MAY 19
1928

SHORT WAVE SET
PICTURE DIAGRAM, FULL SIZE

15
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RADIO WORLD

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ELECTRO-MAGNETIC THEORY

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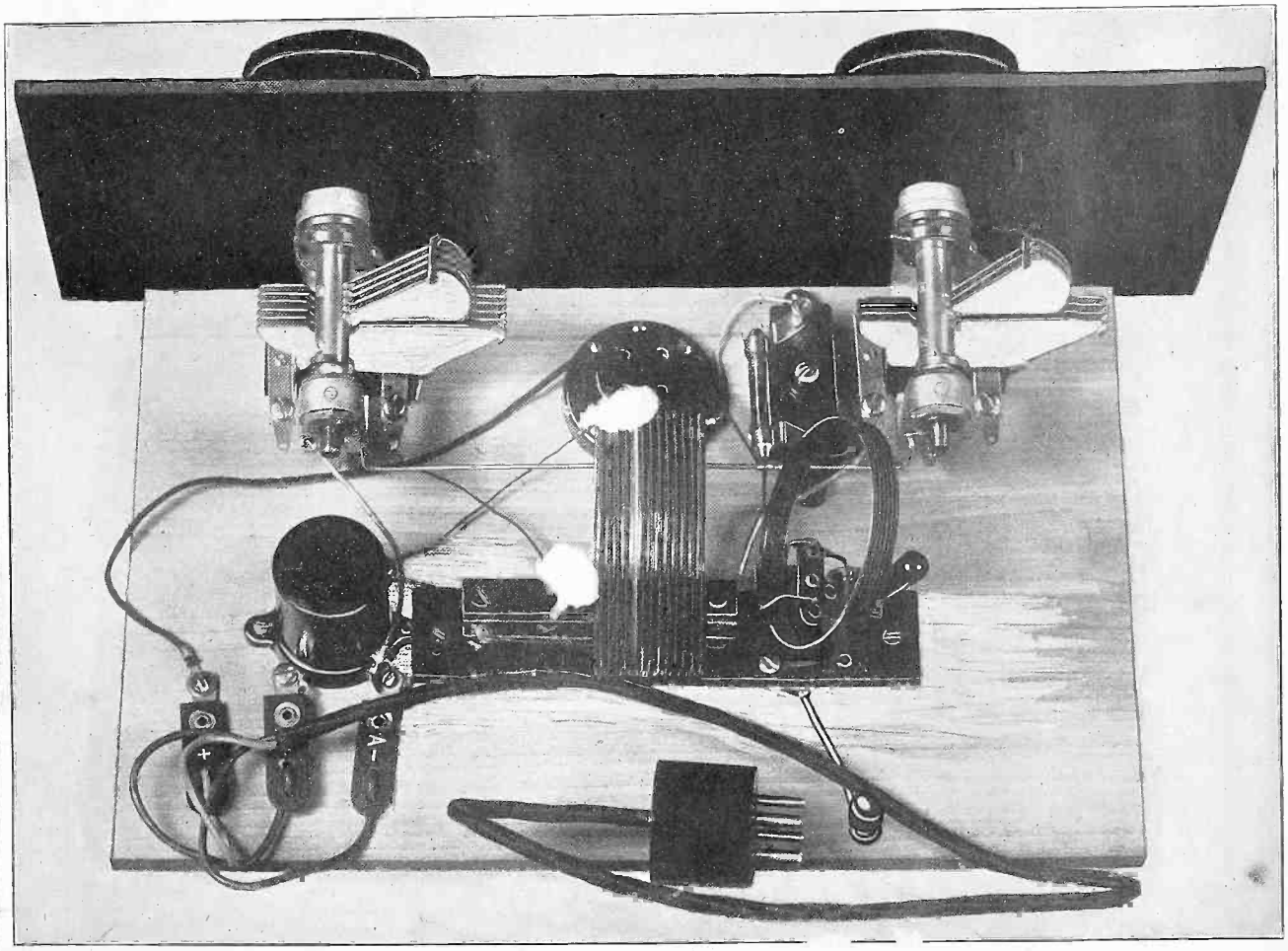
AN AC "B" SUPPLY DIRECT TO LINE

A ONE TUBE SHORT WAVE ADAPTER



The Hammarlund One Tube Short Wave Adapter—See page 3

HBH

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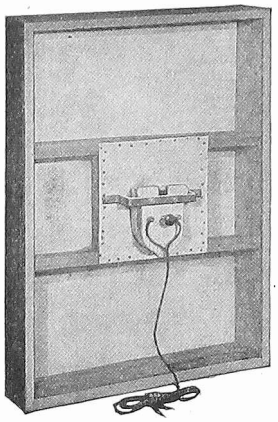
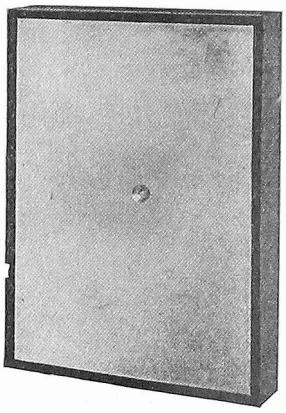


Rear View of the HBH Airplane Cloth Speaker Size, 16½x22½ Inches



Front View of the HBH Airplane Cloth Speaker Size, 16½x22½ Inches

An Opportunity is presented to you to obtain a kit of this special but attractive size, 16½x22½", because a manufacturer accumulated an extraordinarily large stock of them.

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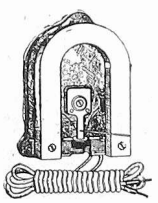
LOUD UNIT



Powerful unit, excellent for any cone or similar type speaker, standard for HBH speaker; very loud. Cat. No. 1098, with apex, $3.75.

The unit is the Powertone model, which provides high degree of volume and is very sensitive. Stands great strain. Used successfully in all radio receivers, including power pack installations up to 550 volts on the plate. Up to 135 volts DC may be passed through coils of unit without damage. For higher voltages filtered output is recommended, but unit has long stood up to 180 v. unfiltered.

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The Simple One Tube Hammarlund Short Wave Adapter

That Brings in High Frequency Reception on Speaker Through Your Broadcast Receiver Audio Channel

By J. E. Anderson

Technical Editor

BELOW the broadcast band there is an immense virgin field for the radio pioneer to explore. Already this field teems with life and activity, but it is the life of the jungle and the activity of hunter and trapper, of the more venturesome. There is not a turn of the dial which does not reveal an unsuspected whistle, melody, discourse, conversation, every sound fraught with interest and capable of being caught, tamed and naturalized in the loudspeaker.

Everybody, it seems, wants to join in the exploration and subjugation of this region. Everybody wants to get his share of the game it contains, and everybody can take all it contains without detracting from the total. The more that is taken the more there will be to take from that field, for the more will be put into it.

There is one thing favorable to those who enter into exploration of that field. The equipment necessary for an expedition is very simple and within the means of everybody, particularly if a broadcast receiver is already available. All that is necessary in that case is a one-tube adapter, including a few coils to cover the entire field from 206 meters down to 16 meters. And that is as far down as the field has been opened for general entry.

Plug-in Coils Used

It is not possible to cover the entire short wave region with a single tuning coil. A set of at least three coils must be used. To make the change from one wavelength range to another as simply as possible the plug-in system should be used. In this system a coil receptacle having four terminal sockets is used, and all the coils in the set are made so that any one may be plugged in, making the proper connections automatically.

Since some of the stations in the short wave field are weak and far away, the short wave adapter must be made of low loss parts. This is much more important in connection with a short wave set than with a set covering the broadcast range,

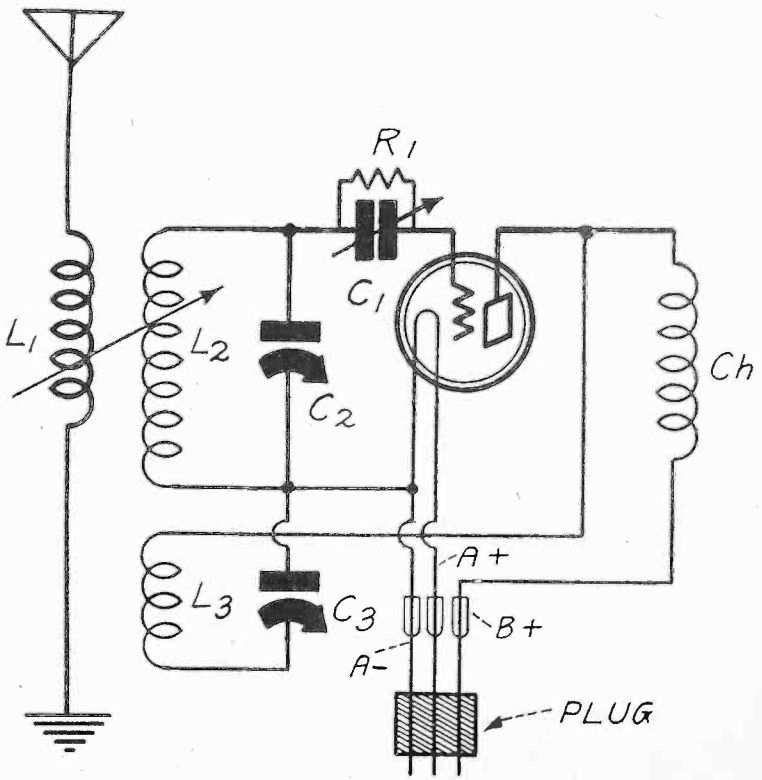
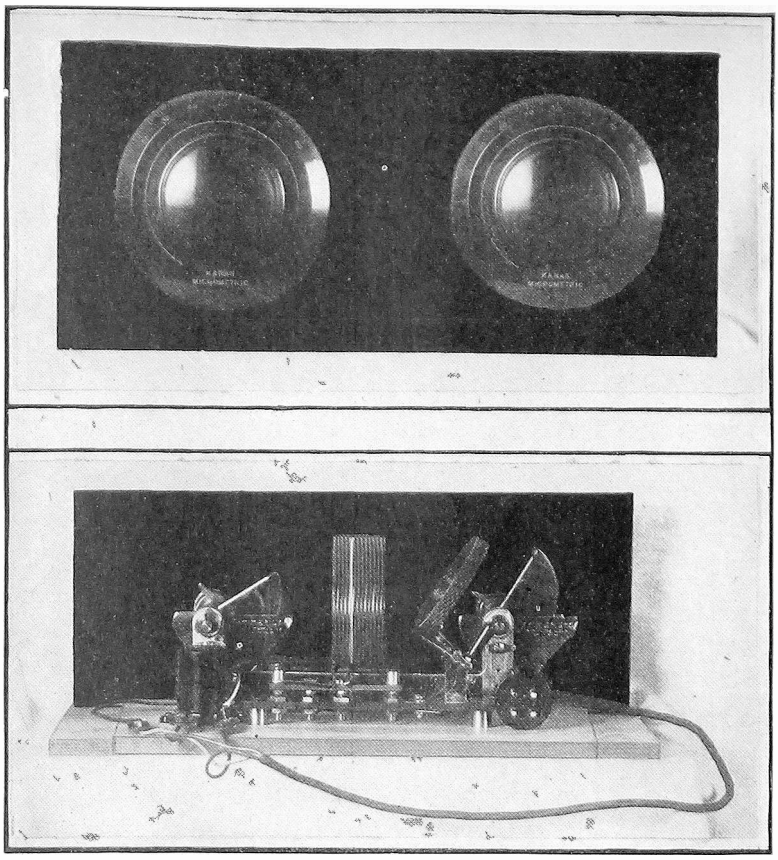


FIG. 1

THE SIMPLER THE CIRCUIT THE MORE EFFECTIVE IS A SHORT WAVE RECEIVER. THIS CIRCUIT HAS BEEN FOUND TO BE HIGHLY SUITABLE FOR A SHORT WAVE RECEIVER OR ADAPTER.



FIGS. 2 AND 3

THE BACK VIEW OF THE SHORT WAVE ADAPTER SHOWS THE 29 TO 65 METER COIL IN THE RECEPTACLE. IN THE PANEL VIEW THE DIAL TO THE LEFT CONTROLS THE TUNING AND THAT TO THE RIGHT THE REGENERATION.

for losses may be enormously greater on short waves. Every precaution must be taken to keep the losses down. The term "low loss" was first used in connection with short wave receivers and was later taken over for broadcast receivers, although for these it never had much technical significance.

There are many sources of loss which must be minimized. Large amounts of dielectric in the field of the tuning coil will absorb a considerable portion of the energy on the short waves. Hence such material must be used sparingly. There should be only enough to hold the wires in place. All other insulators should be banished from the set.

The best of all insulators for short wave work is air. But no practical coil can be wound on air alone. Lack of rigidity would result in lower effectiveness than if there were a little solid material in the field. Hence some supporting material must be used for the coil, but this material should be electrically as nearly like air as possible. Thin tubing of celluloid is suitable provided that the turns on the coil are embedded in the substance so that they cannot move about.

The coils must be space wound. That is, the turns must be separated from each other so that the capacity between turns is as low as possible. Any considerable capacity between turns will allow current through this capacity and this current will result in loss.

The coils must also be wound with suitable wire. It cannot be fine, for then the resistance of the coil would be excessive and the loss high. Neither can the wire be too heavy, for then eddy current losses would mount to excessive values.

For a given coil structure and wavelength range there is a size which gives the optimum compromise between series resistance losses and eddy current losses. This size should be used. Small variations from the optimum size are allowable for near the optimum value the increase in losses is small.

The shape of the coils is also important. There is a given length of winding for every diameter which gives the least resistance. The proper ratio of length to diameter should be used as far as practical considerations permit. This ratio can only be determined experimentally, for on short waves it differs considerably from the theoretical value that applies to long waves or low frequencies. Certain short wave coil manufacturers have determined the optimum ratio very carefully, taking all the various sources of loss into consideration, so that their coils have the least possible loss within the tuning range of each design.

The Circuit

The simpler the circuit used for short wave work the better. Needless coils and condensers only add to the resistance and losses of the circuit. Therefore only one low loss tuned circuit should be used.

Regeneration is necessary to get the most out of a single tube adapter. The regeneration coil also should be of low loss construction, since this coil necessarily must be placed in the field of the tuning coil. And it should not have any more turns than necessary, because additional turns will only require more dielectric to absorb energy and more metal in which eddy currents can circulate.

