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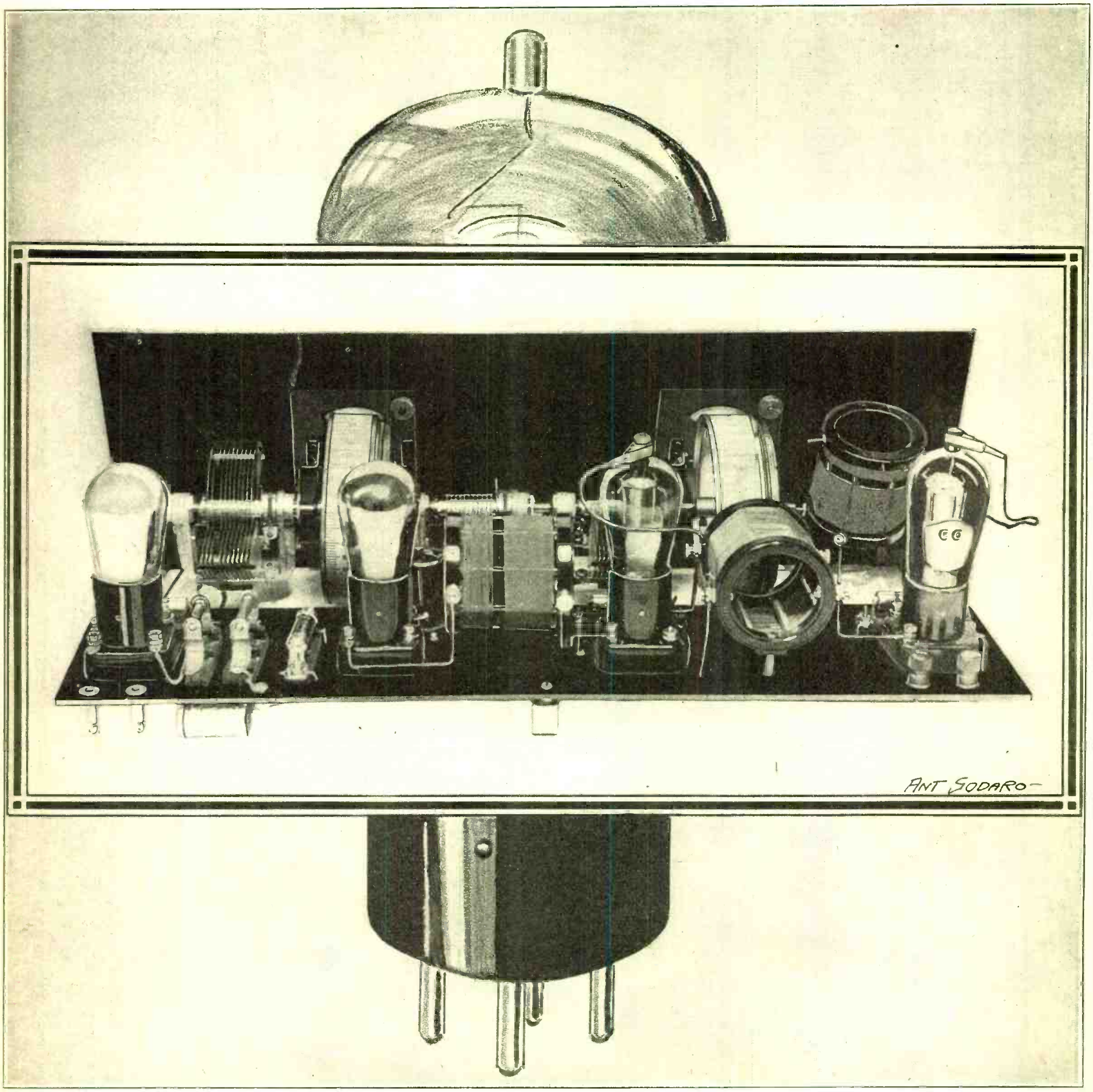

(Hayden)

The heart of the High Mu Tuner is the screen grid tube. Two such tubes are used as radio frequency amplifiers. The detector is a high mu tube, used as a grid bias detector. **See the constructional article beginning on page 3.**

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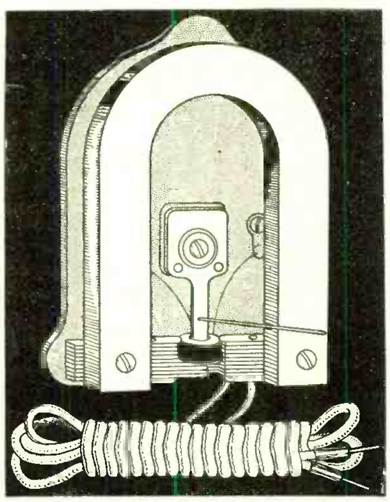

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Vol. XIII. No. 8. Whole No. 320.
MAY 12, 1928.
15c per Copy.
[Entered as second-class matter, March, 1922, at the post office at New York, N. Y., under Act of March, 1879.]

Technical Accuracy Second to None

A Weekly Paper published by Hennessy Radio Publications Corporation, from Publication Office, 145 West 45th Street, New York, N. Y.
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The High Mu Tuner

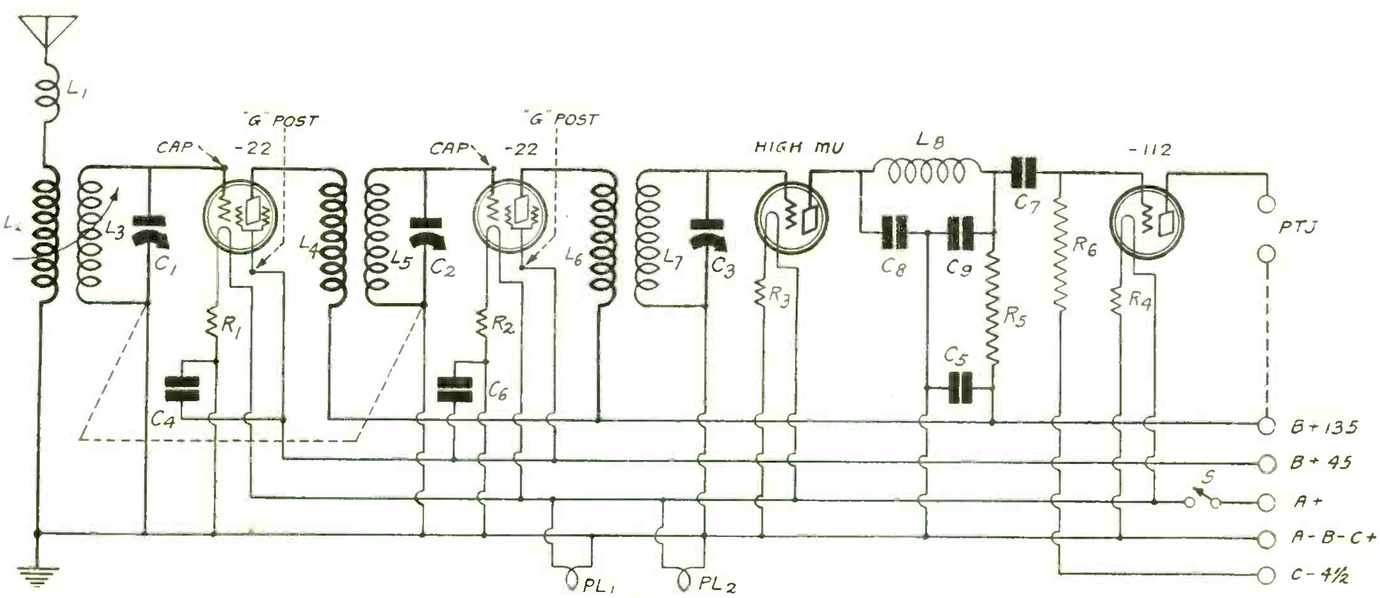


FIG. 1

THE HIGH MU TUNER FOLLOWS THE GROWING PRINCIPLE OF OBTAINING STILL HIGHER SENSITIVITY AND VOLUME, WITH FEWER TUBES, DUE TO THE HIGH AMPLIFICATION CONSTANT OF THE NEW TUBES EMPLOYED. THE RF AMPLIFIERS ARE SCREEN GRID TUBES, WHILE THE DETECTOR IS A HIGH MU TUBE USED AS A GRID BIAS DETECTOR. THE BIAS IS ONE VOLT NEGATIVE, DUE TO THE VOLTAGE DROP IN R3. B+45 MAY BE LESS THAN THAT, IF NECESSARY TO KILL OFF OSCILLATION.

Two Screen Grid Stages and a High Mu Grid Bias Detector Precede a Resistance Audio Stage—Fine Circuit to Feed a Power Pack.

By Herbert E. Hayden

Photographs by the Author

THE new screen grid tubes are high mu radio frequency amplifiers, above all else, and the gain per stage is easily made greater than practical operation permits.

