kroblak" tapped power resistor

Atwater Kent Announces New Units

Two new models in receiving sets, a new speaker and a "B Power Unit" are announced by the Atwater Kent Manufacturing Company of Philadelphia as distinctive developments in its products for the forthcoming radio year. The company's laboratories have been working steadily for three years to perfect an instrument to supply B power and has produced a unit with a number of new features, the most important of which is a gas tube with a life in excess of 2,000 hours.

It is asserted that the new product is free from "hum." Another feature is that the operation of the "B" unit is automatic, due to a built-in "relay" which is actuated by the power supply switch on the receiving set. Provision is also made for connecting the "A" battery and charger to the "B" unit, in which case the relay also automatically starts and stops the charger. The new instrument is designed for alternating current, 60-cycle circuits with 110 to 115 volts.

Electrodyne Filter Condensers

The Electrodyne Company, Inc., of 128 Cypress Avenue, New York City, have placed upon the market a new series of filter condensers which are about one-half the size per microfarad than the general run of condensers being manufactured today, considering equal voltage. According to the manufacturer, this is made possible through the use of improved machinery which is able to wind a much tighter condenser than has been possible heretofore.

The new Electrodyne small type filter condenser

These filter and by-pass condensers are made in capacities ranging from 0.1 mfd. up to 4.0 mfd.

The Apco Automatic Charger

A new Automatic Charger has just been placed on the market by the Apco Manufacturing Company of Providence, R. I.

Full wave rectification is accomplished by means of a series of special analysis copper discs in the transformer circuit. Each disc is coated on one side with an oxide of great endurance. Rectification occurs between the disc and its own oxide.

This Apco Automatic Charger is for use with regular six volt, three cell storage batteries of anywhere from 60 to 120 ampere hour capacity.

Durham Upright Resistor Mounting

The International Resistance Company of Philadelphia, announce a new upright resistor mounting which is made to accommodate either the resistor alone or the resistor and condenser. It is made of high grade moulded insulation with phosphorus bronze nickel plated clips and occupies less space than the ordinary type of resistor mounting.


The Durham upright resistor and condenser mounting

Raytheon "A" Rectifier

With an entirely new principle as the basis, there has been developed and placed on the market by the Raytheon Manufacturing Company of Cambridge, Mass., a highly efficient, non-breakable, and foolproof rectifier known as the Raytheon "A." This device is in the form of a stout metal cartridge about the size of a man's thumb, quite free from delicate filaments, chemicals or moving parts. It is merely snapped into a clip holder and forgotten, whereupon it goes to work supplying a current of 2½ amperes or less, at 6 volts. Suitable step-down transformers have been designed by several leading manufacturers, and complete units using this rectifier are now on the market.

Raytheon "A" is ideal for storage-battery charging. It provides the highly desirable taper charge feature, reducing current drain, gassing and the wear and tear on the battery. The overall efficiency when employed in a properly designed charging unit is better than 50 per cent., as contrasted with the popular bulb type charger which runs from 17 to 35 per cent. under the best conditions. Raytheon "A" is especially suited to economical full-rate charging rather than trickle charging, and as such it provides the cheapest form of filament power as regards first cost and operating cost.

Because of its efficient rectification, Raytheon "A" may be applied to A-eliminator practice, or filament supply for standard receivers.

New "A-B-C" Eliminator Block

The Dubilier Condenser Corporation has announced the release of a special condenser to be used with Raytheon 350 mill. BA tubes. By the use of an 8 mfd. a 12 mfd., and .1-.1 mfd., buffer condenser, 350 milliampere current is delivered to the set satisfying all A, B, and C power demands. The blocks are in two containers in the buffer separate.

Yar True—Tone Speaker

Yahr-Lange, Inc., Milwaukee, manufacturers and distributors of the Super-Ball Antenna, announce a new radio speaker. It will be known as the "Yar True-Tone Speaker."

This speaker has several new, unique features that will undoubtedly be of interest to the radio trade. It is of cast aluminum construction and has a tone column of new design. By means of a scientifically designed tone distributing chamber a forced crossing of sound waves is accomplished, and a divisional tone chamber of unique design segregates high and low tones, reproducing both with equal facility states the manufacturer. The cast aluminum construction is said to eliminate all artificial overtones and vibrations.

The new Yahr-Lange speaker of cast aluminum construction

A special reproducing unit is used, which will not "blast" or oscillate under any volume. It will successfully handle any "B" voltage up to 200 volts.

The speaker is artistically designed and is made in three different color combinations, finished in crackled lacquer. It stands 41 inches high and is provided with twenty feet of cord.