One of the best methods of controlling the regeneration in a short wave set is by means of a variable condenser in series with a fixed tickler coil. And this is the only practical method when the plug-in

LIST OF PARTS

L1—One Hammarlund plug-in coil receptacle with antenna coil.
L2, L3—One set of Hammarlund short wave plug-in coils.
Ch—One Hammarlund 85 millihenry RF choke coil.
C1—One XL adjustable grid condenser with resistor clips, type G (30 to 350 mmfd.)
C2—One Hammarlund .00014 mfd. Midline tuning condenser.
C3—One Hammarlund .00025 mfd. Midline condenser.
R1—One 3 megohm Lynch metallized grid leak.
One Silver-Marshall X type socket.
One Double R No. 21 cord and plug.
Two Karas Micrometric dials.
One 7x14-inch front panel.
One 7x11-inch baseboard.
One Ely binding post (Ant.).

system of coils is used. It allows the use of the proper size tickler for each tuning coil.

When this method of regeneration is used it is necessary to use a radio frequency choke coil in series with the load on the detector to force the radio frequency current through the tickler circuit. Without the choke the currents might pass by this circuit and defeat oscillation or regeneration.

The circuit diagram of the simplest short wave adapter is shown in Fig. 1. L1 is the antenna coil. This is mounted permanently on the coil receptacle and is used for all the different coils in the set. It consists of six space wound turns of No. 20 double silk covered wire on a form 2½ inches in diameter. The spacing between turns is about the same as the diameter of the wire.

The primary L1 is mounted on a hinge and is provided with a convenient handle so that the coupling between this coil and the tuning coil may be varied to suit the antenna used and the frequency of the signals received. The coupling can be varied from zero to a close maximum. The coil also can be turned far enough to reverse the direction of the coupling when that proves desirable.

L2 is the secondary or tuning coil and L3 is the tickler. These two are wound on the same form and mounted on a plug arrangement for insertion in the coil receptacle.

Coil Data Given

The secondary of the 20 meter coil (16 to 30.5 meters) contains 3 turns and the tickler contains 2 turns, although the coil will stand 3 turns on the tickler. The 40 meter coil (29 to 65 meters) has 8 turns on the secondary and 4 on the tickler. The 80 meter coil (52 to 107 meters) has a secondary 15 turns and a tickler of 6 turns. This secondary will stand 16 turns.

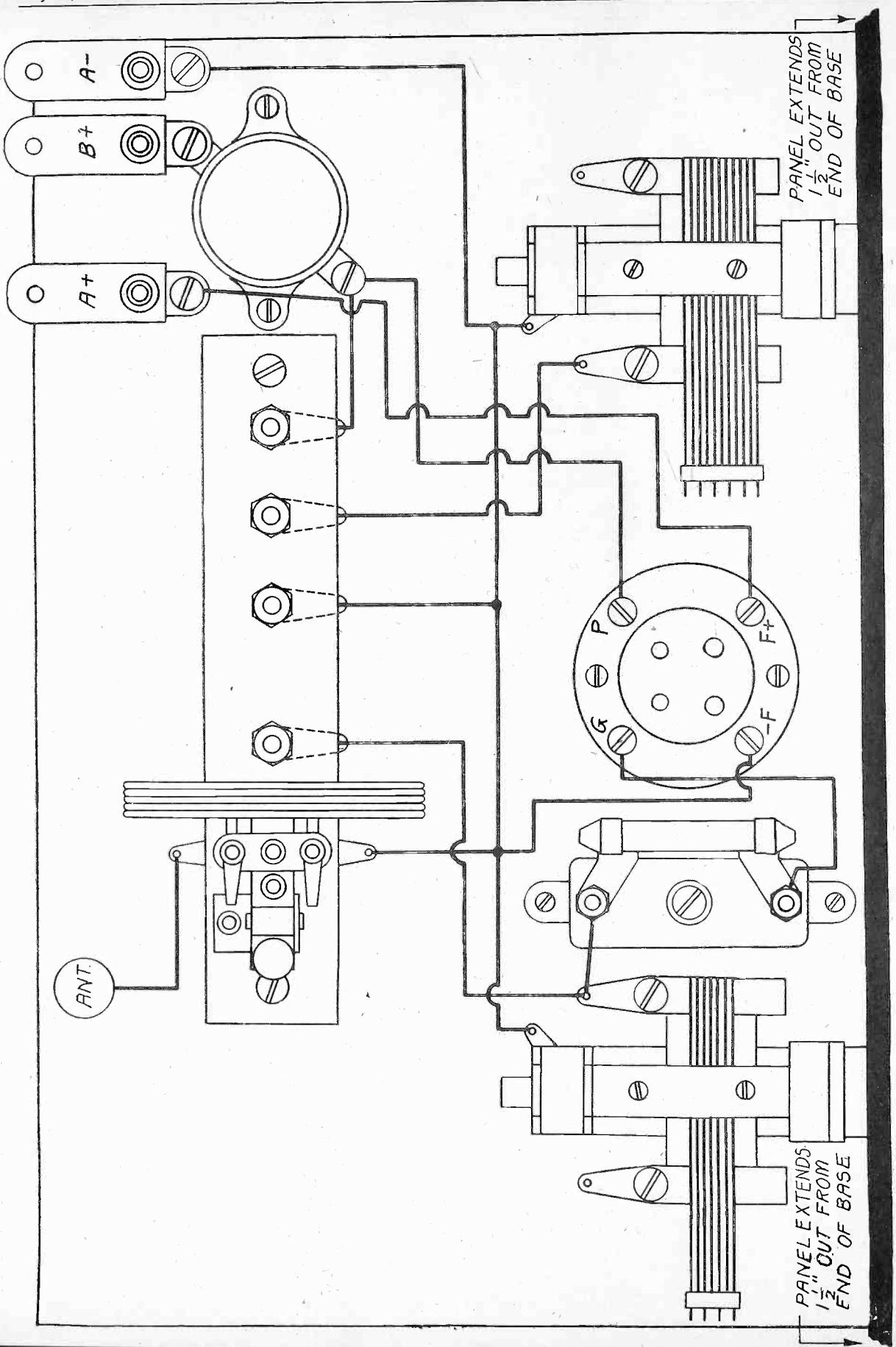
The diameter of each of these coils is 3¼ inches and all coils are wound with No. 18 double silk covered wire.

C1 is an adjustable grid condenser. This is used because for best results a smaller value condenser is required than the usual fixed value grid condensers. The capacity of this condenser may be adjusted with a screwdriver or a wooden dowel with end cut down, to obtain any capacity value within the limits of about 30 and 350 micromicrofarads (mmfd.). Once adjusted the capacity remains fixed.

The condenser is provided with resistor clips which hold the grid leak R1. A fixed value of leak should be used but various values should be tried to find the best for each circuit. The values tried should range between 1 and 10 megohms. A leak of 3 megohms is a good average value.

A full-sized wiring diagram of the short wave adapter is on opposite page. This is drawn to scale and printed full size so that it may be used as a blueprint.

(*Continued on page 7*)



THE HAMMARLUND ONE TUBE SHORT WAVE ADAPTER IN ACTUAL-SIZE PICTORIAL DIAGRAM.

An Insight Into

By Sebastian

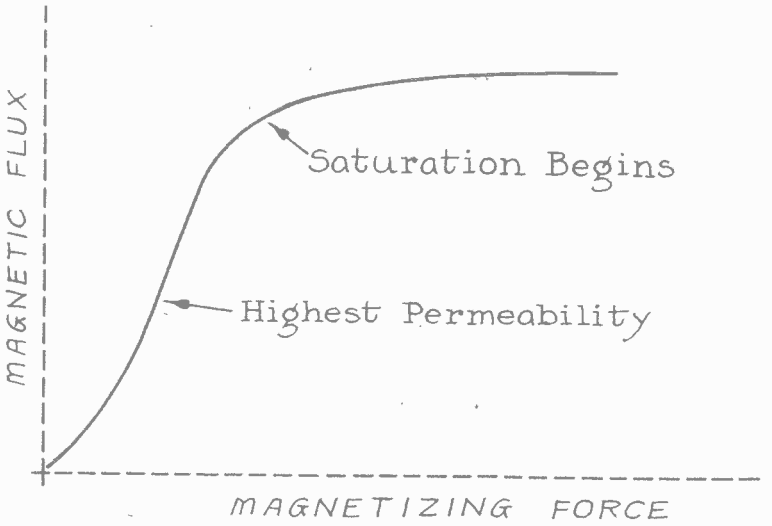


FIG. 1

A QUALITATIVE GRAPH SHOWING THE RELATION BETWEEN THE DEPENDENCE OF THE MAGNETIC FLUX IN IRON ON THE MAGNETIZING FORCE. THE PERMEABILITY—MAGNETIC CONDUCTIVITY—IS THE SLOPE OF THE CURVE. IT IS HIGHEST WHERE THE CURVE IS STEEPEST.

THE electric circuit is well understood. Not so the magnetic circuit. Yet the two are analogous in every respect.

A full understanding of both the electric and the magnetic circuit is necessary to the understanding of electromagnetic devices. And there are few electric devices which are not magnetic also.

In the electric circuit we have electromotive force, which is the force that drives current around a circuit. If the force is steady and always in the same direction the current is steady and direct. If the force is unidirectional and pulsating so is the current. If the electromotive force is alternating the current is alternating also. As the electro-motive force is, so is the current also—in a circuit containing no other obstructions to the current than pure resistance.

In the magnetic circuit we have magneto-motive force. This causes magnetic "flux" in the circuit. This is the magnetic current. The magneto-motive force is resisted by "reluctance" in the circuit. The flux in a magnetic circuit is proportional to the magneto-motive force and inversely proportional to the reluctance. This is analogous to Ohm's law in the electric circuit.

Magnetic Conductivity

Some substances "conduct" magnetic flux more easily than others. These substances are called magnetic. Iron, nickel, cobalt with their alloys, are the best conductors of magnetic flux. Pure iron and certain alloys of iron and nickel or iron and silicon are the best conductors of magnetic flux. In fact, some of them may be thousands of times as good conductors as air or wood or glass and other non-magnetic substances.

A given piece of these good magnetic conductors has a very low reluctance, that is, it is magnetized very easily. This means that it takes only a small magnetizing force to send a large flux through a closed ring made of one of these materials.

The magnetic circuit does not have to consist of a closed ring or closed path, of such material. Part of the circuit may consist of air or of some other non-magnetic material. For example, a horseshoe magnet constitutes a magnetic circuit in which the air between the poles is part of the circuit. The flux jumps across this air gap. If a piece of iron is put across the poles the reluctance of the circuit decreases greatly, and the flux increases. But then very little of the flux passes through the air.

The magneto-motive force resides in the permanent magnet by virtue of previous magnetization of the steel and by the power of the steel to retain its magnetization. There is a certain magneto-motive force per unit length of the steel. The reluctance of the magnet is also proportional to the length.

Putting a piece of iron across the poles of a permanent magnet is equivalent to short-circuiting a resistor in an electric circuit.

Magnetic Potential

Just as there is electric potential so there is magnetic. And where there is magnetic flux there is drop in the magnetic potential. The total drop of magnetic potential in a magnetic circuit is equal to the magneto-motive force, just as the total drop of potential in an electric circuit is equal to the electro-motive force in that circuit.

The drop of magnetic potential in any portion of a circuit is equal to the product of the magnetic flux and the reluctance in that portion.

In the horseshoe magnet or similar magnetic circuit almost the entire drop of potential occurs in the air gap, because nearly the whole reluctance in the circuit is concentrated there.

Saturation of Magnetic Material

Magnetic materials cannot carry an indefinite amount of flux. The conductivity, or permeability, varies with the amount of flux and as the magnetizing force is increased a point will come where an increase in the force will not produce much increase in the flux.

The material is then said to be saturated.

This saturation depends on the material, on the cross-section of the material and on the length of air gap in the magnetic circuit. The higher the permeability of the material, the more quickly, as a rule, the saturation point is reached. The greater the cross-section, the more flux will circulate before saturation sets in. And the shorter the air gap, the greater the flux will be for a given magnetizing force, and the sooner saturation will set in as the magnetizing force increases.

All these facts have a direct bearing on the design of all electro-magnetic devices such as loud-speaker units, relays, transformers and choke coils. The magnetizing force in the magnetic circuit is the ampere-turns on the coils, the permanent magnet, or a combination of ampere-turns and the permanent magnetism.

In a loudspeaker unit there are two magneto-motive forces. One is that which is introduced by the permanent magnet or by an electro-magnet. This sets up a steady flux and a steady magnetic field. The other is that which is set up by the ampere-turns of the signal-carrying coils. This is variable and sets up a variable flux which follows the signal.

Condition for Sensitivity

The sensitivity of a loudspeaker depends on the steady flux and on the ampere-turns on the signal-carrying coil. The greater the flux, the greater the sensitivity. This means that the magnet used should be large and powerful and that the air gaps in the magnetic circuit should be small for high sensitivity. But there is no use of increasing the magnet until the pole pieces and the armature are saturated. Doing that would not increase the sensitivity. It would only produce distortion.

The mechanical pull on the armature is proportional to the square of the flux across the air gaps. Thus if the flux is doubled the pull is increased four times. But this does not mean that the sound output of a speaker is proportional to the square of the flux produced by the signal current. The response of the speaker is directly proportional to the signal flux and to the steady flux.

If this were not true the output of the speaker would be all distortion, which is not true.

The Formulae

Suppose the permanent flux set up by the magnet is F and the variable flux set up by the signal is f. The total flux is then F+f. The pull on the armature is $K(F+f)^2$, in which K is simply a force constant, depending on the design of the unit.

This formula may be written $K(F^2+2Ff+f^2)$.

Of these three components of the pull KF^2 is steady and it simply pulls the armature to one side. It has no effect on the signal. Kf^2 is a variable pull which varies as the second harmonic of the signal frequency. It produces distortion. The useful pull is 2KFf. It is proportional to the signal flux and varies at the same rate as the signal current. It is also proportional to the steady flux.

This shows the importance of making the steady flux strong to make a sensitive unit.