When the tube is operated somewhat under its maximum, absence of self-oscillation is one of its virtues, while high gain still remains a feature.

If the interstage radio frequency transformers have primaries of sufficiently high impedance, say about half the number of turns that is on the tuned secondary, the gain, using two stages, is so great that the leak-condenser method of detection, an easily overloaded form of rectification, becomes inadvisable.

Volume Aplenty

Instead, grid bias detection is used, and if this is followed by a resistance coupled audio stage, you have ample input for a power pack that, according to the prevalent fashion, includes a stage of transformer-coupled audio. Hence the diagram, Fig. 1, shows the High Mu Tuner followed by a stage of resistance coupled audio, the output intended to feed the single transformer audio stage of a power pack. Designs for such a power pack are published on pages 12 and 13 of this issue.

The volume is easily great enough to tax a 210, so it may well be imagined that the volume is high.

The whole scheme of the circuit is to build up the volume at radio frequencies only to such a point that the sensitivity is sufficiently keen, and this necessarily follows if the screen grid tubes are worked together at anything near their full capabilities.

In theory an amplification of 300 is obtainable from each tube, but under such a condition the selectivity is low. The gain in selectivity in the High Mu Tuner is made at the expense of amplification, but it is a favorable compromise.

The interstage coils, with the large primaries, are so designated in the diagram, but the antenna coil has a relatively small primary, on a rotary form, so that adjustment of this primary controls volume. A regular 3-circuit coil may be used and primary and tickler connected in series in the antenna circuit.

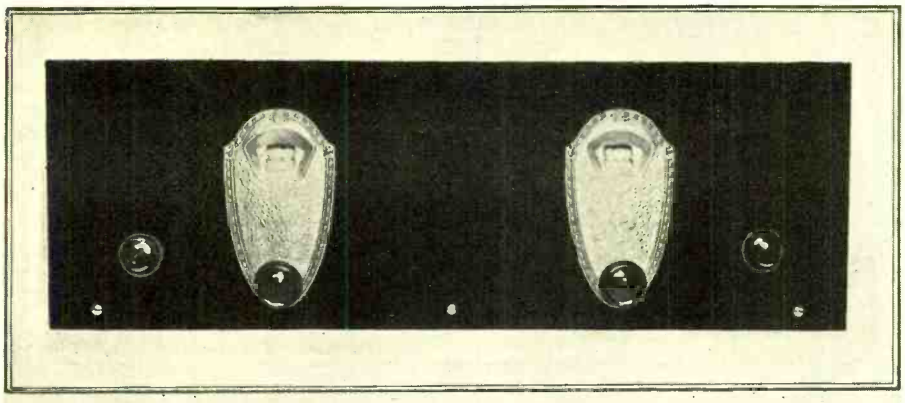
No better place than the very input to the radio receiver could be chosen for a volume control, since it prevents overloading at all points, a particularly favorable advantage, since this precaution also affects the detector, overburdening of which is the chief cause of distortion in a sensitive receiver.

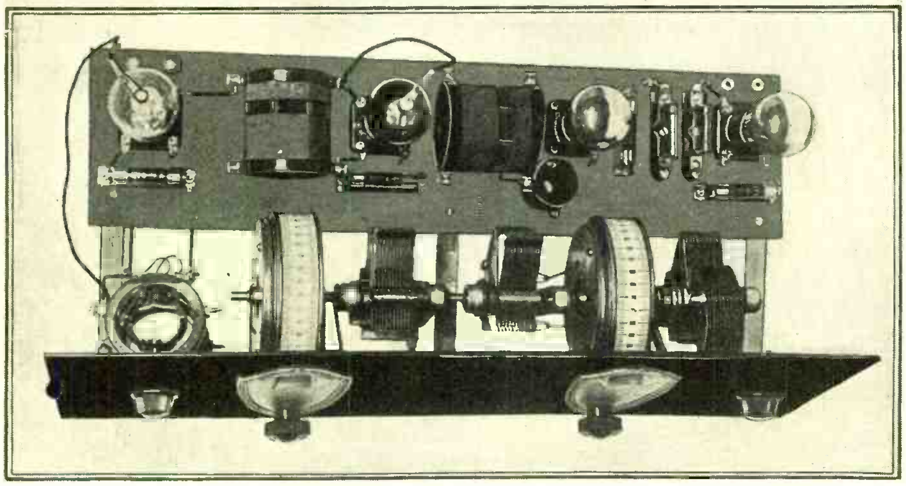
Balances Tuning

The adjustable primary in the antenna circuit also serves as an inductive trimmer, so that condensers C1 and C2 may be ganged.

The detector has to be tuned separately by C3, because the inter-electrode capacity of the screen grid tubes is incredibly small, about one-tenth of that of other tubes, and this shows up in the tuning, causing condensers that tune a screen grid input to give higher dial setting, assuming that increase in dial numbers accompanies increase of capacity in the tuning condenser.

The design of Fig. 1 accommodates even large reflection of antenna capacity into the secondary of the coupler, by the compensatory or trimming function of the





FIGS. 2 AND 3

THE FRONT AND TOP VIEWS SHOWS THE PANEL ARRANGEMENT AND THE TWO STAGE SCREEN GRID RF CHANNELS THAT FEED INTO A HIGH MU DETECTOR TUBE. A STAGE OF RESISTANCE COUPLED AUDIO IS INCLUDED, SO AS TO WORK NICELY INTO A POWER PACK. THE FRONT PANEL SHOWS THE TWO TUNING CONTROLS, VOLUME CONTROL AND SWITCH

LIST OF PARTS

L1L2L3—One Bruno 3-circuit tuner (standard).
L4L5, L6L7—Two Bruno Screen Grid model SG No. 99 RF transformers.
C1, C2, C3—Three Hammarlund .0005 mfd. Midline Variable Condensers.
R1, R2—Two 622 Amperites with mountings.
R3, R4—Two 1-A Amperites with mountings.
L8—One Hammarlund radio frequency choke coil No. 85, Ch.
R5—One Lynch .25 to 1 meg. resistor (for detector plate).
R6—One Lynch 8 meg. leak (for first audio grid circuit).
C4—One Polymet .006 mfd. fixed mica condenser.
C8, C9—Two Polymet .0005 mfd. fixed mica condensers (in detector plate circuit).
C5, C6—One Carter .5 mfd. bypass condenser.
C7—One 1 mfd. Carter bypass condenser.
PTJ—Two Frost Pup jacks, (output).
S—One Yaxley No. 10 switch.
One Lynch moulded bakelite double mounting.
One 7x21-inch front panel, bakelite or hard rubber.
One 4½ x 20-inch sub panel, bakelite or hard rubber.
Two flexible leads with Peewee clips attached for attaching to screen grid cap.
Four Frost sockets.
Two National Velvet Vernier illuminated drum dials, with lights DL.
Two Eby binding posts (Ant., Gnd.).
One U angle to brace up sub panel rear three Karas sub panel brackets (may be bent for sloping panel).
One Hammarlund flexible coupling (to join shafts of two condensers).
Three Karas subpanel brackets.
Four CeCo tubes; two RF22, one G, one F12A.

rotary coil, this advantage being additional to volume control achieved by that coil.

With DX stations the question of volume reduction never arises, the problem always being to make a distant station come in louder.

That is why a receiver should be able to serve a thousand to one ratio, since easily a thousand times more volume could be fully enjoyed on a weak, fardistant station, as compared with comfortable volume setting for a strong adjacent local.

A standard three-circuit tuner may be used. If the primary (small fixed winding) is not used, selectivity will be higher. But in most instances it may be well to connect this winding in series with the rotary coil, and have the total inductance of both in the antenna circuit. The coil has a 2¼ inch diameter and is wound of No. 24 insulated wire, 53 turns on the secondary, ¼-inch separation, then 12 turns on the primary, while the rotary coil has 30 turns of No. 26 or 30 wire on a 1¼-inch diameter.

The interstage couplers have 25-turn primaries and 53-turn secondaries on 2¼-inch diameters, with ¼-inch separation, using No. 24 wire.

These primaries are large enough to cause self-oscillation if the screen grid voltage is too high. Usually 22½ volts or less will be found sufficient. Use up to 45 if oscillation does not set in. An easy way to kill off oscillation is to use grid suppressors in series with the flexible leads to the caps, say 800 to 2,000 ohms each.

All High Mu Tubes

The tubes in the tuner are all high mu, the —22 being the highest of the high mu tubes so far developed for public distribution.

With a tempting maximum of 300 per stage gain, it is nevertheless a tube that scarcely should be worked at more than 50 or 60 gain per stage, this being easily achieved, and contrasting in a marked manner with the effective gain of 6 per stage of the —01A, which has a possible amplification of about 8.

Rated mu or amplification factor is scarcely ever attained in circuit practice, due to the effect of the plate load in particular as a limiting factor.