PROFESSIONAL DIRECTORY

Buyers Directory of Equipment and Apparatus

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

Addresses of companies listed below, can be found in their advertisements—see index on page 894.

ADAPTERS:
Bakelite Corp.
Carter Radio Co.

AERIALS, LAMPSOCKET:
Dubilier Condenser Corp.

AMMETERS
Jewell Elec. Inst. Co.
Westinghouse Elec. & Mfg. Co.

AMPLIFIERS, RESISTANCE:
Amsco Products, Inc.
De Jur Products Co.
Electric-Motive Eng. Co.
Polymet Mfg. Co.

ARRESTERS, LIGHTNING:
Bakelite Corp.
De Jur Products Co.
Jewell Elec. Inst. Co.

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.

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.
Silver Marshall, Inc.

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

CLAMPS, GROUND:
Aurora Electric Co.

CLIPS, SPRINGS:
Aurora Electric 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.
Silver Marshall, Inc.

COILS, MAGNET:
Acme Wire Co.
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:
Concourse Elec. Co.
Dubilier Condenser Corp.
Globe Art Co.
Polymet Mfg. Corp.

CONDENSERS, FILTER:
Concourse Elec. Co.
Dubilier Condenser Corp.
Globe Art Co.
Polymet Mfg. Co.

CONDENSERS, FIXED:
Amsco Products, Inc.
Cardwell, Allen D., Mfg. Co.
Concourse Elec. Co.
Dubilier Condenser Corp.
Electrad, Inc.
Globe Art Co.
Micamold Co.
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.
Hammarlund Mfg. Co.
United Scientific Laboratories.
Wireless Radio Co.

CONDENSERS, FIXED TRANSMITTING:
Dubilier Condenser Corp.

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

CONDENSERS, VARIABLE:
Amsco Products, Inc.
Bruno Radio Corp.
Cardwell, Allen D. Mfg. Co.
Hammarlund Mfg. Co.
National Co.
Silver Marshall, Inc.
United Scientific Laboratories
Wireless Radio Co.
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:
Bakelite Corp.
Bruno Radio Corp.
Eby, H. H. Mfg. Co.
General Plastics, Inc.
Martin-Copeland Co.
National Co.

DIALS, VERNIER:
Martin-Copeland Co.
National Co.

ELIMINATORS, B BATTERY:
American Transformer Co.
Dongan Elec. Mfg. Co.
Martin-Copeland Co.
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Zapon Co., The

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LOCK WASHERS:
Shakeproof Lock Washer Co.

LUGS:
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Zierick Machine Wks.

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METERS:
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MOUNTINGS, RESISTANCE:
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NAME PLATES:
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NUTS:
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Lynch, Arthur H. Co.
Micamold Co.
Polymet Mfg. Corp.
Ward Leonard Electric Co.

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International Resistance Corp.
Polymet Mfg. Corp.
Ward Leonard Electric Co.

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K. H. Radio Laboratories.
Paragon Elec. Co.
Silver Marshall, Inc.

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National Co.
Silver Marshall, Inc.

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The STANDARD

AS THE oldest member of the Clarostat family, the Standard type has become universally known as the greatest variable resistor. This type has countless applications, since it is obtainable in various resistance ranges including extra low for filament control, low for certain socket-power and recharger applications, and the universal range running from 200 to over 5 megohms in five complete turns of its knob. The Standard type is a favorite in B-eliminators, as a variable voltage control. It is employed in receivers for all purposes from the extreme of a variable grid leak of several megohms to a volume control of a few thousand ohms. Its current-carrying capacity is 20 watts.

The HEAVY-DUTY

IN GENERAL appearance — and quite aside from the Clarostat family resemblance—there is little difference between the Standard and the Heavy-Duty types. The latter, however, is a trifle deeper, so as to provide greater current-carrying capacity. It was mainly to provide a variable line voltage control that the Heavy-Duty type was introduced, although it has many applications in receivers and socket-power devices where heavy-duty conditions are met. It is available in various resistance ranges, from the lowest for filament control, to the low range for line-voltage control. The current-carrying capacity is 25 watts.

The POWER

THE big brother of the Clarostat family, for the present at least, is the Power type, fully capable of meeting present-day demands in electrified radio sets and socket power devices. It is a Clarostat in every sense — same design, same operation, same knob — but on a giant scale. In the low range, this type may be employed as a line voltage control, in which event it does a real job unaided by supplementary fixed resistances. It may be employed as a filament current control in the case of series-connected filaments supplied by a high-voltage rectifier. It has many applications in radio transmission and in broadcasting where real work must be done, with a current-carrying capacity of 40 watts.

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