Reducing the Distortion

But there is a greater reason for making the steady flux great in comparison

Magnetic Circuits

le Groot

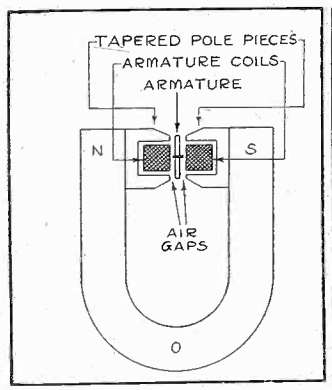


FIG. 2

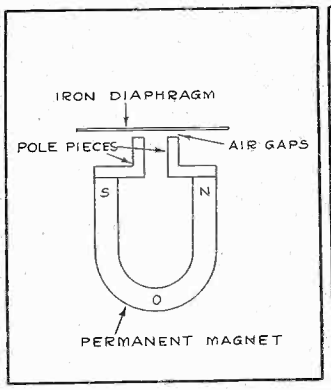


FIG. 3

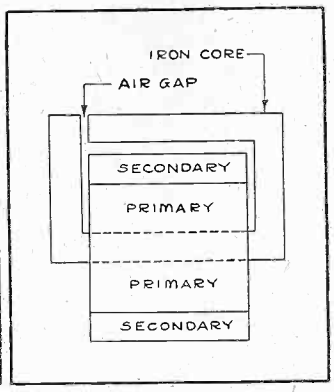


FIG. 4

Fig. 2, cross section of a balanced type loudspeaker unit showing the tapered pole pieces for directing a strong flux to the ends of the armature.
Fig. 3, cross section of a non-balanced telephone unit with the pole pieces directing the flux to the center of the armature or diaphragm Fig. 4 shows a cross section of an iron core transformer. The magnetic circuit contains an air gap in one corner of the core, the purpose of which is to prevent magnetic saturation of the iron.

with the variable signal flux. The larger that F is in comparison with f, the smaller Kf^2 is in comparison with $2KFf$. That is, the larger the steady flux, the smaller is the distortion in the unit. It can be made as small as desired, say 1 per cent. of the useful or first harmonic pull.

In the balanced type of unit construction the steady pull represented by KF^2 is balanced out so that the armature is not pulled to one side. The distortion term Kf^2 is also balanced out in this type of construction. Therefore the balanced unit is almost free of distortion. Nearly all of the better types of units are now balanced.

The balanced unit is also more sensitive than the unbalanced for the same size of magnet and signal carrying coil.

The balanced armature is so mounted in the steady field that saturation does not occur readily, hence most of the distortion which would result from saturation is balanced out, just as the second harmonic pull is balanced out.

Object of Pole Piece

The object of the pole pieces in a loudspeaker unit is to direct the flux in the magnetic circuit to points where it can be put to use most efficiently. They serve the same purpose as the pipes leading from a steam boiler to the piston, or a flume leading from a water reservoir to a turbine or water wheel. The armature, of course, is the piston or the turbine.

The balanced armature may be likened to a steam engine in which the piston is pushed both ways by the steam.

The power developed by a loudspeaker is proportional to the flux density at the air gaps between the armature and the pole pieces, that is, the flux per unit area of the pole piece faces. Thus to develop much power the areas of these faces should be small. It is for this reason that the pole pieces usually are tapered so as to increase the flux density.

This is just another feature of directing the flux where it will do the most work in a given time.

Maximum Output

In electrical circuits the principle that impedances should be matched for maximum output is well established. For example, a generator will deliver the greatest power when the impedance of the generator is equal to the impedance of the load. The same holds for a battery or a vacuum tube.

A similar condition holds for the magnetic circuit. The reluctance in the iron path should be equal to the reluctance in the air gaps if the greatest power is to be developed at the air gaps. But this condition is difficult to satisfy in a magnetic circuit, for a very small air gap will have much greater reluctance than a relatively long iron path. But the deviation from the optimum condition is in the direction of greater efficiency though less output.

In power work the condition for maximum output is never met, for economical reasons. Maximum output would mean an efficiency of only 50 per cent., whereas economics decrees an efficiency as nearly 100 per cent. as possible. In most cases it is actually over 90 per cent.

The overall efficiency of a loudspeaker rarely exceeds one per cent., comparing the power put out in sound with the electrical power that goes in. But electromagnetically the loudspeaker unit compares favorably as to efficiency with many other electrical power devices.

Actual efficiency is of very little importance in a loudspeaker, for the power involved is so small. Sensitivity is the important thing.

The Transformer

The electrical transformer contains a magnetic circuit as well as an electrical circuit. In air core transformers the magnetic circuit is mainly the air surrounding the turns of wire. In an iron core transformer the magnetic circuit is the iron path.

In some transformers the magnetic circuit consists partly of iron and partly of air. The open core transformer is an example.

Many transformers of the so-called iron core type actually have a short air gap in the iron path. The length of this gap may vary from .0001 inch to .05 inch. It is used to prevent saturation of the iron.

The current which flows in the primary of a transformer in conjunction with the turns of wire around the iron is a magneto-motive force which causes a flux in the core. If the current is alternating this flux changes in direction and magnitude in proportion to the changes in the primary current.

The wave form of the flux is approximately equal to the wave form of the primary current. Differences are due to saturation effects in the iron.

The changing flux in the core of the transformer induces an electro-motive force in the secondary winding, and the wave form of this electro-motive force is the same as that of the flux. If the secondary is open, the electro-motive force does not produce a current, but only a variable electric pressure across the terminals. It is this variable pressure which constitutes the signal voltage in the case of an audio coupling transformer.

If the secondary winding is closed through a resistance some alternating current flows as a result of the induced electro-motive force. This current produces a difference of potential or a difference of electric pressure across the resistance, which may be used to impress on the grid circuit of a vacuum tube.

* * *

[*Next week the author will discuss magnetic features of the phonograph pickup. The front cover illustration will show such a pick up.*]

The Hammarlund Short Wave Adapter

(*Continued from page 4*)

signal out entirely and may bring in another. Hence if a station is to be tuned in easily and kept in, there must be no hand capacity. To minimize it the coil system has been set as far back of the front panel as practicable.

Even with the coils set back and the condenser rotors grounded there may be a trace of hand capacity on the shorter wave ranges. A Karas Micrometric dial, which has a large hidden shielded plate, is a great aid not only for accurate tuning but also for reducing hand capacity effects.

If all these precautions will not remove the last trace of hand capacity, it will be necessary to place a grounded metal plate back of the panel, or else make the panel itself of metal.

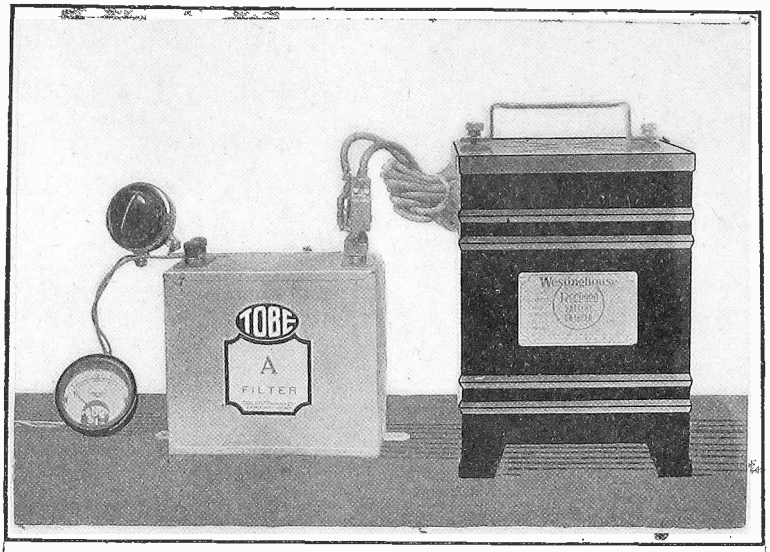
Another reason for placing the coil system at the rear of the set is to minimize eddy currents if this shielding is used. The coils are also placed with their axes parallel with the panel to reduce still further the eddy currents in the shielding.

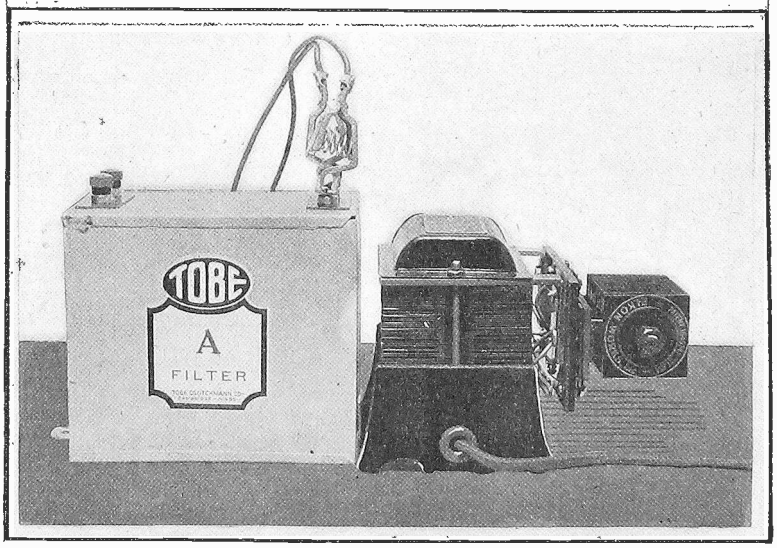
(Part II, conclusion, next week)

A New A Filter

Makes Any DC Receiver AC Operated, when Used with a 2-Ampere Charger and a B Supply

By Perry S. Graffam





THE NEW A FILTER IS SHOWN IN CONJUNCTION WITH TWO TYPES OF DRY CHARGERS OF 2 AMPERE RATING. WITH SUCH A COMBINATION ANY DC SET IS MADE AC OPERATED.

LONG before the AC tube was brought out we had B eliminators, but the A battery, then still in general use, was an objectionable unit. Trickle chargers and similar devices were makeshifts at the best. The regular charger being thrown on and off to keep the battery up was only little better and at the best we had a heavy, messy, rapidly deteriorating storage battery.

The AC tube has received much publicity, but whether it is entirely satisfactory is a question. Interviews with the public and radio men at large will show a difference of opinion. Excellent work is being done, however, to develop them further.

In the meantime, in a quiet way, research has been going on toward the development of a real dry A eliminator which would be as effective as its companion unit, the B eliminator. That was most desirable, as it meant that one could use his regular tubes and that no rewiring, harnesses, tube adaptors or other similar arrangement would be needed.

This year has seen several of these developed, most of them pretty fair, but usually very complicated, particularly if a man wanted to assemble one himself.

A Difficulty Solved

The difficulty in the way of a good A eliminator has been primarily the great capacity needed to filter out the hum. Tobe Deutschmann Company's engineers have developed a perfectly dry A condenser which gives 3,600 mfd. and is contained in a can smaller than a good high voltage B condenser.

With a view to making this unit economical and simple to build, two especially designed choke coils have been combined in a case with one of these condenser units, affording a complete A filter.

Now all that is necessary to complete the A eliminator is a charger of some two amperes capacity feeding into this unit as if the charger were a battery. However, the charger is left on only when the set is being used. Thus thousands of chargers of 2 ampere capacity, now in use, may be combined with one of the Tobe A filters to give the owner AC operation, yet without rewiring, harnesses or new tubes.

Use 2-Ampere Charger

Hundreds of thousands of excellent receivers are now in existence and the owners already have good B eliminators. They would be faced with the necessity of junking all this apparatus to get AC operation, a considerable sacrifice. But the new Tobe filter now may be attached to their two ampere charger and completely dry and permanent AC operation achieved.

Those who have no charger need only a rectifier and transformer and high voltage rheostat and in a few minutes they can build one of these eliminators, as the majority of wiring is already done inside of the Tobe A Filter. A ten ohm heavy-duty Clarostat should be connected in the negative lead to the set in order to control the voltage from the eliminator and compensate for line voltage variations.

For rectifiers the Elkon and Benwood Linze units have been found effective. These are rated at two amperes but will actually handle quite a little more.

Function Analyzed

Transformers tested to date which work out well with this unit were 75 watt rating, with a secondary from 10 to 14 volts. These are made by Acme, National, Thordarson and Elkon. In one photograph a voltmeter is shown, which may be inserted. This is advisable if an accurate check is to be kept on the line voltage variations common to all AC sources.

A point worthy of attention is that receivers using available screen grid tubes become AC operated under the Tobe A Filter plan.

A rectifier delivers unidirectional current pulses to the filter. These pulses are poured into the condenser which acts as a reservoir. The choke coil permits current to leak out of this reservoir at a steady rate but will not permit any sudden changes in the rate. Hence current pulses flow into the filter but a steady current flows out.

[Schematic diagram next week, issue of May 26]

A B-Eliminator for Lean Purses

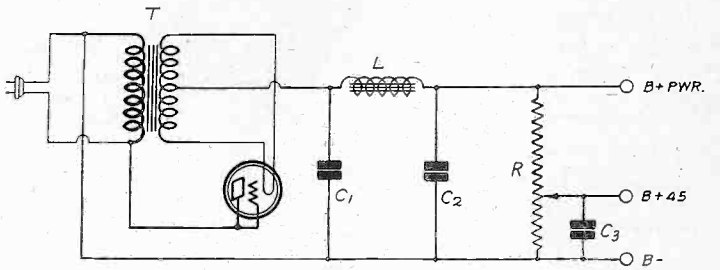


FIG. 1

THE CIRCUIT DIAGRAM OF A VERY SIMPLE B BATTERY ELIMINATOR WHICH REQUIRES NO STEP-UP TRANSFORMER AND ONLY A STEP-DOWN TRANSFORMER FOR HEATING THE FILAMENT OF THE RECEIVING TUBE RECTIFIER.

Step-up Transformer Omitted, 90 Volts Supplied for Low Current Drain Sets and Simple Filter Used.

By Jameson Franklin

A FRIEND of mine with the lean purse recently complained to me that he had been entirely overlooked. No one has designed a B battery eliminator for him, he said, for nearly all his earnings went to the landlord, the butcher, the grocer, and little remained for the radio dealer.

But this man needs a B battery eliminator, for in the long run it will be cheaper than batteries.

He proudly owns a small receiver which requires a small current and comparatively low voltages. His set can be operated with dry batteries without great expense. But it can be operated at less expense and less replacement trouble with a suitable B battery eliminator.

A Simple Eliminator

We shall try to design the simplest possible eliminator for a small receiver with small current requirements. All unnecessary parts will be eliminated.

In most eliminators a power transformer is required. This comprises a step-down and a step-up section. But suppose we only require a low plate voltage. Do we need a step-up transformer? Not at all. We can use the voltage as it comes from the line.

The effective line voltage is normally 110 volts. The maximum possible voltage from the eliminator is 155 volts, which is voltage when no current is delivered. As soon as current is drawn this voltage will drop to a value perhaps a bit below 100 volts. That is DC and filtered.

Well, if we get 90 volts on the small set all is well, and it will surely be that.

Filament Transformer Needed

We can use an ordinary receiving tube for the rectifier—any tube, from a -99 up, depending on how much current is required. A -01A, a 112A, -26 or a -27 should be suitable. There is no point in using a larger tube for then it would be cheaper and better to use one of the special rectifiers.

The filament of the rectifier tube must be heated. The heating current can be taken from a battery if desired, but this battery must be independent from the battery in the set. An extra battery is not a simplification in the circuit. A transformer is a better solution. Of course the winding must be suitable to the tube used. It must have a voltage of 1½, 2½, 3.3, 5 or 7½ volts, depending on the tube used.