But with the screen grid tube the 50 or 60 per stage is actually there—it is the effective gain—and it is won without necessity of resorting to neutralization.

Simple or Not?

When self-oscillation is present in a circuit there is no virtue more warmly appreciated than a device that bids good riddance to the squeals, but in every instance neutralization must introduce some loss in amplification.

It is customary to report all circuits "simple to build," particularly the more difficult ones, so the reader is earnestly invited to look at the diagram and the photographs, and judge for himself.

The two tubes used as radio frequency amplifiers have been discussed theoretically. In practice they are inserted in standard push type sockets, but the post marked "G" on the diagram, which is the socket G post, is connected to B plus 45 volts or less, whereas the lead we have been used to connecting to the G post is now made of flexible insulated wire, has a clip soldered to the free end, and this clip is sprung onto the cap of the tube.

The Cap's the Control Grid

It is the cap that's the grid now, as we understood the word "grid" all along. Now we must differentiate between the screen grid and the control grid, and this we do by remembering that the familiar grid of a tube is the control grid, and in the case of the —22 tube it's the cap of the tube, while the screen grid is the G post.

As for the detector, as high mu tube was chosen, e. g., CeCo type G, or a 340 or 240, because it works exceedingly well into a resistive plate load, and furthermore is a fine tube for grid bias detection.

The grid bias method of detection permits about twice as great a signal input before serious distortion occurs, compared with the condenser-leak method. While the grid bias method may not be as sensitive as the other, we have obtained all the sensitivity a detector can be expected to tolerate, unless we invent some new systems of detection, and such hasn't been done in more than a decade.

Another point about grid bias detection is the purity of reproduction it enables, since it does not attenuate the higher audio frequencies as does the other method. The hissing consonants come through with great fidelity, yet the lowest base is not slightly as much.

Piano a Good Test

Listen particularly to a piano solo, and to a talker, when judging grid bias detection, for speech is rendered most intelligible and natural when the esses, zees and the like come through with proper emphasis, and much of the delight of listening to a piano solo depends on the tingle of the soft high notes, sweet and crystal clear.

A radio frequency coil of 60 to 80 millihenrys is advisable in the detector circuit (plate) while the by-pass condensers, each of .0005 mfd. in circuit with the RF choke, are at least as important.

The rectification of the detector tube

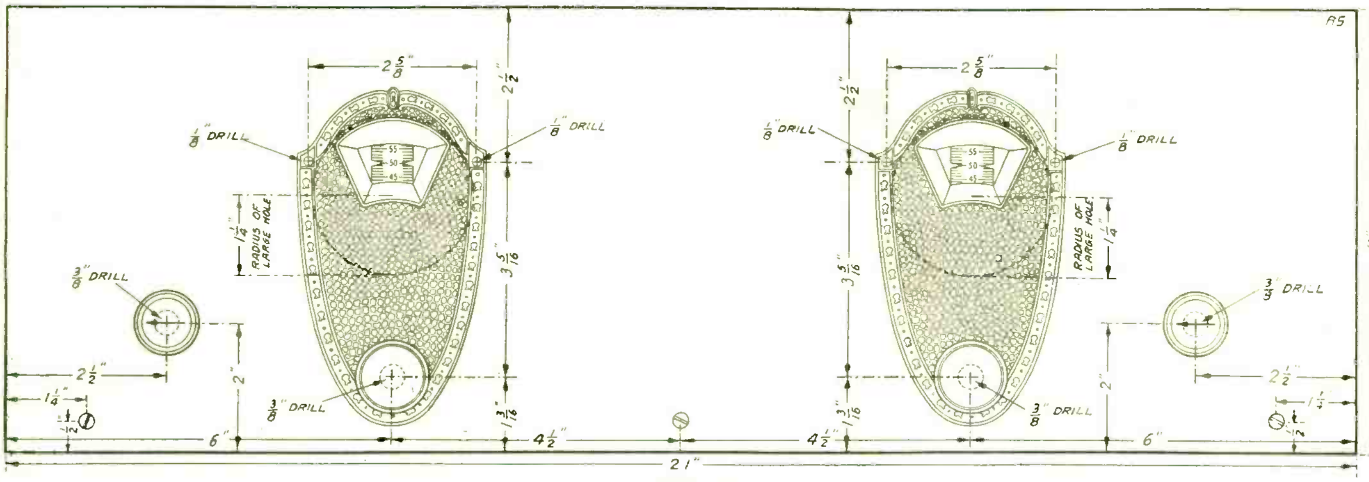


FIG. 4
DIMENSIONAL PLAN FOR DRILLING THE FRONT PANEL OF THE HIGH MU TUNER.

depends on operation of the tube at the upper or lower parts of the characteristic curve, where the curve is relatively bent. To obtain such operation is not quite so simple as using the leaky-condenser method, because a difference of half a volt negative bias makes all the difference between amplification and rectification or between fine rectification and poor rectification.

Three Factors

Too much or too little bias will cause the detector tube to function more as an amplifier, indeed yielding only so much rectification as is due to tube distortion, just as all amplifiers, no matter where placed, rectify a little.

Hence there are three factors to consider: (1) the applied plate voltage, for if the grid bias is regarded as fixed negatively, at a certain amount, rectification will depend on the plate voltage; (2) grid bias, since if this is adjustable for a fixed plate voltage, detection depends on the bias; (3) the value of the plate resistor in ohms, since the actual effective plate voltage, upon which rectification is to depend, indirectly hinges on the effect of this resistor upon the originally introduced plate voltage.

The higher the value of resistance, the lower the effective plate voltage, but the higher the amplification of the particular detector tube. Hence no set plate voltage is shown on the diagram for the detector tube. The lead may be connected to B plus 135 and the negative bias may be 1 volt, obtained from the drop of the resistor R3. Therefore, try various values of plate load resistance, from .25 meg. to 1.0 meg. or settle on 1.0 meg. and manipulate the plate or grid voltages or both, until you get detection. Your ear will tell you, for when you're a tiny bit off, in the voltage reckoning, you're far and away off on volume.

True Clarity

The tube will distort badly as a detector when off the flat part of the curve, but will rectify like a crystal—indeed the action is almost identical—when you hit it right.

This finesse of voltages has been the main reason why grid bias detection has not been popularly recommended in the past, but in all extremely sensitive receivers it must be used if the detector tube is to be protected from the overgenerosity of the preceding channel.

The first audio tube may be a 112, 135 volts applied, and the bias may be from 4½ volts negative. This relatively low bias gives greater volume, but the plate current drain is higher, which is all right, if you use a power pack. If layerbuilt B batteries are used instead, favor higher bias, thus conserving B. Even at 3 volts negative, however, the grid is biased enough to work into a —10 tube in the power pack, indeed even into a type —50 tube, provided the plate voltage does not exceed 400 volts.

The illuminators or dial lights (DL) are part of the equipment of the new National Velvet Vernier drum dials. The dial light sockets are housed in rubber grippers that are sprung onto the side bracket built in the dial frame.

[Other Illustration on Front over.]

Germany's New Tastes Are Revealed

Leipzig, Germany.

A unique opportunity to compare the latest development of radio in Europe and America was afforded by the Radio Show at the Leipzig Trade Fair. More than 500 exhibits, chiefly German, illustrated every phase of the science.

Remarkable progress has been made in the past year in improving tonal production, selectivity, reducing static and simplifying and cheapening many forms of apparatus. It is noticeable that Germany advances along theoretical lines, while in the United States the practical side is amazingly developed. Each country, it is apparent, may learn from the other.

A notable advance has recently been made in Germany in the technique of broadcast transmission. The microphones now employed are especially good in the transmission of the violin and the distinctive instruments of large orchestras and the soprano voice.

Great on High Frequencies

The German stations transmit the high frequencies faithfully. American stations, it is recognized, reproduce the lower notes extremely well.

Germany has fewer broadcasting stations than America while the programs, especially the musical features, are of a very high grade. Although the distances are great in the United States the land line relays in America are considered better than those in Europe.

Much more attention is paid in Germany today to simplifying and decorating cabinets than formerly. A five tube set in an attractive cabinet to work effectively with stations in all parts of Europe sells for about $125. Sets which will work satisfactorily with local stations sell for one-half or even one-fourth this. Multiple dials have been done away with, and the newest dials have the names of the broadcasting stations marked on them instead of the wavelengths. American sets are being imported for getting stations on low waves.

Returning to Metal Horns

Germany is returning to the metal horn loudspeakers. The other forms, especially the paper disks, are thought to require too much power to give the same results. Great improvements have been made technically along this line, and the metallic quality has been eliminated. A good loudspeaker sells as low as $5, and the best for about $35. The newest German batteries are much smaller than formerly, and are claimed to be a great improvement. By using very thin plates batteries are made less than two inches square, yet can be charged with any kind of current. The prices of batteries are considerably lower than in the United States.

Most of the German sets use an outdoor antenna. There has been a notable advance recently in developing the loop. It is possible to pick up stations in all parts of Europe with an antenna which is mounted on a frame less than one foot square. There are several highly ingenious forms of folding antenna which can be adjusted in a few seconds.

A novelty of the show this year was a new triple tube which is claimed to do the work of three ordinary tubes and do it better, especially in working with distant stations. A number of ingenious lightning arrestors have been developed in Germany recently. The simpler forms, which cost about $2, can be readily connected in circuit and prove a complete safeguard. Recent experiments in Germany have proved that radio antennas are not inviters of lightning any more than metal gutters or wire clothes lines.

Germany is beginning to export radio sets and parts to America and anticipates a ready sale, especially for her newest tubes. Many American sets are also finding their way to Germany where their technical excellence is greatly appreciated.

The radio show was the common ground where the latest radio products of many nations were displayed on equal terms. The central position of Leipzig makes it possible to tune in upon the powerful broadcasting stations all over Europe, and listen to programs in nearly a dozen languages, including Esperanto broadcast from Moscow.

* * *

A horn loudspeaker is usually more sensitive than other types, or apparently so. Much of this sensitivity is due to resonance in the horn at certain frequencies. At frequencies between the resonance points the horn is no more sensitive than other forms. A properly shaped exponential horn is an exception. It radiates sound equally well for all frequencies within its working limits.
—EDITOR.

How Phases Make

By J. E.

Technical

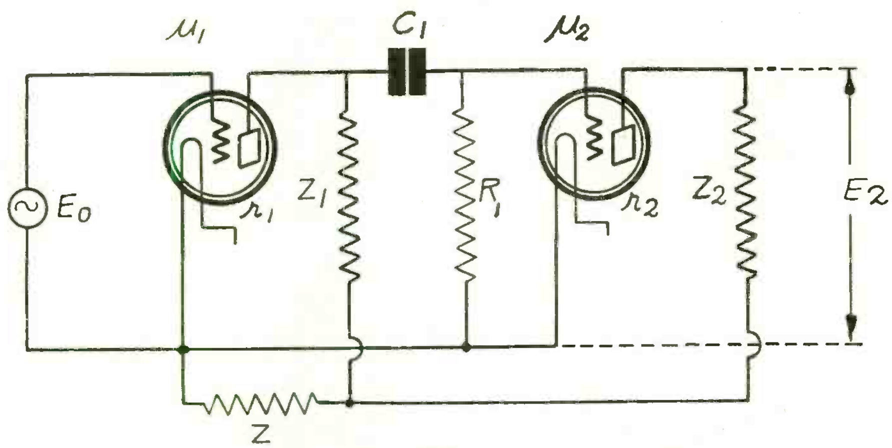


FIG. 1
A TWO TUBE RESISTANCE COUPLED CIRCUIT ILLUSTRATING HOW THE FEEDBACK OF THE SIGNAL CURRENT IN THE PLATE OF THE SECOND TUBE THROUGH THE COMMON IMPEDANCE Z REDUCES THE AMPLIFICATION.

[The subject of oscillation in audio frequency amplifiers, which became important when B power supplies came into vogue, at first proved baffling, because the theory was not well understood. One of the first to expound the theory, with supporting theorem, was the author of the following article. He blazed the trail in his highly scientific discussion in the March, 1927, issue of "Proceedings" of the Institute of Radio Engineers, and has become the outstanding contributing authority on this subject in the United States. The article that follows is couched in as simple terms as the circumstances permit, all supporting theorem being omitted, since it is complicated mathematics. The article creates a new point of advance in technical literature on the subject of audio oscillation.—Editor.]

PART I

EVER since B battery eliminators have been generally used to power receiving sets considerable trouble has been experienced from oscillation in the audio frequency amplifier. At first this trouble was attributed to blocking of the grids, mainly because the oscillation was more frequent in resistance, impedance and auto-transformer coupled circuits than in transformer coupled circuits. All remedies suggested were based on the theory of blocking.

The fact that this theory was inconsistent with observed phenomena seemed to have no effect on the general acceptance of the explanation. There was some reason for this acceptance, for many of the remedies did stop the oscillation and that was the important thing.

Batteries Not Exempt

In the early days of radio when cheap transformers were used in all receivers and when B batteries were used for powering the sets, oscillation at audio frequency was common. That could not be ascribed to blocking of the grids so the coupling between the transformers was blamed. The remedies usually suggested were to place the cores of the transformers at right angles, to ground the cores and the cases of the transformers and to place shields between them. Often it was suggested that a pair of transformer leads be reversed.

The efficacy of grounding and shielding was doubtful, except perhaps when the frequency of the oscillation was very high, but the reversal of a pair of leads usually stopped the oscillation or changed its frequency.

Blasting and distortion often noticed in those days were not attributed to blocking of the grids, but to resonance effects in the loudspeaker. It was not generally realized that much of this blasting was due to the same cause as the oscillation.

Lack of Filtering

The oscillation occurring in receivers powered with B battery eliminators was often attributed to lack of adequate filtering of the plate current supplied by the eliminator. But this view was untenable, for the same type of oscillation sometimes occurred with battery supply, in which the current was steady. Also in some cases when another filter section was added the oscillation started or became much worse than it was previously.

Oscillation at Radio Frequency

When oscillation started at radio frequency the trouble was attributed to coupling between the various stages of RF amplification, and rightly so. It seems queer that when the cause of oscillation at radio frequency was so well understood that so many untenable explanations should have been offered for oscillation in the audio amplifier. The cause of oscillation is the same no matter what the frequency may be. It is feedback from one stage of the circuit to a previous stage in the same frequency level. The route by which energy was fed back is not the same in all cases but that does not defeat the principle.

Cause of Oscillation in AF Amplifier

The casue of oscillation in an audio frequency amplifier is feedback through that portion of the circuit which is common to two or more of the audio frequency stages. This portion has been called the common impedance, and it will be so referred to in this article.

When the oscillation occurs at a frequency below the directly audible limit it is usually called "motorboating" because of its similarity in sound to the put-putting of the exhaust of a motorboat engine. When the frequency of the oscillation occurs at a directly audible frequency it is called a hum, or howl or a shriek, depending on how high is the frequency. If the frequency is of the order of 5 cycles per second or slower it is often called flutter, or even fading. Sometimes the oscillation may be of a very high or even super-audible frequency. It may then be mistaken for a heterodyne whistle.

May Have Any Frequency

The oscillation in the audio amplifier caused by the common impedance may have any frequency from zero to at least 20,000 cycles per second. The actual frequency in any receiver would depend on the type of coupling used in the amplifier, on the number of stages, on the connection of the transformers, if transformer coupled, and on the type of common impedance causing the trouble.

No type of plate supply is exempt, except possibly a storage plate battery. All other devices will have enough impedance to cause oscillation if the amplification in the receiver is high enough. Even if the common impedance and the amplification are not high enough to maintain an oscillation they may be high enough to cause serious distortion of the signal and severe blasting on certain notes. The frequency at which blasting and overloading occur is that at which oscillation would occur if the amplification were a little higher, or very nearly equal to that frequency.

When Blocking of Grids Occurs

While blocking of the grids is not the cause of oscillation in an audio frequency amplifier, it may be a result of it. This of course only arises in circuits which have stopping condensers in the grid circuits and grid leads. The blocking occurs because the amplitude of the oscillation is very high or because the amplitude of the signal voltage on blasting peaks is very high.

Sometimes it is said that the radio frequency signal causes oscillation in an audio frequency amplifier. It cannot be said logically that it causes oscillation, but it may well start audio oscillation. This is done by a sort of trigger action. An oscillation of any kind cannot start of itself. It must be started by an impulse. A radio frequency signal may be such an impulse. Also the fluctuation in the plate voltage supply due to inadequate filtering may be the trigger which sets it off. An audio frequency signal may do the same thing, particularly a signal of the frequency of the oscillation. But none of these triggers is necessary, for there are innumerable disturbances about a sensitive audio frequency amplifier which will start the oscillation.

Amplification Suppression

The feedback through the common impedance does not always produce oscillation in an audio amplifier. Sometimes it causes a suppression of the amplification, that is, renders the amplifier less effective. When that is the case the circuit is stable.

But that does not mean that the amplifier is faithful to the impressed signal.

The suppression will not be the same for all the frequencies. It may be high for the low notes, depressing the amplification to the point where these notes are almost absent. At the same time the depression may be nil at the higher frequencies. Or the amplifier may be such that the high notes are depressed and

or Break Audio Stability

Anderson

Editor

the low notes are brought out with normal volume.

The common impedance always produces distortion in the amplifier. Therefore every amplifier with its power supply should be so designed that the common impedance is as low as possible.