A small heating transformer may be made from the core of an old audio transformer by putting on suitable windings. The primary winding should be put on first and it might consist of 1500 turns of No. 28 enameled copper wire. This is for a 110 volt source. The number of secondary turns will depend on the secondary voltage required and the size of wire will depend on the amperage which the rectifier tube will take. The number of turns on the secondary can be determined by direct proportion because the primary voltage is to the secondary as the number of primary turns is to the number of secondary. Thus if the primary has 1,500 turns and the voltage is 110 and a secondary voltage of 5 is desired, the proportion reads 110:5::1500:X. Thus the secondary turns should be 68. For a 5 volt winding intended for only one -01A tube No. 22 DCC wire may be used for the secondary. The secondary winding should be tapped at the mid-turn, that is at the 34th from either end.

Filtering Needed

The filter has been cut down to two condensers and one choke. The first condenser C1 should have a capacity of 2 mfd. and the second C2 should have a capacity of 4 mfd. Since neither of these condensers will be subjected to a voltage higher than 155 volts, condensers designed for 200 volts will serve. These are small in size and comparatively inexpensive.

The choke coil required depends somewhat on the amount of current drawn from the eliminator. If the current is less than 10 milliamperes the secondary of an old audio transformer will do. If more current is required, it is better to purchase a 30 henry choke coil which will carry up to 60 milliamperes. Such coils may now be had very reasonably.

If a coil of higher inductance than 30 henrys is available, having the required current carrying capacity, it should be used. The greater the current carrying capacity of the coil the less will be the voltage drop in the coil and the more will be available for the receiver. Also the greater the inductance for a given current carrying capacity, the better will the filtering be.

Output Potentiometer

The output potentiometer should have a fairly high resistance so that it will not take much current. its total resistance might well be 50,000 ohms. Two 25,000 ohm resistors may be used, bringing out a tap from the junction of the two for the 45 volt terminal. The voltage at that point does not have to be exactly 45 volts, hence two fixed resistors of equal value and connected in series may be used.

A 2 mfd. condenser C3 should be connected across the lower portion of the potentiometer resistance for by-passing audio and radio frequency currents.

Since the house line is connected directly to this rectifier it is safest to put in a 3 or 6 ampere fuse in each side of the 110 volt line as near the plug as possible. That is the fuses should be placed so that they protect both the primary of the transformer T and the rectifier. There is no particular danger if these fuses are not used, but it is much better to have the fuses in the rectifier go before the fuses in the basement. They are much more easily replaced.

LIST OF PARTS

T—One step-down filament transformer as described.
L—One choke coil of 30 henrys or more.
C1, C3—Two mfd. condensers like Tobe 302
C2—One 4 mfd. condenser like Tobe 304
R—Two 25,000 ohm fixed resistors or one 50,000 ohm potentiometer
Three binding posts
One plug and cord
One standard vacuum tube socket.
One vacuum tube like an -01A
One small baseboard for mounting the parts.

High Current Makes Filtering a Problem

In the construction of a B supply, if the current drain is low the filtering is made easier, that is, smaller capacity and inductance may be used. Also under low current loads the voltage is usually kept low, so that condensers of high-voltage continuous duty test are not necessary.

In an A supply the current is naturally large—always at least 60 milliamperes, often up to 2 amperes or more—so the filtering problem is a big one. Large capacity condensers are necessary, also a heavy-duty choke the wire of which will pass the current safely.

AC Detector

Why They Don't Burn Out

By Capt. Peter

Contribu

RADIO fans who have AC operated receivers incorporating heater types have found that the life of these is sometimes very short. What is the cause of this premature demise of the -27 type tubes?

One explanation is that it is due to the sudden current rush when the filament current is first turned on. The filaments (heaters, marked H) are made of a metal which has a positive coefficient of resistance change. This means that the resistance of the filament is least when the filament is cold and that it increases to a much higher value as the filament temperature rises to white heat. Naturally the current at first is much higher than it is in the steady state.

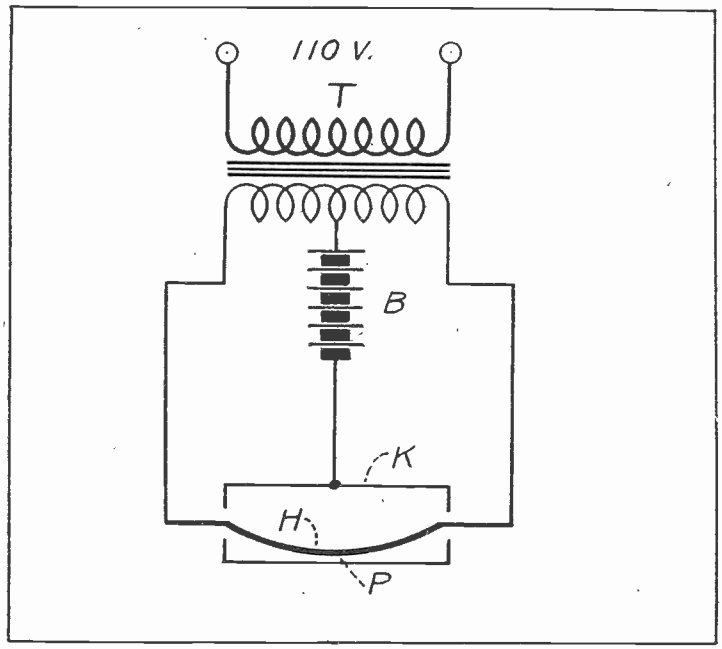


FIG. 1

THIS ILLUSTRATES HOW SAGGING OF THE HEATER FILAMENT MAY CAUSE A SHORT CIRCUIT BETWEEN THE HEATER AND THE CATHODE WHEN THE FILAMENT AND CATHODE ARE MOUNTED HORIZONTALLY.

It is easy to calculate the maximum value of this current by making a reasonable assumption. Suppose that the steady state temperature is 2,800 Kelvin degrees, The voltage across the filament at that temperature is 2.5 volts and the current is 1.75 amperes. That is, the steady state resistance of the filament is 10/7 ohms.

Now a reasonable value for the temperature coefficient of resistance change per degree Kelvin is .00366. The cool temperature is about 300 degrees Kelvin. Hence the rise in temperature is 2,500 degrees. The resistance change is therefore about 9 times as great as the cool temperature resistance, and the actual cool temperature resistance computes to only .14 ohms. The starting current is then about 18 amperes. That is a dangerously high current.

The Other Side

But actual initial current is not anywhere near that value. The transformer winding will not pass it. The voltage drops so that the actual current is not much in excess of the steady state current. If such heavy current would pass for any length of time it would not be the filament which would be endangered, but the transformer winding, because nearly the entire voltage drop would occur in that.

But just for the sake of argument let us suppose that the winding could pass all the current. Would the filament of the tube be in danger? Not at all. No damage can occur to the filament as long as it is cool, for it is overheating which causes damage. And when the filament has become hot the resistance is high and the current is low. The heavy initial current theory of damage is therefore a fallacy.

The positive coefficient of voltage change is a very efficient safety guard against burn-out as long as the applied voltage does not exceed the rated value.

In addition to this safety factor there is another additional advantage accruing from the heavy initial current. The filament heats up and attains its steady state value much more quickly than if the initial current were low. With a low initial current it would take perhaps ten minutes before the tube would heat up to operating temperature. Now half a minute is long enough to wait for the tube to warm up.

Negative Coefficient

What is the condition when the filament is made of a material that has a negative coefficient of resistance change? The initial current is low for the resistance of the filament is very high in comparison with the steady state resistance; it will take a comparatively long time for the filament to heat up to operating temperature and for the resistance to drop to the steady state value. If any one doubts that fact turn on a Mazda and an old carbon type lamp at the same time. Which attains full brilliancy more quickly? The Mazda lamp is white hot before the carbon lamp is dull red. The Mazda has a tungsten filament with a positive coefficient of resistance range and the carbon filament has a negative coefficient of resistance change.

And how is the safety factor of the filament with the negative coefficient as compared with that of the positive? The hotter the filament gets, the lower the resistance and the higher the current. The negative coefficient is no safety factor at all, but a danger factor. The filament is in unstable equilibrium with respect to the heating. It will go with a flare.

But here, too, the regulation of the supply transformer comes in to protect the filament. It is that which keeps the filament from going up in a flare—that and the natural radiation which keeps the heat equilibrium.

Why Filament Burns Out

There are many reasons why the filament or heater of a -27 type tube burns out, whether the temperature coefficient of resistance change is negative or positive. One is the fact that the filament may have been operated at too high temperature in order that the cathode be kept at a high enough temperature to emit electrons copiously. Another is that the voltage of the heater winding is not constant and may rise to values so high as to drive excessive current through the filament. Another reason is that the heater under certain conditions may act as a plate and suffer an electron bombardment which heats it more than the heating current proper.

Any one who looks into the interior of the cathode will see that the filament or heater is white hot, or even blue white hot. That means that the temperature of the heater is near the fusion point of the metal.

Under this condition if the line voltage should increase slightly the current would become excessive and the filament would melt.

Effect of Slight Jar

Also when the heater filament is white hot a slight jar might break the filament or cause it to sag and come in contact with one of the other electrodes, particularly the cathode, which is surrounding it. That in many cases would cause a short circuit which would be ruinous to the heater.

This danger is always imminent when there is a considerable voltage between the heater and the cathode. Often a voltage as high as 45 is applied between the two. The polarity of this voltage with respect to the two filaments does not make any difference. If they come in contact the filament fuses.

Fig. 1 shows how a short circuit may cause a burn-out when a voltage is applied between the heater and the cathode. K is the cylindrical cathode and H is the heater filament.

The voltage applied across the terminals is 2½ and is derived from the secondary of a step-down transformer. A battery B is connected so that the fila-

Filaments
nd Why They Do
'Rourke

ment is kept positive with respect to the cathode.

Instantaneous Vaporization

If the filament of the heater and the cathode cylinder are mounted in a horizontal position, or even at an angle from the vertical, the filament will sag toward the cathode as soon as the filament gets hot. If there is contact the battery B, which may have a voltage of 45 volts, will send a direct current through the filament wire in addition to the AC current. Since the total resistance in series with the battery is very low the current will be very high. The filament vaporizes in an instant.

When the tube is mounted vertically, the normal position, as in Fig. 2, this danger is not nearly so great. But a jar of the tube may cause the soft white hot filament to swing over to the cathode just the same, and the result of such a contact would be equally disastrous.

Another cause of short life is that the filament is kept at such a high temperature that particles of the metal are continually leaving it just as the metal particles in a tungsten lamp leave the filament and deposit on the glass envelope. In the tube the deposit takes place on the inside of the cathode. This continual drift of metal particles from the filament reduces the diameter of the heater, increases its resistance, and also increases the temperature. The hotter the filament is, the greater is this evaporation of the metal, hence if there is a weak spot on the filament, where the filament is brightest, that is attacked first.

The Electron Bombardment

When a battery such as B is connected in the circuit with the positive toward the heater, its filament acts as a plate and takes some of the electrons emitted from the cathode. Every electron that strikes the filament makes it just a little hotter. Hence if there is a considerable electron current between the two elements in the direction of the heater, the filament will be excessively heated. As it gets hotter, the cathode also gets hotter and the electron drift becomes more intense, and the filament is heated at a still greater rate. That is an unstable condition which may lead to catastrophe. Obviously from this viewpoint it would be preferable if the polarity of the battery B were reversed.

The electron stream would then cause the cathode to heat up without endangering the heater filament.

Burn-out Insurance

The best insurance against a burn-out of the heater in a -27 type tube is to make sure that under no conditions of operation the temperature of the heater is more than normal. It may be somewhat lower and still give satisfactory service. If the supply transformer has been designed to give 3 volts, for example, instead of 2½, a resistor should be put in the heater circuit to limit the current to the 1.75 ampere normal. This resistor might well be adjustable so that it accommodates varying conditions of the supply voltage. The tube is designed so that it will stand a voltage fluctuation of 5% from the normal.

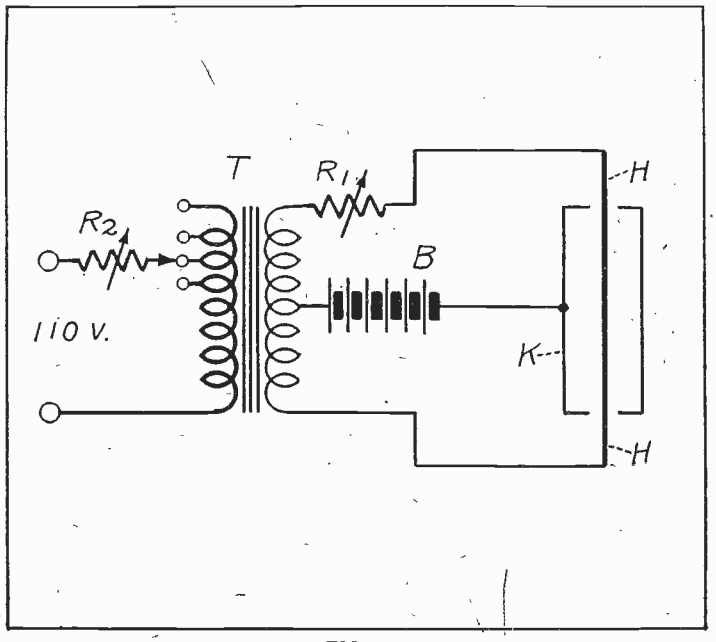


FIG. 2

WHEN THE CATHODE CYLINDER AND THE HEATER FILAMENT ARE MOUNTED VERTICALLY THE FILAMENT REMAINS IN THE CENTER WHEN HEATED AND DOES NOT SAG. HENCE A SHORT CIRCUIT WILL NOT OCCUR SO QUICKLY. THREE METHODS OF CONTROLLING THE HEATER VOLTAGE ARE SHOWN, RHEOSTATS R1 AND R2 AND THE TAP SWITCH T.

Normal potentials are 110 for the primary and 2½ for the secondary. But in many cases the supply voltage may rise to 125 volts or even more. Thus the secondary voltage may rise as much as 15% above normal. That is much more than the allowable variation on the tube and a voltage adjustor must be inserted into the circuit somewhere.

It may be the variable resistor in the heater circuit mentioned above or it may be a tapped primary on the supply transformer. Or again it may be an adjustable resistor in series with the primary. Fig. 2 illustrates all three of these methods. Rheostat R1 is in the heater circuit, R2 is in the primary, and T is a tap switch for selecting the number of primary to give the desired secondary voltage. It is only necessary to use one of these in a circuit unless some other tube in the receiver requires a different adjustment.

The battery B shown in Figs. 1 and 2 is used to reduce hum. But there is no definite method of connection with respect to polarity. Sometimes the heater is made positive, sometimes the cathode.