Nature of Common Impedance

The common impedance is very seldom a simple thing. In the case of a B battery it is usually a pure resistance shunted by a certain amount of capacity. This is the simplest case met in practice. In a B battery eliminator it may be a pure resistance at one frequency, a condenser at other frequencies, and an inductance at still other frequencies. When an output potentiometer is used in an eliminator for suitably dividing the voltage not all the tubes share the same impedance. All of them will be on a part of the impedance of the eliminator but other tubes in the circuit will share additional impedances.

The distribution of the impedance of the B battery eliminator and the output potentiometer is so complex that it is impossible to predict in the general case what the effect might be. To consider the problem it is necessary to simplify the case as much as possible. When the principles involved are understood in the simpler cases they can be applied qualitatively to the more complex cases and steps taken to avoid detrimental feed-back.

Common Grid Impedance

In many complex circuits there is not only a common plate circuit impedance but also a common grid impedance. The effect of this is similar to that of the common plate impedance. But the coupling between the grid circuits may at times partly neutralize the coupling between the plate circuits.

Resistance Coupling Simplest

We shall first consider the resistance coupled amplifier, for that is the simplest and at the same time most subject to oscillation as the result of a common impedance, Fig. 1 is such an amplifier having only two tubes. E0 is the input voltage, $\mu 1$ and $\mu 2$ are the amplification constants of the two tubes, r1 and r2 the internal plate AC resistance of the two tubes, Z1 and Z2 the coupling resistors in the plate circuits, R1 the grid leak resistance, C1 the coupling condenser, E2 is the output voltage and Z is the common impedance which causes all the trouble.

The signal voltage Eo will cause a signal current to flow in Z1 and in Z. The input voltage to the second tube is very nearly equal to the sum of the AC voltage drops in Z1 and Z. The input to the second tube causes a signal current to flow in Z2 and in Z. This current is much greater than that which flows in the first plate circuit, and it flows through Z in the opposite direction.

Overwhelming the Cause

Thus the sum of the voltage drops in Z1 and Z is less when the plate current of the second tube flows through Z than when it does not. Hence the feedback is such as to reduce the amplification. And this reduction is greater, the greater the amplification in the second tube and the larger the value of Z. This circuit is therefore stable and not subject to oscillation. Exceptions will be brought out later.

If the value of Z1 is very large in comparison with the value of Z, the feedback of the second tube current through Z will not have as great effect in reducing the amplification as when Z1 and Z are of the same order of magnitude. This is true even though increasing Z1 increases the amplification of the circuit. Hence one method of reducing the effect of the common impedance of given value is to increase the value of the coupling resistance. This overwhelms the cause of "motorboating."

As long as the impedances concerned in Fig. 1 are pure resistances the reduction in the amplification by the feedback through Z is the same for all frequencies. But the stopping condenser C1 is not a resistance, and its impedance varies with frequency. Hence the feedback through Z will not be the same for all frequencies.

But the change from the pure resistance condition depends as much on the value of the grid leak resistance as on the capacity of the coupling condenser.

Effect of Stopping Condenser

The direct effect of the stopping condenser is to suppress the amplification on the low notes. The lower the frequency the greater the suppression. Also for a given size of stopping condenser the smaller the value of the grid leak, the greater the suppression in the low note amplification. This effect has much to do with "motorboating."

An indirect effect of the stopping condenser is to change the phase of the current in the plate circuit of the second tube with reference to that in the first tube. This effect also depends as much on the resistance R1 as on the condenser C1.

When all the impedances involved are pure resistance the signal current in the plate circuit of the second tube is directly in opposite phase to the signal current in the plate circuit of the first tube, and the suppression of the amplification is maximum. If the stopping condenser and grid leak combination introduces any phase shift the second plate current will no longer be exactly in opposite phase with the first plate current, and the suppression in the amplification by feedback will be less. Thus the phase shift effect and the stopping effect partly neutralize each other.

Nevertheless the phase shift plays a very important role in slow frequency motorboating in resistance coupled amplifiers having three or more tubes.

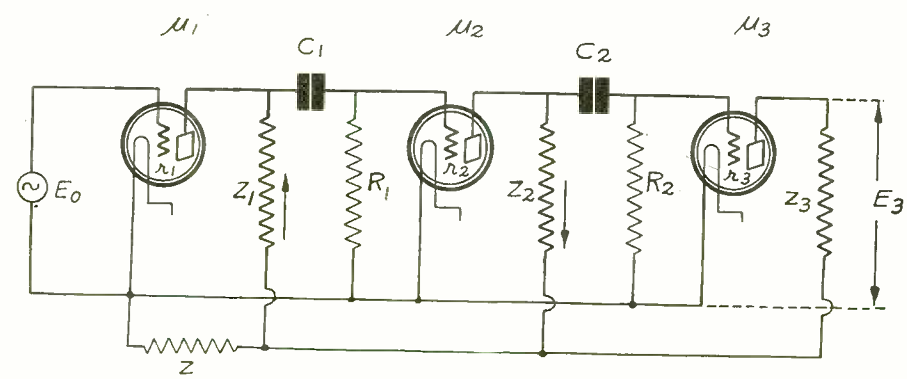


FIG. 2
A THREE TUBE RESISTANCE COUPLED AMPLIFIER ILLUSTRATING HOW THE FEED BACK OF THE SIGNAL CURRENT IN THE PLATE OF THE THIRD TUBE THROUGH THE COMMON IMPEDANCE Z CAUSES AN INCREASE IN THE AMPLIFICATION AND GIVES RISE TO INSTABILITY.

Three Tube Circuit

Fig. 2 shows a resistance coupled amplifier having three tubes. The meaning of the symbols used in connection with this circuit is the same as in Fig. 1. The subscript 3 is used to denote impedances and constants in the third stage.

The same arguments as were used for the two tube circuit apply to any two adjacent tubes in this circuit. It follows that the same conclusions hold. The plate signal current of the second tube feeding back through Z reduces the amplification because the second current is opposed to the first. Likewise the third plate current opposes the second and thus reduces the amplification when it flows through Z.

But it will be observed that the plate signal current in the third tube is in phase with that in the first tube. And the third plate current will be many times greater than either the first or the second plate current, depending on the amplification by the tubes.

Thus the plate signal current in the third tube flowing through Z will greatly increase the input to the second tube.

This increased input will be amplified by the second and the third tubes and the augmented will make the fed-back current still greater.

Oscillation at some frequency is quite likely due to this regeneration. The circuit is unstable, the unstability depending on the value of the common impedance Z and on the amplification in the tubes. With high mu tubes and usual coupling devises it only requires a small value of Z to start oscillation.

Phase Shift Effect

This circuit builds up the amplification on the higher frequencies where the effects of the stopping condensers are negligible. The stopping condensers suppress the amplification of the lower notes, just as C1 did in the two tube circuit. But there are two of them and therefore the suppression is about twice as great. The total phase shift is also doubled, that is the shift between the first and the third plate currents. For very low frequencies these two currents may not be in phase but they may actually be in nearly opposite phase. In that case feedback will be negative and the low notes or the sub-audible frequencies will be

(Continued on next page)

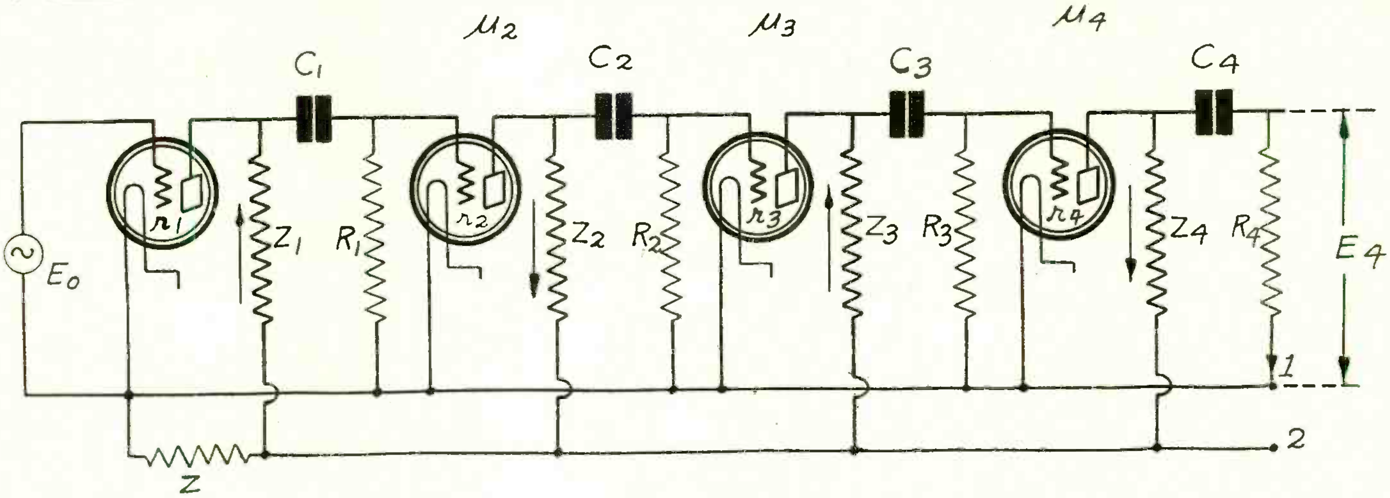


FIG. 3

A FOUR TUBE RESISTANCE COUPLED AMPLIFIER ILLU STRATING HOW THE SIGNAL CURRENT IN THE PLATE OF THE LAST TUBE WHEN FLOWING THROUGH Z CAUSES A DEPRESSION IN THE AMPLIFICATION AND INCREASING THE STABILITY. TWO METHODS OF CONNECTING THE SPEAKER ALSO SHOWN.

(*Continued from preceding page*)
suppressed by feedback as well as by stopping.

This three tube circuit will have a distorted characteristic. The lowest notes will be suppressed, notes somewhat higher will be amplified normally, and the high notes will be amplified more than normally, or they will be built up by regeneration. Oscillation may occur at about 16 cycles.

This applies to the circuit as drawn and when Z is a resistance. It does not necessarily hold for an actual three tube resistance coupled amplifier. In such a circuit there are complications which alter conditions.

Four Tube Circuit

In Fig. 3 a fourth tube has been added. Arrows have been put in the plate circuit of each tube to show how the signal current flows at some instant. It will be observed that the currents in Z1 and Z3 flow through Z in the same direction and toward the plates. At the same instant the currents in Z2 and Z4 flow through Z away from the plates. It is clear that more signal current flows through Z so as to reduce the amplification than so as to increase it.

This circuit is therefore stable and will not readily oscillate.

It may be stated generally that an amplifier with an even number of plate circuits on the same common impedance is stable and one with an odd number of plate circuits is unstable. This rule is upset to a certain extent by the effects of the stopping condensers, the by-pass condensers and by the load inductance.

A four tube circuit like that shown in Fig. 3, as it is ordinarily used, may motorboat or oscillate at one of two frequencies. One is a high pitch squeal and the other is usually a sub-audible oscillation or from one to five cycles per second.

The squeal can be removed very easily by adding more capacity across Z.

Stopping the Oscillation

The low frequency oscillation, which is caused by high effective amplification of the circuit and by the phase shift introduced by the stopping condensers, is more difficult to overcome.

Condensers that are connected across Z are useless at such low frequencies and remedies must be based on phase shifting or reduction in amplification at the low frequencies, or at all frequencies.

Decreasing the capacities of the stopping condensers usually stops the low frequency motorboating because it suppresses the amplification of these frequencies. This it does without seriously affecting the amplification of the audible notes.

Reduction in the grid leak resistances has a very similar effect to reducing the coupling condensers.

The phase shift also enters to affect the oscillation when the stopping condensers and the grid leaks are reduced. A slight change in the value of either a stopping condenser or of a grid leak may change the phase of the last plate signal current until the low frequency oscillation stops, or it may shift the frequency of oscillation to a much higher value where it can be stopped with bypass condensers.

Connection of Load Circuit

The nature and connection of the load circuit have a great deal to do with the stability of an amplifier in which all the tubes derive their plate voltage from a common source. If a circuit motorboats the oscillation sometimes can be stopped by making a slight change in the connections of the load circuit, that is of the loudspeaker.

Assume that the circuit in Fig. 3 is a typical resistance coupled audio frequency amplifier. Eo is then a fictitious signal voltage introduced into the grid circuit of the detector by the process of detection. Also assume that the impedance Z4 is that of a high inductance choke coil. Let C4 be the stopping condenser in series with the loud speaker and let R4 be the impedance of the loudspeaker. All the plate circuits are assumed to be connected so that Z is common to all.

If R4, that is the loudspeaker, is connected to point (1) the signal current passing through the speaker does not pass through the common impedance Z. Hence the four tube circuit, as far as feedback through Z is concerned, becomes a three tube circuit. If the loudspeaker is connected to point (2) the signal current through the speaker also passes through the common impedance and the circuit is a typical four tube circuit with respect to feedback.

It is obvious that the circuit will not oscillate at the same frequency for both connections.

Low Note Behavior

When No. 2 connection is used the oscillation may be at a very low frequency or at a very high. When No. 1 is used it may oscillate at a medium or low audible frequency. Or the circuit may oscillate in one case and be perfectly stable in the other. Of the two connections No. 1 usually gives less trouble, greater output for the same input, and more even amplification.

The behavior of this circuit on the No. 1 connection largely depends on the effective inductance of Z4 and the value of the capacity C4. The smaller Z4 is, the more current will flow through the common impedance. Also the smaller C4 is, the more will flow through Z. The effect of small Z4 and C4 is greater the lower the frequency. Hence for the very lowest frequencies both connections are about the same as far as feedback through Z is concerned.

But the feedback stabilizes the circuit at the low frequencies. Therefore it is desirable to have a little energy go back to stop any possible oscillation on the low sub-audible frequencies.

But the inductance of Z4 and the capacity of C4 should both be large so that the lower audible notes are not suppressed.

Based On No Phase Shift

The above conclusions were largely based on no phase shift at the lower frequencies. But the shift is considerable and may amount to a complete reversal of the last current with respect to the first. This reversal of phase gives rise to an oscillation of 5 cycles per second or less. To reduce the phase shift in the region where the amplification is considerable large stopping condensers should be used and high values of grid leak. Increase in these values often stops the low frequency oscillation. In fact there is nothing more effective in doing it except putting the various tubes on separate plate voltage supplies, which amounts to eliminating the common impedance.

Previously we concluded that small stopping condensers and low values of grid leak would be beneficial. Now we concluded the exact opposite. Both follow from the effects of these values on the phase shift and on its effect on the feedback. Both should be tried in cases of trouble. The simplest way to change the phases of the currents is to change the grid leaks since they can usually be changed by merely inserting other resistors in the clips.

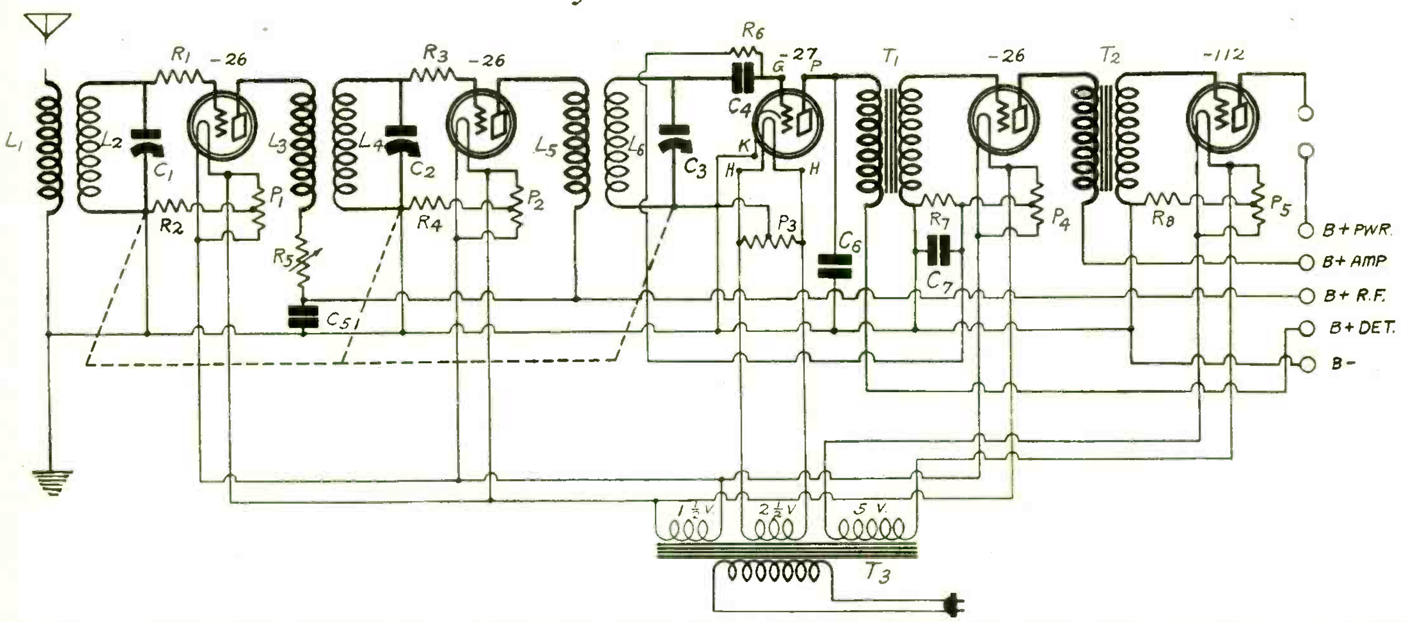
For some reason the term phase as used in electrical practice refuses to become naturalized in the minds of some radio fans. As soon as an article contains the term it is thought to be abstruse and only fit reading matter for trained engineers. But there is no good reason for thinking so. Phase is really a simple conception.