Can't Allow Any Bigger Discount on Modulation

Suggestions have been made in lay circles that the percentage of modulation of a broadcast wave should be increased so that the carrier will not travel much farther than the modulation. It is argued that if this is done much of the present interference will be eliminated because the power put into the carrier could be greatly reduced without any reduction in the carrying range of the station. The program from a given station could then be picked up almost as far away as the carrier of that station.

If increased modulation were practical radio engineers would have used it long ago.

There are many technical reasons why the modulation should not be increased. In the first place the object of broadcasting is to transmit entertainment and instruction by way of radio. If the modulation were increased much above its present average level nobody would be much entertained by what the radio receiver brought in, no matter how good was the stuff that went into the microphone.

Suppose the modulation is 100 per cent. The amplitude of the modulating frequency would then be 50 per cent as great as the amplitude of the carrier. When such a modulated wave is detected the amplitude of the second harmonic of the signal frequency would be 25 per cent. of the fundamental, and all the other harmonics would be of considerable intensity, though less than that of the second harmonic. If the second harmonic of the signal frequency amounts to 5 per cent. of the fundamental, the distortion becomes noticeable to the trained ear. A 15 per cent. harmonic renders the distortion very bad. Suppose we had to start with 25 per cent. harmonic? It would be preferable to listen to the cats in the alley.

Which Tube is W
Power Tube or

By Billy

ONE of the outstanding points of progress in audio amplification is that the high-powered audio tubes enable one to cut down on the amplification at radio frequencies, and thus have a much more stable receiver. Previously too much was often demanded of standard tubes at radio frequencies.

Stability is an important factor now. Three years ago all sorts of instability would be tolerated, with plenty of dials to twist and knobs to adjust, but now the radio trend is toward convenience, and high-powered audio tubes make this easier to achieve.

The last tube in the audio chain, known familiarly as the output tube, may determine the performance of a receiver, since that tube will handle a certain maximum undistorted power output, from which one may calculate backward and determine how much each preceding tube will be called upon to handle without distortion in any tube. This is simple arithmetic.

Let us assume a type —50 tube is used as the output, with 475 volts on the plate and 80 volts negative bias on the grid. If a 1-to-4 ratio transformer is used, the maximum allowable voltage at the output of the previous tube would be one-quarter of 80, or 20.

The Tube Ahead of a —50

Assuming the tube preceding the output has an amplification factor of 8, then the maximum allowable grid voltage thereon would be 20 divided by 8, or 2½. Add an extra half volt for safety sake, and because 3 volts is a bias easily obtained from a battery. Therefore, even under theoretical conditions, which always presuppose greater amplification than actual conditions develop, an —01A tube is satisfactory ahead of a —50, a fact few persons realize until they think it over.

However, it is customary to reduce the theoretical figures 50 per cent., because that gives a result nearer actual values. The reduction would require similar reduction all along the line, forward from the plate output of the last tube, to the detector tube, but it is always good practice to maintain as high a negative grid bias as even the theoretical reckoning calls for.

An excellent plan is to use a 112A ahead of a —50 tube, and give the 112A a plate voltage of 135, with a negative bias of 4½ volts. This is plenty bias for the requirements of the following tube, but not as high as the recommended bias when the 112A is used as an output tube.

The biases recommended on the circulars enclosed in the tube cartons are usually based on the assumption the 112A is to be used in the last audio stage, where the undistorted maximum power output should be made as high as practical, but when that tube or any other precedes an output tube, the bias may be considerably less. This permits of higher amplification and facilitates low-note reproduction.

Output Without Amplification

Few output tubes are of the —50 type, but a great many are of the —71 or —71A type. The same system of reckoning applies, but it is well to keep in mind that the —71 and the —71A have a low input impedance, which means that a given signal applied to the grid-to-filament circuit has a smaller effect upon the tube than upon other tubes. Thus the output tube may add nothing whatever to the amplification, although it does handle large power.

Therefore mistaken choice of a —71A where a 112A may well be used as the output tube often causes the output volume to be too low to satisfy the customers, as the men behind the counter say. The remedy is easy. Use a 112A instead, and adjust plate and grid voltages accordingly.

Instead of following that course, however, many try to retain the —71 or —71A, and force the amplification ahead of the detector, or in the entire radio frequency amplifier, including the detector. Often a set that was stable is thus rendered unstable. Self-regeneration is made inevitable on the higher frequencies (shorter broadcast wavelengths) and body capacity effects are noticed.

Rising Characteristic

The volume drop, where the wrong type output tube is used, first is noticed on the lower frequencies (higher wavelengths), e. g., stations like WEAF, WJZ and WOR. Tuned radio frequency amplification, some type of which is in every broadcast receiver, even the Super-Heterodyne, has a rising characteristic, that is, the amplification increases as the frequency increases, due to self-regeneration in the tubes. So long as the signal is plentifully loud the volume drop is not a source of complaint, but when you tune in WNYC, KSD, WEAF and stations thereabout on the frequency spectrum, even grandma notices the difference, and protests.

Therefore one need pay strict attention to his audio channel. The amplification at audio frequencies should be large. The volume should be adjusted at radio frequencies.

Under such conditions, with suitable output tube, you have a receiver that will stand the greatest volume with which it may be taxed, and still give music that is music, while even the lowest volume you want to listen to is likewise at your command. This large volume range is essential, for unless local stations can give much more than comfortable volume, distant stations will not be loud enough.

Troublesome Detector

In previous years the limitation was largely in the output tube, for it never would give you anything near the output power you needed, but within the past year conditions have been brought to such a point that you can get enough volume, without distortion, to give dance music to a hall on which 500 couples are tripping their toes, yet it is possible to cut down the volume to enable bare audibility with earphones connected in the output. The radio frequency amplifier is therefore freed from an unnecessary burden and the detector tube is kept clear of signal overload.

Any detector tube overloads easily. Under the grid-leak-condenser method this overloading takes place before it does under the grid bias method of detection. But in either instance, with large amplification at radio frequencies, you now get into trouble at the detector, rather than at the output tube, another way of saying that with an incorrectly designed RF amplifier your high-powered output tube does you little good. Distortion, bad cases of it, too, takes place long before the output tube is reached. The detector tube is the culprit.

Again we come to the volume control. While it is possible to overload the detector, it is also true that it should be possible, and any receiver that makes it impossible to overload the detector is not very sensitive, and we do like our receivers to be sensitive these days.

Location of Volume Control

The volume control, if located ahead of the detector, that is, not in the detector circuit at all, but in one of the RF tube circuits, or in the antenna circuit, enables one to control the signal amplitude so that the detector can be operated at an undistorted load. When distance beckons, and high volume is needed for enjoyable reception, the big-boosting audio amplifier comes into play.

The choice of the audio amplifier is a matter of taste—if one tastes with one's ear—but at least we are sure of this much: three stages of audio amplification, properly chosen, may be used, if the output tube is "large" enough.

Generally, the output tube measures the constant extent of the audio amplification that may be used, while the detector tube measures the inconstant extent of the radio amplitude that may be handled. There is a difference between the amplification and the amplitude. The amplification is the degree of magnification, while amplitude is the height or intensity of the wave, whether that intensity is obtained with or without amplification. One may be so close to the transmitting antenna that the input, to a receiver, without any RF amplification, would overload a simple detector tube. When the degree of audio amplification remains constant, and the only change taking place in the amplitude is introduced ahead of the input to the audio system, we have an excellent condition.

Squeals Limit RF

At radio frequencies we are limited in the amount of amplification by self-regeneration at high amplification, the familiar squealing, and by the power handling capabilities of the detector tube. RF oscillation may be suppressed in a variety of ways. These are generally familiar and include neutralizing condensers, grid resistors, plate resistors, reversed phase, etc. But with three-stage audio amplifiers, and even with high-powered two-stage ones, we face the possibility or even likelihood of audio frequency oscillation, stray coupling, audio feedback, motorboating—they are all the same fundamental evil. The ills arise chiefly when a B power supply is used. The curing of

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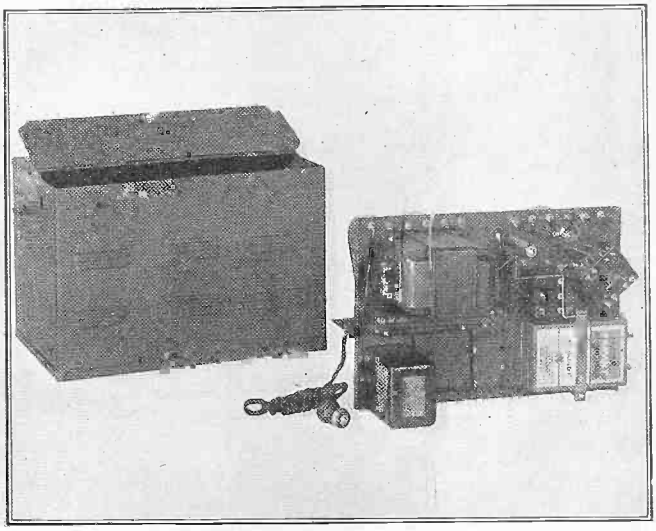

HIGH-POWERED B SUPPLIES, FEEDING INTO LARGE POWER TUBES LIKE THE TYPE —50, ARE BECOMING INCREASINGLY POPULAR. WITH AN UNDISTORTED MAXIMUM POWER OUTPUT OF THE ORDER OF 4,000 MILLIWATTS, WOULD YOU SAY THE POWER TUBE OR THE DETECTOR TUBE WAS THE STRONGER IN THE DISTORTIONLESS REALM?

such ills is not so generally understood, but there is a cure for every case of motorboating and the like, although sometimes the cure is more expensive than the cause.

Careful design is indeed necessary for high-amplification audio channels such as are now growing in popular favor.

The three-stage audio came into existence before there were adequate coupling and output devices and tubes for it, for the third stage was part of a power pack, and received the second stage output of an existing receiver. To-day we have the tubes, the coupling media, the sets, the power packs—everything—and all we need are the right designs. These we are getting with gratifying regularity, so there's nothing to complain about, we're sorry to state.

Even Eminent Ones Fail in Tryouts

MOST of us know something about theatrical "tryouts", those nerve-trying efforts where singers or dancers or other more or less skilled vaudeville acts appear, usually at out-of-town theatres, and where they are reviewed by representatives of the vaudeville booking powers. These are frequently rather heartbreaking occasions, for on these showings may depend a whole season of work over the circuits.

Few folk know that radio also has its "tryout" periods.

All the big stations spend certain hours of certain days in testing the ability of those who think their voices will carry properly over the ether. Some fail utterly in satisfying the requirements of sharp-eared broadcasting experts and never get farther than a "tryout." Among these failures well, you'd be surprised to know how many eminent singers and speakers and others who simply cannot "get over." It's a trying thing and not one of the pleasant things of radio. Ask one who has been through the ordeal!

CIVIL SERVICE

The United States Civil Service Commission announces the following open competitive examinations: radio engineer, $3,800; associate radio engineer, $3,000; assistant radio engineer, $2,400.

Applications for radio engineers must be on file with the Civil Service Commission at Washington, D. C., not later than June 6. The examinations are to fill vacancies occurring in the Departmental Service and in the field.

Full information may be obtained from the United States Civil Service Commission at Washington, D. C., or the secretary of the United States Civil Service Board of Examiners at the post office or custom house in any city.

PHILCO GETS LICENSE

Wm. J. Murdock Co., 347 Washington avenue, Chelsea, Mass., has transferred its R. C. A. TRF power supply and power amplifier license to the Philadelphia Storage Battery Co., of Philadelphia (Philco).

KEEP BATTERY WATERED

Particularly during warm weather keep plenty of distilled water in storage batteries.

LITERATURE WANTED

E. E. Schultg, 2148 Berteau Ave., Chicago, Ill.

Chet G. Wood, 1965 Belle St., San Bernardino, Calif.

A. Cederroth, 651 58th Street, Brooklyn, N. Y.

Louis Blackman, 734 Alabama Ave., Brooklyn, N. Y.

Jack G. Cannivet, 414 Wiley Street, Fairmont, West Virginia.

A. H. Brockbank, 1316 South Western Ave., Los Angeles, Calif.

Jos. M. Ruddy 2614A Eads Ave., St. Louis, Missouri.

Ben Bailey, Lloydell, Pennsylvania.

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Mr. W. M. Outcalf, 945 Dana Avenue, Cincinnati, Ohio.

L. A. Dickinson, 246 River View Ave., Newton Falls, Ohio.

Geo. H. Peterson, 227 Van Alst Ave., L. I. City.

Edgar Dehrenbach, 3365 Boulevard, Jersey City, N. J.

T. I. Mack, 1655 Putnam Ave., Brooklyn, N. Y.

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Edward Weed, Benedict St., Norwalk, Conn.

John Anderson, 455 40th St., Brooklyn, N. Y.

C. F. Fritz, 551 N. St. Paul St., Wichita, Kansas.

Reversed Primary or Seco

By J. E.
Technical

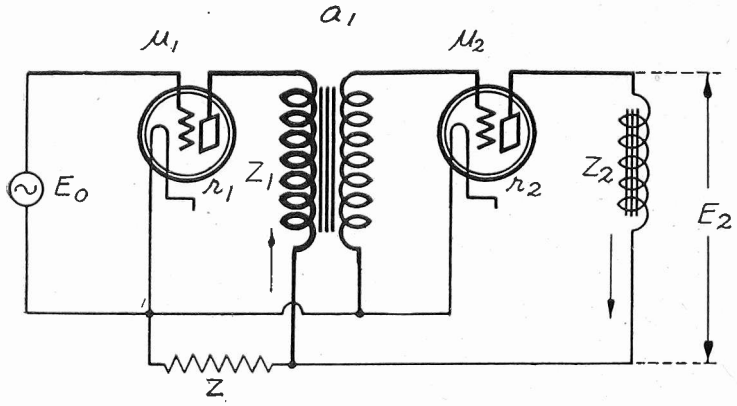

FIG 4
A TWO TUBE TRANSFORMER COUPLED AMPLIFIER ILLUSTRATING HOW THE AMPLIFICATION MAY BE INCREASED OR DECREASED BY FEED BACK THROUGH Z, DEPENDING ON THE CONNECTION OF THE TRANSFORMER.

[Part I of this authoritative article on the causes of and cures for oscillation in audio amplifiers was published last week, issue of May 12. The final instalment is printed herewith.]

PART II

THE behavior of impedance and auto-transformer circuits is much the same as the behavior of resistance coupled circuits. They are not so likely to oscillate at low frequencies, because their low frequency amplification is much less and the feedback much less effective. If trouble arises at low frequencies the remedies are the same.