Suppose two pendulums of two identical clocks are swinging side by side, say on an east wall. The two pendulums will swing back and forth in a north-south plane. If the two swing north at the same time and reach the farthest point at the same time they are in exactly the same phase. They pass through the lowest point at the same time and at that time they move in the same direction. They also reach the farthest south point at the same instant.

[PART II, conclusion, next week, issue of May 19.]

Positive Bias for AC Detectors

By Humbolt Pratt



IN AN AC OPERATED RECEIVER A POSITIVE GRID BIAS CAN BE GIVEN TO THE GRID OF THE —27 TYPE DETECTOR BY CONNECTING THE CATHODE TO THE NEGATIVE SIDE OF THE POWER SUPPLY AND THEN CONNECTING THE GRID LEAK RETURN TO THE HIGH VOLTAGE END OF ONE OF THE GRID BIAS RESISTORS. (R7 ABOVE.) THE POSITIVE BIAS ON THE DETECTOR THEN HAS THE SAME VALUE AS THE NEGATIVE BIAS ON THE FIRST AUDIO AMPLIFIER.

IN receivers heated with alternating current and in which grid bias for the amplifiers is obtained from resistance drops care should be taken to insure that there be the least possible coupling between the various stages. The price of carelessness in this respect is hum and possible oscillation both at audio and at radio frequency.

The first requirement for hum elimination is that the grid returns be connected to the exact center points on the filament. A separate mid-tapped resistor should be used for each tube for this purpose, and each should be placed as close to the tube filament terminals as practicable.

There are two reasons why separate center-tapped resistors should be used. The first is that if a common resistor is used it must necessarily be placed at some distance from some or all of the tubes. This means long leads which may be of unequal length. Thus it may be that the same point will not be the electrical center for all the tubes connected to the resistor. The circuit would then be partly unbalanced and the hum would find its way into the signal. The other reason is that the common resistor would constitute a coupling impedance between the various tubes.

Separate Resistors Insure Balance

When separate resistors are used each can be placed next to its tube, the leads would be short, and the accuracy of the electrical center would depend on the accuracy of the resistor tapping alone. These usually are center-tapped very carefully.

As a further means of avoiding coupling between the various stages separate grid bias resistors should be used, and these too should be placed near the tubes which they serve in order to avoid long leads.

When both separate center-tapped resistors and grid leak resistors are used the only common coupling is the single winding which supplies the tubes with heating current. But this coupling is ineffective because the transformer winding is balanced just as the filaments. As a matter of fact, due to this balance, it can hardly be called a common impedance.

Values of Grid Bias Resistors

The value of each of the grid bias resistors for a —26 type tube should be 1,500 ohms. Thus R2, R4 and R7 should be of this value. This value is almost independent of the applied plate voltage so that no adjustments are necessary to adapt the grid bias to different plate voltages. The grid bias changes automatically.

The grid bias for the —112 type tube is given by resistor R8, which should have a value of about 1,200 ohms. This is correct whether the applied plate voltage be 135 or 157½ volts.

The heater terminals HH of the —27 type tube is also shunted by a center-tapped resistor. This is mainly done for the purpose of grounding the mid-point of the heater and making the average potential of it the same as the steady potential of the cathode, K.

LIST OF PARTS

L1L2, L3L4, L5L6—Three radio frequency transformers for .00035 mfd. condensers.
C1, C2, C3—Three .00035 mfd. tuning condensers on one control.
T1, T2—Two audio frequency transformers.
T3—One filament transformer with 1½, 2½ and 5 volt windings.
R1, R3—Two grid suppressor resistors.
R2, R4, R7—Three 1,500 ohm grid bias resistors.
R5—One 2,000 ohm wire wound adjustable resistor.
R6—One 2 megohm grid leak with mounting.
R8—One 1,200 ohm grid bias resistor.
P1, P2, P4—Three 20 ohm center-tapped resistors.
P3, P5—Two 50 ohm center-tapped resistors.
C4—One .00025 mfd. grid condenser without clips.
C5—One .5 mfd. by-pass condenser.
C6—One .0005 mfd. mica dielectric by-pass condenser.
C7—One 1 mfd. by-pass condenser.
Four standard push type sockets.
One —27 type socket.
Three —26 type AC tubes.
One —27 type heater tube.
One —112 type tube.

Positive Bias on Detector

Note carefully how a positive bias is obtained for the grid of the detector. The low potential side of the grid leak R6 is connected to the positive end of the grid bias resistor R7 while the cathode is connected to the negative end of the same resistor, which is at ground potential. Since a negative bias of 6 volts is given to the —26 tube under the operating conditions, a positive bias of 6 volts is given to the detector grid.

While R7 is common to the grid circuits of both the detector and the first audio tube the coupling between these circuits is negligible because the value of R7 is very small compared to R6 and also because one is working at radio frequency and the other at audio. But in order to minimize even this coupling a 1 mfd. condenser C7 is put across R7.

Instead of connecting the grid leak to R7 it could also be connected to the corresponding point on R4, that is to the mid-tap of potentiometer P2. A condenser of about .1 mfd. could then be connected across R4 to eliminate any coupling which would result between the detector and the second radio tube.

Note that the grid leak is in shunt with the tuned circuit. This is done to make it possible to put all the condensers on the same shaft without resorting to special insulation.

Volume and Oscillation Controls

Resistors R1 and R3 are put in the grid circuits for suppressing radio frequency oscillation. Each should have a resistance of about 600 ohms.

R5 is a variable wirewound resistance of about 2,000 ohms. It is used both for controlling the volume and for adjusting the tuned circuit to synchrony.

The AC Concertrola

By Leo Fenway

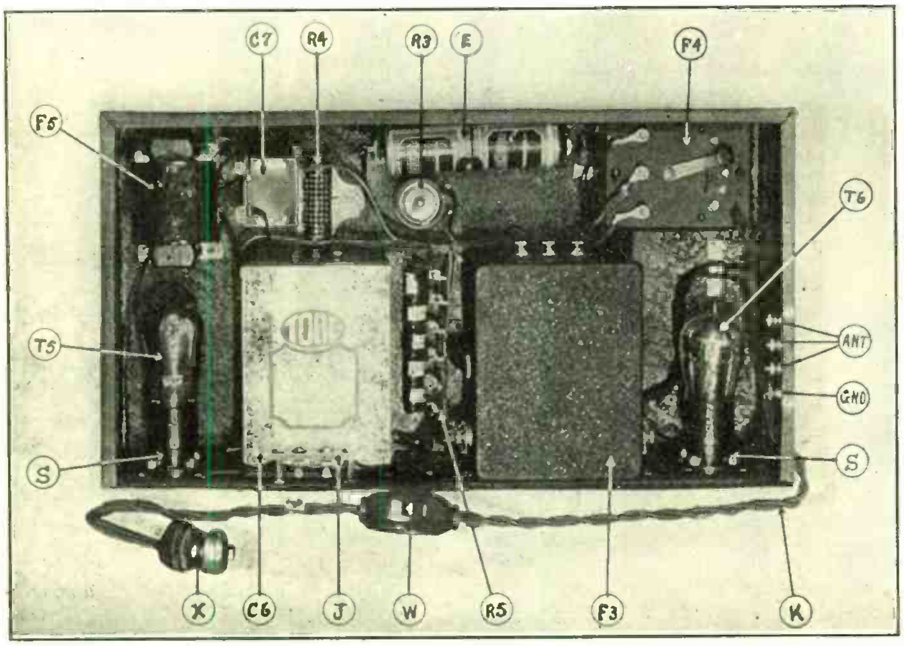


FIG 5

C6, TOBE 171 B BLOCK; C7, TOBE 2 MFD; R3, CARTER 75 OHM POTENTIOMETER; R4, ELECTRAD TRUVOLT, T-50; R5 THORDARSON VOLTAGE DIVIDER, 508-1; T5, 171 POWER TUBE; T6, RECTIFYING TUBE, BH TYPE; F3, THODARSON 171 COMPACT; F4, FENWAY CONCERTROLASTAT; F5, THORDARSON 30 HENRY CHOKE; S, STANDARD X-TYPE SOCKETS; J, TERMINAL BLOCK FOR SPEAKER; W, FEED-THROUGH SWITCH; X, LIGHT SOCKET PLUG; E, FLASHLIGHT CELLS.