Transformer Coupled Circuits

The behavior of transformer coupled amplifiers in which all the tubes are on the same plate voltage source depends on the connection of the transformer leads as well on the amplification, the common impedance and on the number of stages. In every case the effect of the common impedance is to distort the signal by suppressing some frequencies and building up others by regeneration.

Fig. 4 shows a two tube circuit in which a1 is the transformer ratio and Z2 the impedance of the loudspeaker or of the primary of the second transformer. The arrows indicate the direction of the signal current at some instant when the leads of the transformer are so connected that the phase is not reversed.

The plate current in the second tube flows through Z in the opposite direction from the first plate current. This reduces the voltage drop in the common impedance and increases the signal current in the first tube. This is regeneration and the circuit is unstable. How the second tube contributes to the signal current in the primary of the transformer is clear when Z is regarded as a dam which forces part of the second plate current up through Z1 and the tube resistance rl in phase with the signal current in that tube.

Reversing the Leads

If one pair of leads of the transformer is reversed the signal current through Z2 is reversed and then the two signal currents through Z will be in the same direction. This will decrease the signal current in Z1 and the amplification will be reduced. The circuit will be relatively stable. This is the customary connection of transformers.

The same principles apply to the three tube circuit in Fig. 5. There are now two transformers which may be manipulated, and there are four different combinations of lead connections. Each produces a different result. Two of them are relatively stable, two unstable. The most stable connection is that which is most commonly used, that is the one which makes all the plate signal currents flow through Z in the same direction. But this connection gives the least amplification.

If a transformer coupled circuit oscillates or motorboats one pair of leads should be reversed. The new connection may be quite unstable but the oscillation might be at a high frequency. If it is, it can be stopped with a by-pass condenser across the B voltage supply. It may be that the condensers already in use in the filter are large enough to prevent any oscillation at the higher frequency.

Any change in an amplifier of any type of coupling which shifts the frequency of oscillation from a low audible or subaudible to a high frequency is a great step toward preventing motorboating or oscillation, because at the high frequency condensers across the common impedance are effective in nullifying that impedance.

In circuits powered with a B battery the common impedance is the resistance of that battery. This becomes very high as the battery runs down. When the battery is fresh the resistance is negligible. Therefore as the battery is running down the amplification becomes worse and worse, aside from the effect of the decrease in voltage, and a time will come when the circuit will start oscillating, or howling, or motorboating. The actual oscillation is preceded by a period of blasting and distortion.

If the battery is well by-passed the oscillation will not occur at a high frequency. It may occur at a low frequency if the circuit is of the type which would oscillate at a low frequency.

In some cases the oscillation will start when the resistance has risen to a few ohms. In others it will not start until the resistance has risen above the thousand ohm mark. The critical resistance depends directly on the amplification in the circuit and on the coupling between the stages.

In a B battery eliminator the common impedance is complex and may be a resistance shunted by a condenser and another resistance, or it may be an inductance in series with a resistance and the whole shunted by another resistance, depending on the frequency. In nearly all cases the common impedance has sufficient value to start oscillation in all but the most insensitive amplifiers.

Trouble at Low Frequencies

The trouble will in nearly all cases be at low frequencies, often sub-audible, because for the higher frequencies the by-pass condensers are effective in nullifying the common impedance. At the very low they have practically no effect.

In Fig. 6 is shown the circuit of a common B battery eliminator in which the effective inductance of the choke coils is given by Lx, the resistance of the choke coils and of the rectifier by Ra, the effective capacity of the bypass condensers by Cx and the resistance in series with the by-pass condensers by Rb. The condenser resistance is usually so small that it can be neglected, but the resistance Ra in series with the line is often quite high. It is the chief trouble maker.

Although the constants in this circuit are more or less fixed, the effective values of Lx, Cx, Ra and Rb depend on the frequency. For some frequencies the resistances may be high, for others com-

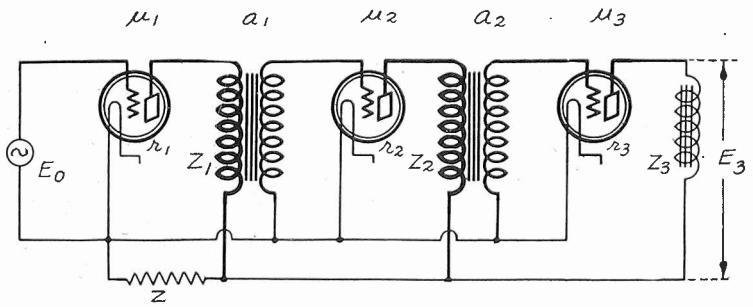

FIG. 5
IN A THREE TUBE TRANSFORMER COUPLED AMPLIFIER THERE ARE FOUR POSSIBLE CONNECTIONS OF THE TRANSFORMER LEADS, EACH GIVING A DIFFERENT RESULT WHEN THE AMPLIFIER IS WORKING ON A PLATE VOLTAGE SOURCE OF CONSIDERABLE IMPEDANCE. THE CONNECTION MOST COMMONLY USED IS THE MOST STABLE OF THE FOUR.

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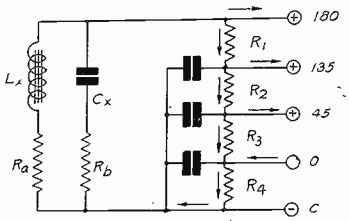

FIG. 6

EQUIVALENT CIRCUIT OF A B BATTERY ELIMINATOR WITH THE VOLTAGE DIVIDER. THE VOLTAGE DIVIDER REDUCES THE COMMON IMPEDANCE.

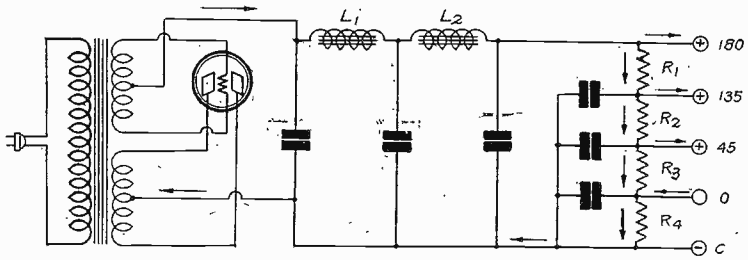

FIG. 7

THE COMPLETE CIRCUIT DIAGRAM OF THE B BATTERY ELIMINATOR SHOWN IN FIG. 6.

paratively low. For some frequencies the series inductance may predominate, for others the shunt capacity may predominate. The intensity and frequency of the oscillation will depend on the relative values of these impedances as well as on the nature of the circuit connected to this eliminator.

Voltage Divider in Shunt

It will be observed that the voltage divider is in shunt with the impedance of the rest of the eliminator. Thus the voltage divider reduces the common impedance. It has been stated that when a voltage divider of low resistance is used the circuit operates more quietly because the voltage regulation is better. It is true that when the current drain on the rectifier and filter is high the voltage regulation is better, that is that the voltage change with current drain change is smaller than when the drain is low. But the improvement in the operation of a receiver under these conditions is not necessarily due to better regulation of the voltage. It is more likely due to the reduction in the common resistance.

When the resistance of the B battery eliminator is measured from the receiver there are two resistances in parallel, which constitute the common resistance. The measured resistance is lower than the smaller of the two. As lowering of the voltage divider resistance improves the regulation it also decreases the AC resistance of the rectifier-filter. Thus both the parallel resistance are lower for large current drains and the common resistance is much lower.

The arrows in Fig. 6 show the direction of the steady plate current in the various sections. The direction at any instant of the signal current in the various sections is indeterminate.

Summary of Oscillation Remedies

If only one tube is given 180 volts, all the tubes in the circuit share the impedance for the tubes using less than 180 share. R1 in addition to the impedance of the rectifier-filter. But the common impedance for these tubes is reduced by the fact that an additional by-pass condenser is used and also by the fact that one of the parallel resistances is reduced. Those tubes which are given a plate voltage of 45 volts have still a lower common impedance because one of the parallel resistances has been decreased still further and an additional condenser has been put across it.

Fig. 7 shows the complete circuit of the B battery eliminator of which the circuit in Fig. 6 is the equivalent.

When the oscillation is of a high frequency, say above middle C, perhaps the simplest remedy for the trouble is to increase the by-pass condensers in the eliminator. The last one particularly should be increased. Also the condensers across the different voltage taps should be increased.

When the trouble occurs at a lower frequency and the circuit is resistance coupled, the simplest remedy is to reduce the grid leak resistors, or the coupling condensers. In some cases increasing the values will prove more effective.

If the trouble occurs in a transformer coupled circuit and at low frequency, reversing a pair of transformer leads usually changes the frequency to a higher value, at which the by-pass condensers are effective.

Increasing the values of the coupling resistors is often effective.

High inductance audio frequency choke coils connected in series with the primaries of transformers or in series with coupling resistors or impedances are also effective. These will be more effective if by-pass condensers are connected across them, that is from the junctions of the chokes and the primaries or coupling resistors to minus A.

Experimental Curves

In resistance coupled circuits if a grid leak is shunted with a choke coil, such as the primary of an audio transformer, low frequency oscillation may be stopped.

If the power tube is equipped with an output filter consisting of a choke coil and a series condenser the speaker return can be connected to one of several points, each connection giving a different result. The speaker can be connected to minus A or to the mid tap of the filament transformer. This is usually the best. It can also be connected to the low side of the choke coil, that is to B plus power. This is not so good, as a rule, but in some cases it may be the only connection which suppresses a low frequency oscillation. The speaker return also can be connected to the negative end of the filter, which is the negative end of the grid bias resistor. This is not so good for low note reproduction, but oscillation may require a suppression of the lows to stop the trouble.

Separate B voltage supply for each of the audio tubes is the surest remedy in any case. But if that is out of the question, it may be practical to put the detector on a separate battery and the rest on the eliminator, or to put the detector and one other tube on the battery and the rest on the eliminator. The tubes to put on the battery are those which take the least plate current.

The effect of the common impedance of a battery or B battery eliminator on the amplification and on the quality of reproduction is most strikingly shown by means of curves. On Fig. 8 are shown three different curves taken on the same three tube transformer coupled amplifier but with different transformer connections and different values of common resistance. The amplification is shown over the range from 80 to 6,000 cycles.

The normal relative amplification in the circuit should be about 45 times. But none of the curves shows this amplification except at one or two points. The deviation from the normal is very great for some frequencies. Curve A shows a maximum amplification of about 175 at a frequency of 180 cycles. The other two curves show a depression in the amplification over nearly the whole audible range. At the higher frequencies curves B and C show regeneration. Curve A shows a depression in the same region where the other curves show regeneration.

Curve A was taken with one particular connection with the transformer leads and with a resistance of thirteen ohms in series with the common B battery. Had there been a little more resistance, or a little more normal amplification, this amplifier would have oscillated or howled at the peak frequency, namely, 175 cycles. There would also have been more suppression in the region above 1,000 cycles.

Curve A is similar to the curve that would be obtained on a three tube resistance coupled amplifier in which the common resistance was not quite enough to cause oscillation at the low frequency. But in this case the peak would most likely be in the neighborhood of 16 cycles per second.

Reversed Connections

Curve B was obtained with a different connection of the transformer leads with a similar value of the common resistance The amplification is considerable up to about 1,000 cycles. Then the gain rises rapidly and at a frequency a little more above 2,000 cycles the curve becomes discontinuous, indicating that the circuit broke into oscillation.

With a slightly lower common resistance, or with a slightly lower normal amplification there would have been a definite peak at the frequency of oscillation. The peak would have appeared as blasting whenever the signal contained the frequency at which it occurred.

Curve B is similar to that which would have been obtained on a four tube resistance coupled amplifier, except in that type of coupling the drop in the amplification above the peak would not have been so rapid.

A moderate size by-pass condenser across the B battery would have reduced the peak

(Continued on next page)

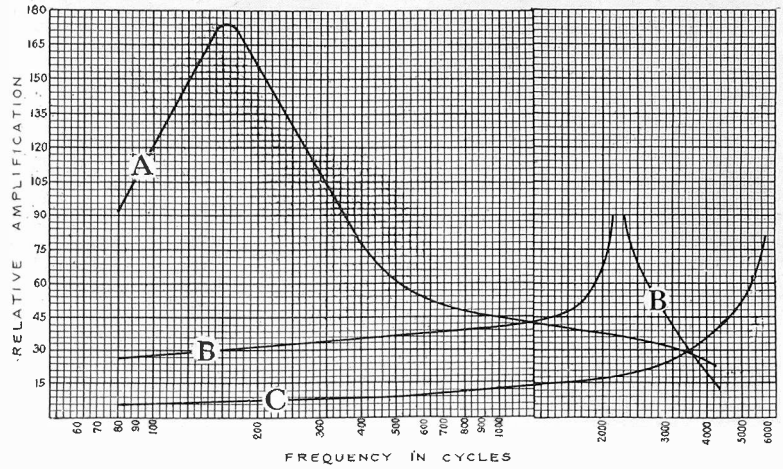

FIG. 8
THREE EXPERIMENTAL CURVES SHOWING THE EFFECT ON THE AMPLIFICATION OF A COMMON RESISTANCE IN THE PLATE BATTERY. THE CURVES WERE OBTAINED WITH DIFFERENT TRANSFORMER CONNECTIONS.

(Continued from preceding page)

in Curve B to normal both for resistance and transformer coupling.

Curve C shows the amplification in the same amplifier with the same connection as in Curve B but with 43 ohms in series with the common battery. The suppression in the amplification is very great over the entire useful range of audible frequencies, and the rapid rise above 5,000 cycles indicates that oscillation would occur at about 7,000 cycles.

Curve C is similar to that which would be obtained with a four tube resistance coupled amplifier working on a common battery of high resistance or on a B battery eliminator. Such an amplifier usually oscillates at a frequency between 7,000 and 10,000 cycles, provided no by-pass condenser is used across the common voltage source. A condenser of 1 mfd. should have been sufficient to stop the oscillation and brought the amplification down to normal. But it would not bring up the amplification to normal below 1,000 cycles. A much larger condenser would have to be used for that.

The peak in Curve A could also be brought down to normal by putting a condenser across the B battery, but it would require a condenser of 68 mfd. to bring down the effective common resistance from 13 ohms to half that value. Only an electrolytic condenser would be practical for the purpose.

Not all regeneration and howling in an amplifier is due to the common impedance. The capacity between the output side of the power tube and the grid of the detector in which grid condenser and leak are used may cause oscillation or amplification peaks at some high frequency, usually above 2,000 cycles. To stop this type of trouble the grid bias method of detection may be used, or the detector can be shielded electrostatically from the output.

A more common source of howling in a receiver, which is not due to the common impedance, is that caused by acoustic feedback, or mechanical feedback, from the loud speaker to the detector or to the first audio amplifier tube. In such cases the tube responsible is usually very microphonic, and the frequency of the oscillation is that which is heard when the tube is tapped gently. Spring or sponge rubber mounting for the defective tube is usually effective. Or in some cases the detector and amplifier can be put in a box into which the sound of the loud speaker cannot enter easily.

If the trouble is due to mechanical coupling the loudspeaker may be put on sponge rubber or other "dead" material. Separation of the speaker and the amplifier is effective both against acoustic and mechanical coupling. For example, the loudspeaker may be put in one room and the amplifier in another, with the door between the two closed.

In case the trouble is acoustic coupling moving the loudspeaker a few inches one way or the other is also helpful. A very helpful step is to put in a good tube for the microphonic one.

Radio University

HOW CAN I CHANGE my four tube set to adapt it to the use of a screen grid tube in the RF stage?

(2)—Advise if balancing condenser is necessary when using this tube.

(3)—Is it practical to put two regenerative stages ahead of the detector?

(4)—Why are .00035 mfd. condensers specified in some circuits and .0005 mfd. in others when otherwise the parts are practically the same?

(5)—In some circuit an RF choke is put between the plate of the detector and the first transformer while in others a condenser is shunted across the primary. Which method is better?

J. A. BOGART,
Harrison, N. Y.

(1)—Treble the number of turns on the primary of the three circuit tuner. Change the RF tube filament resistor to a 622

(2)—Not necessary, but it may be left in the circuit.

(3)—No.

(4)—When different size condensers are used the tuning coils are also different. The smaller coil takes a larger condenser. The smaller condenser and larger coil give a little more sensitivity than the other combination, but it does not cover the entire tuning range so well. It makes little difference which combination is used.

(5)—The by-pass condenser is more important than the RF choke coil. In many circuits the RF choke is a useless appendix, but in others it serves a very useful purpose.

* * *

WHY IS IT THAT the low notes do not come out so well when the coupling transformer or an output choke carries much plate current? I believe from observation that this is so.

(2)—What is the connection between the grid bias on the tube and this frequency discrimination?

ANTON SCHROEDER,
Chicago, Ill.

(1)—When a heavy plate current flows through the primary of a coupling transformer or through the winding of a choke coil the core becomes saturated magnetically, and when it does the permeability of the core is low. This makes the inductance and the impedance low also. The amplification of the tube depends largely on its load impedance. If the impedance in the plate circuit of any tube is low the amplification is low. This decrease in amplification due to core saturation shows up at the low frequencies first, because the impedance of a coil is directly proportional to the frequency. Hence at low frequencies the load impedance is low, as is the amplification.

(2)—The grid bias is connected with this decrease of the amplification in that it controls the amount of plate current. If a core is saturated, the magnetic density in the coil can be reduced by increasing the grid bias. The gain in the amplification by the resulting increase in the coil inductance affects the low notes more than the high.

* * *

I READ WITH INTEREST the description of how to build the 5-tube AC set, using Victoreen and Hammarlund parts, as described in the April 21st and 28th issues. Please explain the value of the Victoreen power switch and three-way socket.

ABNER FORCE,
Beloit, Wisconsin.

A special feature of the circuit is the Victoreen socket block and power switch (No. 333) into which the primary of the filament transformer and that of the power pack can be plugged. There is a third outlet in this block which may be used for some other transformer if required. The line switch is placed on the panel and is connected to the block which enables the operator of the set to control the power from the panel without the aid of any relays. This outlet block complies in every way with the underwriters' specifications and is therefore safe to put in the set. The power switch S can be seen on the lower right of the panel directly in front of the outlet block.

* * *

CAN an —01A, AC heated, be used in a small transmitter?

JOHN FORK,
Racine, Wis.

Yes.

* * *

I HAVE TRIED all the various schemes suggested for stopping motorboating but none stopped the oscillation. Please suggest some sure remedy, for I want to get some good out of my receiver.

(2)—Will changing tubes help in my case? I now use high mu tubes in the first two stages and a 112A tube in the final stage.

(3)—Will electrolytic filter condensers help?

OSWALD BORGESEN,
Sheboygan Falls, Wisc.

(1)—A storage B battery is a sure remedy for motorboating.

(2)—It will. A —71A in the last stage will help some but it may not stop the trouble in your case. If not, put in —01A for the high mu tubes.

(3—Next to using a storage B battery, the use of an electrolytic condenser of large capacity is most effective in stopping motorboating. The condenser by all means must be of large capacity and must have been formed at a voltage higher than the maximum voltage which will be met in the eliminator.

Radio University

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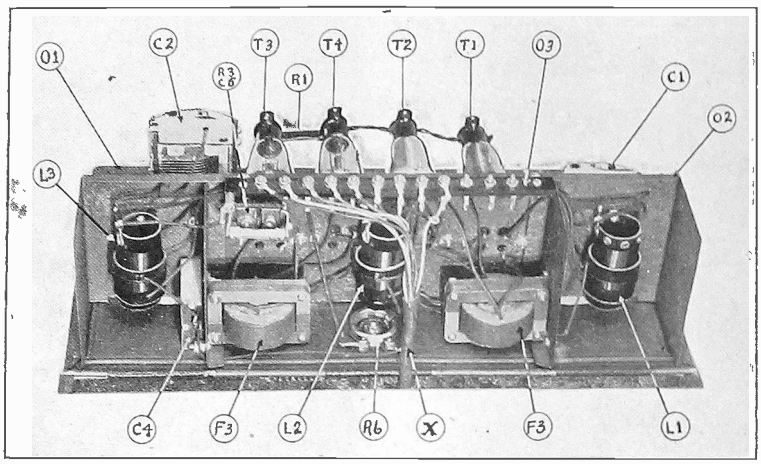

FIG. 617

WILL YOU PLEASE publish a photograph or a pictorial diagram of the under side of the Fenway Concertrola? Also, if possible, please identify the parts and give their values.

(2)—Can the —27 type heater tubes be used interchangeably with the McCullough tubes specified in the Concertrola?

MANFRED SCHIRTZ,
Milwaukee, Wisc.

(1)—See Fig. 617 for such a photograph of the Concertrola.

(2)—The —27 heater tubes are not interchangeable with the McCullough or the Kellogg specified for the Concertrola.

* * *

ENCOURAGED BY THE SUCCESS of a friend of mine with the Magnaformer 9-8 receiver I built one also, following your description in the Dec. 10 issue. I have measured the voltages and know they are correct. And I have also checked over the circuit against the diagram and am sure that all connections are correct. The set does not perform properly. What could be the matter with it?

MILTON FREDERICKSON,
Omaha, Nebraska.

The voltages are very deceptive and undoubtedly the trouble is that the plates are not getting enough voltage when the set is operating. The eliminator may show rated voltage when the tubes are not operating but as soon as they are turned on the voltage may drop to a third of the proper value. The oscillator tube is the most critical. If the voltage applied to its plate is not high enough the tube will not function, and if it does not function the circuit as a whole is inoperative. Boost the plate voltage and the set should begin to show its power.

* * *

I WISH TO GET a meter which measures alternating currents lower than 1 milliampere. I have not been able to find such a meter in catalogues. Where can I get one?

PERCY CRAMER,
Wheeling, W. Va.

Such sensitive milliammeters generally are not made. When alternating currents of a few milliamperes and less are to be measured, sensitive thermo-couples in conjunction with micro-ammeters are employed. When very small alternating currents, say 15 microamperes and less, are to be measured, a Duddell thermo-galvanometer is used. This may be purchased from scientific instrument houses, such as James G. Biddle & Co., Philadelphia, Pa.

* * *

I AM USING a resistance coupled amplifier powered with batteries throughout. For several months it has given wonderful quality and volume. But recently it has been giving trouble. It is no longer so sensitive as it used to be and the quality is not good. What is the cause of this change?

(2)—Would I get better results if I powered it with a B battery eliminator instead of batteries?

(3)—Would boosting the voltage improve the results? The highest voltage is now 135 volts.

WILSON CRAWFORD,
Montgomery, Ala.

(1)—The cause of the change in the receiver is exhausted tubes or batteries. Get new batteries and the circuit should work as it did at first.

(2)—The quality might not be so good.

(3)—Yes. You well might boost the voltage on the last tube to 180 volts. But this must be accompanied by an appropriate change in the grid bias on that tube. You may also boost the voltage on the high mu tubes to 135 volts.

* * *

WHAT IS THE FUNCTION of the radio frequency choke coil in the plate circuit of detector tubes? I cannot notice any difference when I use it.

(2)—What is the effect of the by-pass condenser in the plate circuit of the detector?

(3)—I have two audio transformers which I want to put into a receiver. One is a 6-to-1 and the other is 2-to-1. Which shall I put next to the detector? I have one article which says the high ratio should be next the detector and another which says that the low ratio should be first. Please give reasons for your choice.

CHARLES A. MARSHALL,
Atlanta, Ga.

(1)—One object of the RF choke coil in the plate of the detector is to prevent radio frequency currents from getting into the audio amplifier. Another object is to guarantee oscillation in certain regenerative sets. In many circuits the choke coil has no perceptible effect on the operation.

(2)—The by-pass condenser aids in detection. It is necessary, although in some circuits the capacity of the primary of the first transformer is enough.

(3)—The low ratio transformer should be put next to the detector. The detector tube has a higher output impedance than an amplifier tube, and to make the detector work efficiently the impedance connected to it should be high. The low ratio transformer, as a rule, has a higher primary impedance than a high ratio transformer. Recommendations that the low ratio transformer be put last were made when radio technique was not so well known as it is now.

* * *

HOW CAN I determine the frequency of prominent resonance peaks in my cone type loud speaker?

HECTOR JONES,
Pocatello, Idaho.

Pick out the key on a piano which is in unison with each of the resonance peaks. Pick a time when the signal contains the particular resonance frequencies often.

PORTABLE SET SOON

A portable set has been designed in RADIO WORLD'S laboratories and construction will be described in an early issue. The circuit comprises four tubes. The cost of construction is low.

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Booklet Expounds Radio Fundamentals

Under the title of "The Gateway to Better Radio," (25c) a vast collection of practical radio data has been gathered for those desirous of obtaining the best broadcast reception. This handy manual is published by the American Mechanical Laboratories, Inc., 285-7 North Sixth Street, Brooklyn, N. Y., manufacturers of the Clarostat.

"The Gateway to Better Radio" contains 32 pages of practical radio information, more than 20,000 words of concise text, together with 88 illustrations. This manual deals with sound fundamentals of radio practice, and on which the reader can base any circuits which may attract his permanent or passing interest. Aside from receiving circuits, the manual dwells at considerable length on socket-power operation, including the making and improving of B power, A power and C power units, as well as amplifiers from the simplest battery-operated type to the largest push-pull auditorium type.

Speed of Photoradio Doubled by the Navy

Washington.

Successful experiments with photoradio apparatus have been conducted by the Communications Service of the Department of the Navy, the process for transmitting a 5x7-inch picture having been reduced by one-half the time required a year ago, according to a statement made public by the Department of the Navy.

At the outset of the experiments, a year ago, the statement said, about 50 minutes were required to transmit a 5x7 photograph, but by remodeling the apparatus the transmitting time has been cut in half and the interference to high frequency reception has been eliminated.

Full Text Given

The full text of the statement follows:

About a year ago, one photoradio transmitter and receiver were purchased and installed at Radio Central, Navy Department, and tests were conducted for about six months with the Radio Corporation of America at New York, and with the U. S. S. Seattle, in which vessel the Radio Corporation of America had installed a duplicate of the Navy Department installation.

These tests were considered very satisfactory, but the process was slow, taking about 50 minutes to transmit a picture 5x7. Considerable difficulty was also experienced in high frequency reception at the Navy Department due to interference caused by the operation of the photoradio apparatus.

Since that time the apparatus has been remodeled and modified to such an extent that a picture of the above stated size can be transmitted in one-half the time formerly required, and the interference to high frequency reception has been eliminated.

Photo-Electric Cell Used

In photoradio, light is made to pass through a film (positive or negative) of the picture to be transmitted.

This light strikes a photo-electric cell and the energy given off by this cell is determined by the amount of light thrown on the cell, the light being controlled by the density of the film through which it passes, or by the "black and white" of the subject on the film.

The energy from the photo-electric cell is amplified and used to modulate a 60-cycle oscillator. This oscillator, allowed to work freely, will key a relay at such speed as to form on the recording paper equi-distant dots.

Spaces between dots are of the same width as the dots themselves, and to the eye appear gray. If the light is entirely shut off from the photo-electric cell the oscillator will become blocked and the key will be held down, marking pure black at the recording end.

Synchrony Determines Success

When a small amount of light comes through, the black is broken up at intervals, or long dashes very close together are made.

This process continues as the light is increased, until the light coming through is pure white and the key is held open.

In other words, for the black part of a picture the key is held down, and for the gray or white the key is released at intervals, according to the "tone" of the picture, and the recording pen at the receiving end is held down on the paper or released.

It can be readily seen that good synchronization determines the quality of a picture. This is obtained by a clock corrected timing fork controlling the transmitting and receiving motors.

Tests are being conducted daily between the Navy Department and the Radio Corporation laboratory at New York. Tests between the U. S. S. Texas and the Navy Department will be resumed when the installation aboard the Texas has received the same modification as the one at the Navy Department.

Fabricone Speaker Designed by Penn

George R. Penn, one of the pioneers in the speaker and unit field and originator of cone kits, has designed and is manufacturing a new and fine speaker, the Fabricone Loudspeaker. This speaker is made of a special fabric treated with Liquitone, which the manufacturer claims revolutionizes reproduction.

The speaker is 15 inches in diameter, comes in beautiful colors and is highly ornamental. It is bound in silk cording and has two tassels and a hanging cord. It is ready for the market in kit form which is easily and quickly assembled and is foolproof. It is driven by the G. R. P. cone unit which has a large, sturdy horse-shoe magnet, four pole pieces and a double adjustment which renders it adaptable to all outputs. Mr. Penn is also putting out a 30-inch collapsible cone.

Full information may be had by addressing George R. Penn, 231 Mercer Street, New York City, and mentioning RADIO WORLD.—J. H. C.

Coby Scours Europe for Tube Progress

George Coby, president of C. E. Manufacturing Company, Inc., of Providence, R. I., makers of the CeCo radio tubes, sailed on the Leviathan for an extended tour of Europe in the interest of television radio tube development and general research of advanced technique in radio tube manufacture.

England, France, Germany, Italy, Austria, Poland and Russia will be included in Mr. Coby's extensive search for radio tube improvements.

The activities of Mr. Coby and his associates, Egnatoff, treasurer; Copek, secretary, and Kauer, vice-president, account Plant No. 2 was opened recently to meet for the concern's rapid expansion. CeCo the national demand for the CeCo tubes. It is said that there are millions of them in use now with thousands going out to the trade daily.

Large accommodations have been reserved by CeCo at the June Trade Show in Chicago. Mr. Coby expressed regrets that he will not have the pleasure of greeting his many friends during the show. Messrs. Steinle and Fiske, general and assistant directors of sales, with Mr. Egnatoff, will see that every visitor is accorded the usual CeCo hospitality.

CeCo representatives from all over the United States will be present also.

GEORGE COBY

THE NATIONAL SCREEN GRID 5, described by James Millen in April 14th, 21st and 28th issues. Fully illustrated, including picture diagrams of wiring. Uses screen grid tube for the single RF stage, four other tubes standard. Send 45c for these three copies and get blueprints free. RADIO WORLD, 145 West 45th St., New York City.

Radio Vision Chain Planned by Syndicate

A television broadcast service for the entire American continent is being planned by an American syndicate which has purchased the United States, Canadian and Mexican rights of the Baird Television Development Company of London.

The American company is headed by Herbert Pokress of New York, Charles Izanstark of Chicago, and Nathan Feldstern of Philadelphia.

John L. Baird, inventor of the system, and Captain O. G. Hutchinson, managing director of the British company, are scheduled to be present in this country for a first public demonstration. Completed receivers will be manufactured, according to present plans, for practical demonstrations during the New York Radio World's Fair in the Fall.

"A chain of broadcasting stations for television, which will reach every set owner and every potential radio listener of the country, will be established on the North American Continent as rapidly as humanly possible," said Mr. Pokress when discussing the proposed development.

"We have been approached by numerous representatives of broadcasting stations throughout the country, who seek to become affiliated with the transcontinental chain which is contemplated. At least 50 percent of the stations in the New York area have either telephoned or sent their representatives to us for this purpose."

Sir Charles Higham, well known British advertising expert, said in commenting on the project:

"In my opinion television will work a decided advantage in the advertising methods of the world. The greatest difficulty heretofore encountered by manufacturers has been to give the consumer his first view of the product. People are curious as to the various ways of making things, and rightly so."

Cowan Joins Staff of Frank Kiernan Co.

Sanford R. Cowan, long identified with radio advertising on a large scale, has joined the staff of Frank Kiernan Co., 41 Maiden Lane, New York City. Mr. Cowan is not only a skilled and versatile advertising man but also possesses a vast and fundamental knowledge of radio technique and merchandising. Frank Kiernan & Co. is one of the oldest and largest agencies in the country and was one of the pioneers in establishing a radio division. It is well equipped in all departments, research, copy and art, to turn out result-getting radio campaigns for advertisers in all branches of radio.—J. H. C.

Quick Action Classified Ads

Radio World's Speedy Medium for Enterprise and Sales

10 cents a word — 10 words minimum — Cash with Order

RADIO—Fastest growing business in the world. Are you sharing the profits? Let us show you how. No selling. Free booklet. Co-operative Radio Doctors, Dept. W, 131 Essex St., Salem, Mass.

THE A C KARAS EQUAMATIC—Full description, analytical article, in Feb. 11th and 18th issues. Send 30c for these isues and get free blueprint. Radio World, 145 West 45th St., N. Y. City.

KARAS SHORT WAVE SET, three tubes, 13 to 750 meters, described in the March 31, April 7, 14, 21 and 28 issues. Send 60 cents for these five issues and get blueprint free. RADIO WORLD, 145 W. 45th St., N. Y. City.

MEN—Big pay working romantic, wealthy South America. Fare. Expenses paid. South American Service, 14,600 Alma, Detroit, Mich.

WHY NOT EARN a new automobile in your spare time? You can do so easily. Let us tell you how. Pequod Nurseries, Yalesville, Ct.

GUARANTEED Safety Razor, with strop, in neat, strong carrying case, 25 cents. First-class, new. Send coin, M. O. or stamps.—P. Cohen, 236 Varet Street, Brooklyn, N. Y.

NEW SHIELDED GRID TUBES for Diamond, S-M Six or Laboratory Super, Tyrman 70. Price $5 each. Philip Cohen, 236 Varet St., Brooklyn, N. Y.

RECENT ISSUES of Radio World, 15c each. Be sure to give date of issue when writing. Radio World, 145 West 45th Street, New York City.

NEW RADIO LOGS, entire week days and chain programs at a glance. On cardboard. Needed daily. Time saver. Two (2) of each postpaid for 25 cents—stamps or coin. Dullnig Printing Co., San Antonio, Texas.

RADIO CARTOONS, CUTS, $1.50. Particulars Free. RAD-GPO, Box 471, New York City.

RECEIVING PARTS.. Bargains. Write for list. A. W. Clement, Bay City, Texas.

THE NATIONAL SCREEN GRID 5, described by James Millen in April 14th, 21st and 28th issues. Fully illustrated, including picture diagrams of wiring. Uses screen grid tube for the single RF stage, four other tubes standard. Send 45c for these three copies and get blueprints free. RADIO WORLD, 145 West 45th St., New York City.

TELEVISION STOCK NOT TOO SAFE

That radio television equipment should be designed to fit the waves was proposed by Radio Commissioner O. H. Caldwell when he was in New York on a recent inspection trip. Waves have been set aside for television and they cannot be changed without encroaching on other services, and engineers working on television must make the equipment fit in with the waves available, he said. He expressed the belief that the engineers would soon find a way of meeting the requirements.

Must Be Fitted In

"The enthusiastic inventor should remember that not only the problems of television transmission and reception have to be overcome, but the problem of fitting television into the wave spectrum has to be surmounted simultaneously before television can become a service to the public," said Mr. Caldwell.

"Great care should be taken by persons proposing to invest in television propositions to make sure that the commercial television application will measure up to the bright prospects indicated in the laboratory experiments.

"According to our present knowledge, a very wide frequency band will be required for any satisfactory television operation, and it is already apparent that only a few such bands can be put into service.

"The Federal Radio Commission has been disposed to grant to laboratories the use of the ether for experimenting, but to date engineers have largely devised things just to put on the wavelengths rather than to devise methods of fitting devices into narrower limits on the all-too-small radio spectrum."

AC Shield Grid Tube Is of the Heater Type

C. S. Redfield, president of Redfield Advertising Agency, on behalf of his client, C. E. Manufacturing Co., made the following announcement:

As the use and operation of AC tubes is being more thoroughly understood a demand has arisen for a high mu tube of the AC filament type.

The Engineering Department of the C. E. Manufacturing Company, of Providence, R. I., has developed a tube of this nature which is now ready for the market.

As in DC operation, this high mu AC tube is especially adapted to resistance audio amplification circuits. The filament is rated at 1.5 volts 1.05 amps. and has the same general appearance as the M-26. The tube has an average amplification constant of 16, which is considered to be the best value for practical purposes. This type of tube should be used under conditions similar to those applying to the M-26 tube.

It is the belief of the Engineering Department of the C. E. Manufacturing Company that development of resistance amplifiers for AC operation has been retarded to some extent due to the fact that high mu AC tubes have not been available. This new tube introduced by the C. E. Manufacturing Co. will undoubtedly stimulate interest and development in resistance coupled amplifiers using raw AC on the filament.

Within the last year great interest has been shown by the radio buying public toward socket operated equipment. Use of batteries or devices of a similar nature is fast becoming undesirable. At a time when direct AC operation was being rapidly accepted as sound practice the shielded grid tube appeared on the market. This tube required direct current, however, for filament operation.

As this meant a return to the storage battery, many engineers were not very enthusiastic about the introduction of the shielded grid tube, realizing that the buying public would not be inclined to go back to battery operation.

The engineering department of the C. E. Manufacturing Company has held from the very beginning that the eventual shielded grid tube must be AC operated. With this idea in mind it has developed an AC shielded grid tube which is now going out to the trade. This tube is of the separate heater type, requiring 2.25 volts maximum, 1.5 amps. on the heater

(*Continued on next page*)

Air Is Clearer, Say Caldwell and Sykes

Washington.

Orestes H. Caldwell, radio Commissioner from the New York and New England district, returned recently after an inspection trip to many of the cities in his district. He declared that reception is better, due to decreased interference from heterodyning with Western stations. He also said that the demand is increasing for greater power stations which will overcome the constantly growing interference from electrical devices. Commissioner Sykes, who is from the Southern zone, also returned from an inspection trip in the South. He reports that reception conditions in the fifth zone are "good."

Judge Sykes stated that interference there has diminished, but that broadcasters are anxious over what the action the Radio Commission will take on new allocations.

AC Screen Grid Tube Announced

(*Continued from preceding page*)

and has a 5 prong socket. The control grid comes out through the top of the tube the same as in the DC shielded grid tube.

This new AC shielded grid tube has characteristics which in many respects are superior to those of the DC shielded type. Comparatively high mutual conductance has been obtained and in general the inherent and recognized advantages of the shielded grid tube are made more available in this new type of AC tube.

THE NATIONAL SCREEN GRID 5, described by James Millen in April 14th, 21st and 28th issues. Fully illustrated, including picture diagrams of wiring. Uses screen grid tube for the single RF stage, four other tubes standard. Send 45c for these three copies and get blueprints free. RADIO WORLD, 145 West 45th St., New York City.

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We do not like to take your name from our subscription list without specific instruction to do so because many of our readers wish to keep a complete file of the paper.

Please, therefore, look at the subscription date stamped on your last wrapper, and if that date is earlier than the issue contained in the wrapper, please send check to cover your renewal.

In this way you will get your copies without interruption.

Subscription Dept., RADIO WORLD, 145 West 45th Street, New York City.

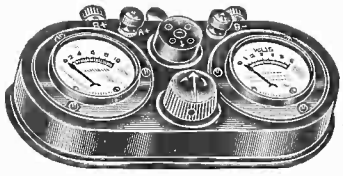
A Scientific Trouble-Shooting Test Set

Consisting of Tube Checker That Reads Filament Voltage and Plate Current; Extra Meter Reads Plate Voltage, including B Eliminator Voltages.

Only $10.00

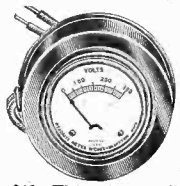
The best inexpensive combination for trouble-shooting is a Double R Tube Checker, comprising a 0-10 D.C. milliammeter, a 0-6 D.C. voltmeter, a switch, a rheostat and a socket. Add a high resistance voltmeter (0-300 v.). With these it is advisable to use a plug, so that all you need do is remove a tube from a receiver that you're testing, put the plug in the empty socket and the removed tube in the socket of the tester. You can immediately find open any short circuits, broken or flimsy connections, reversed connections, etc. The Double R Cord and Plug, the Double R Tube Checker, and 0-300 high resistance voltmeter constitute the Scientific Trouble-Shooting Test Set.

The Biggest Value That $10 Can Buy

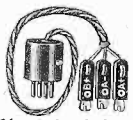


No. 210 Tube Checker consists of 0-6 volts D.C. Voltmeter, 0-10 D.C. Milliammeter, Grid Bias Switch, Rheostat, Socket, Binding Posts (with instruction sheet) in handsome noire case....$6.50

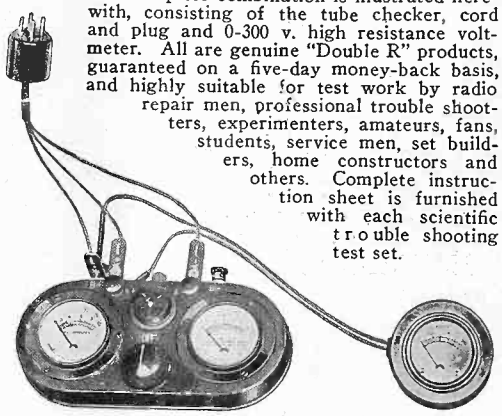
The cord terminals of the plug leads correspond with the binding posts of the tube checker. Now connect the 6-300 volts high resistance voltmeter from A+ to B+ posts and you get all necessary readings. You can test plate voltage from B eliminators, or any other B supply, D.C. plate current and D.C. filament voltage, as well as the efficacy of the tube, by throwing the grid bias switch, for the plate current should change within given limits, depending on the type of tube.



No. 346—High resistance voltmeter, for reading any and all DC voltages, including B eliminators, up to 300 volts. Portable type, full nickel finish, long connecting cords and tips $4.50



No. 21—Cord and plug, with markers and lugs that fit tube checker binding posts..$1.85



The complete combination is illustrated herewith, consisting of the tube checker, cord and plug and 0-300 v. high resistance voltmeter. All are genuine "Double R" products, guaranteed on a five-day money-back basis, and highly suitable for test work by radio repair men, professional trouble shooters, experimenters, amateurs, fans, students, service men, set builders, home constructors and others. Complete instruction sheet is furnished with each scientific trouble shooting test set.

Service Men! Custom Set Builders! Experimenters! Students!

Equip your testing outfit with the indispensable combination that constitutes the Trouble Shooting Test Set and Time-Saver. You quickly locate trouble while others flounder about.

WHAT YOU GET

One No. 210 tube checker, with 0-6 voltmeter, 0-10 milliammeter, socket, rheostat, binding posts and bias switch, all built in; one No. 21 cord and plug, and one No. 346 high resistance 0-300 v. voltmeter.

FOR ONLY $10

If You Want Complete Test Set, as Above, But With 0-500 High Resistance Voltmeter, price is $11.

SEND NO MONEY!

Our Five-Day Money-Back Guaranty Fully Protects You!

Many professional and other radio technicians require a 0-500 high resistance voltmeter, as part of their scientific trouble-shooting test set, so that they can test ALL power pack B voltages. They do a great deal of work with high voltage power packs, especially where a —10 or —50 tube is used in the output of a receiver. For them the 0-500 v. high resistance voltmeter, No. 347, is just the thing to include in the test set, instead of the No. 346 high resistance 0-300 v. voltmeter. The combination may be obtained with the 0-500 v. voltmeter, instead of the 0-300 v. voltmeter, at only one dollar extra. The 0-500 v. meter is exactly the same as the 0-300 v. meter, except for difference in maximum voltage reading.

Guaranty Radio Goods Co.

145 West 45th Street, New York, N. Y.

GUARANTY RADIO GOODS CO.,
145 West 45th Street, New York City.

Please send me at once, on a five-day money-back guaranty, one complete scientific trouble-shooting test set, consisting of one No. 21, one No. 210 and one No. 346, for which I will pay the postman $10, plus a few cents extra for postage.

☐ If 0-500 v. high resistance voltmeter No. 347 is preferred, put cross in square and pay $11, plus postage, instead of $10, plus postage.

NAME .....

ADDRESS .....

CITY .....STATE .....

ALL METERS SOLD ON FIVE-DAY MONEY-BACK GUARANTY