[*The new Fenway AC Concertrola was discussed in the April 28 and May 5 issues. The following is the final instalment.*]

ENTERING the market just as interest in standardized radio parts was quickening, the Electric Concertrola became very popular, because it revealed what an electric set can be. And builders soon discovered that the set was electrically and mechanically sound. Moreover, they learned that the full measure of Concertrola merit could be summed up in four phrases—easy to build—remarkable on DX reception—economical to operate—quiet and dependable in performance.

It is easy to build because every effort has been made to make assembly as simple as possible. The triple-shielded metal case is all drilled for the parts listed in last week's article. It is remarkable on DX reception because, right in New York City, where receiving conditions are not all they might be, it reproduces on the speaker station from the far West, far South, and stations from all parts of Canada.

Because it consumes about as much current as a 50 watt lamp it is very economical to operate. And so, the set builders have conceded that the Concertrola is a good set. And when the custom set builders of the country speak of a good set, they use the term in an intensely practical sense. They award it only on convincing proof of power, volume, selectivity, quality, and most important of all, humless operation.

Backed by Experience

Most valuable of all the assets that can be applied to the creation of any product is a fund of successful experience. The Concertrola is particularly fortunate because of its association with the craftsmen of the industry. The reliability of Thordarson engineering assures the set builder that the power plant in his Concertrola will render unquestionable performance and quietness in operation. Tobe condensers—because of their effective insulation, freedom from leakage, compactness, accuracy, rigid construction, one could go on singing their praises without end, anyway, because Tobe knows how a power plant condenser should be made—are standard equipment in the Concertrola. What can be seen—visual value—figures largely in the success of any radio set. The more closely the set builder examines the mechanism and construction of any popular receiver, the more emphatically his confidence in standardized parts is confirmed. He knows that a set made up of Hammarlund condensers, Ferranti transformers, Electrad resistances, Mar-co dials, Carter products, and the like, merits a high rating. He knows all this because such men and such firms have brought their vast fund of radio experience to a sharp focus upon their work.

Because of the experience, the leadership, of these men, and because a standard circuit is used, the Concertrola is an inherently fine electric set—soundly conceived, brilliantly capable, and worthy to the utmost degree.

Some Intimate Details

Going back to last week's issue of RADIO WORLD, we find on the front cover a rear view of the set. Practically everything connected with that picture is outlined in the caption below. However, one or two things may be added.

The sockets are mounted with the "pin" towards the back of the set, that is, away from the panel. The condensers are insulated from the metal shelf by means of a small piece of bakelite, clearly visible in the picture. The condensers are also insulated from the Mar-co dial with a bakelite shaft. This method enables the dial to be grounded to the metal panel, which is desirable. The coils are not fastened close to the metal shelf, but are removed ¾ of an inch by means of metal bushings.

By looking closely behind the first and fourth tubes in the picture it will be noticed that the AC wires for the heater are brought up through metal tubes, which are built right on the metal panel.

Notice that flexible leads are used to carry the current from one tube to another, the reason for this method being used, is that all tubes are not the same height, some are slightly "taller" than others. In the same picture, the tubes appear in the following order: T1, first RF; T2, second RF; T3, detector, and T4, first AF. The second audio tube is located in the eliminator compartment, as shown in Fig. 5.

Coil Winding Data

The antenna coil is wound on two forms, one being 1¼ inches in diameter. Using No. 32 wire, enameled or silk covered, wound 120 turns. The primary has 17 turns of No. 24 enameled or silk covered wire on a 1½ inches in diameter, tubing of 1 inch axial length. The secondary form is 2¼ inches long. The antenna primary is tapped at the third, seventh and seventeenth turns. The interstage couplers are the same as the antenna coil, but untapped.

When home-made coils are used it might be well to install a small trimmer condenser for synchronizing the second radio frequency stage with the detector grid coil. This midget condenser should be a Hammarlund 7 plate, located on the front panel, between the volume control and the right-hand Mar-co dial. Connections are made from the rotor plates of the midget to the rotor plates of the double condenser, and from the fixed plates of the midget to the fixed plates of one section of the double condenser. Of course this trimmer condenser must be insulated from the panel. Even when perfectly matched coils are used, it is a good idea to incorporate this small condenser as outlined, since it aids materially in controlling volume.

A Hammarlund 85 millihenry radio frequency choke, in the detector plate lead, is optional; in some very stubborn cases, wherein the set oscillates too much, it ought to be uesd.

In the construction the F—post on each socket is grounded directly to the shield, which is correct. The grid condenser is firmly fastened to the terminal strip, far removed from the metal shield and from all parts. This is excellent radio practice, especially when constructing electric sets, because if this condenser is too close to metal parts the set is bound to hum a little.

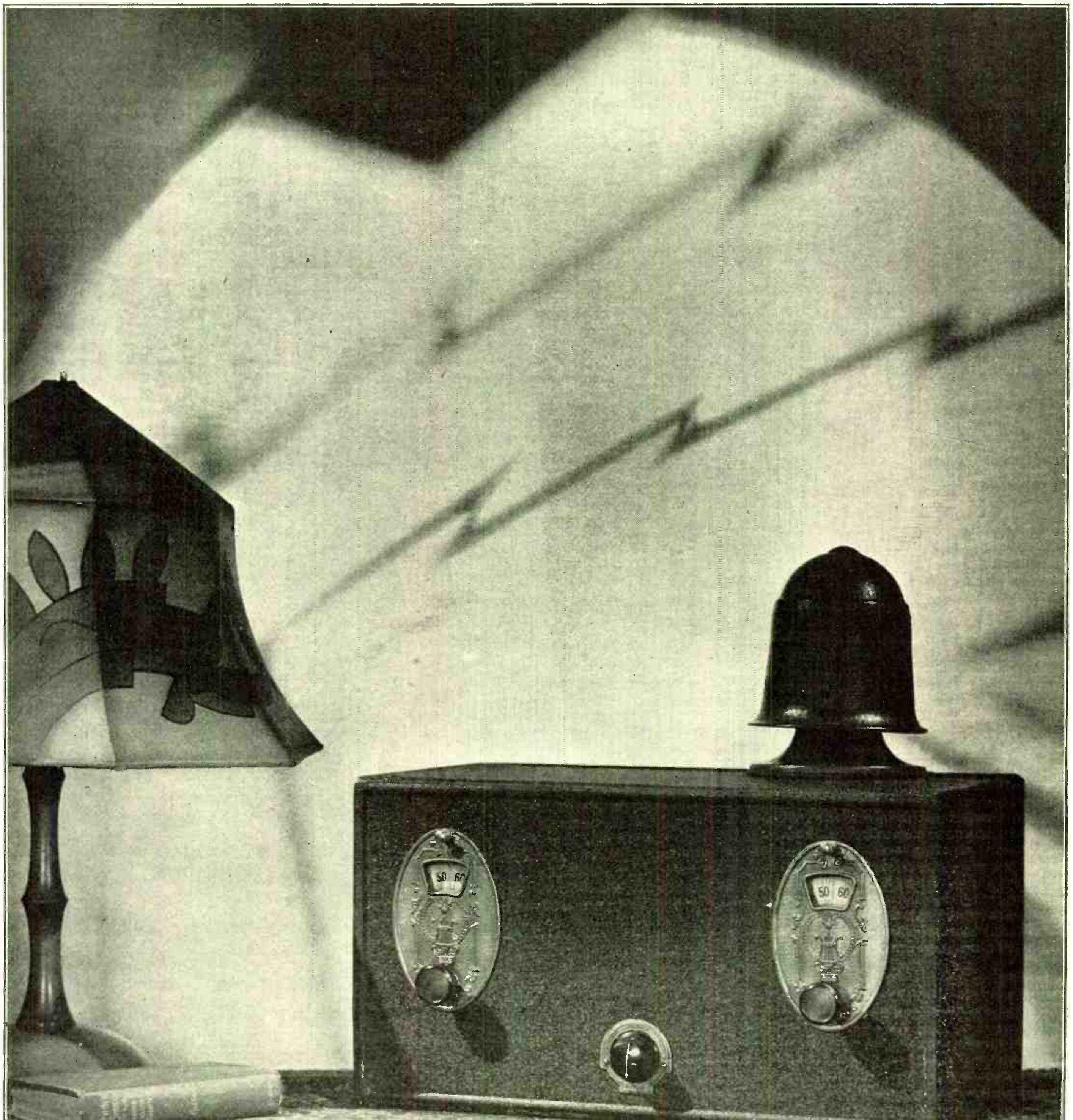
Words of Caution

Caution in wiring, caution in mounting the parts and caution in selecting the parts are the things which either make or break this set, yes, make or break any set. Trouble-free radio reception is the result of slow, methodical assembling and wiring in the early stages of the set. One could almost say that any set will produce fine results, provided that its builder has learned the first necessity of being careful when mounting the parts, careful in wiring and careful in connecting the set to the proper line supply.

In wiring the receiver, a well-tinned

(*Continued on page 22*)

The Fenway Set in the Home of a Futurist



The Right Place in Any B Su

By Bru

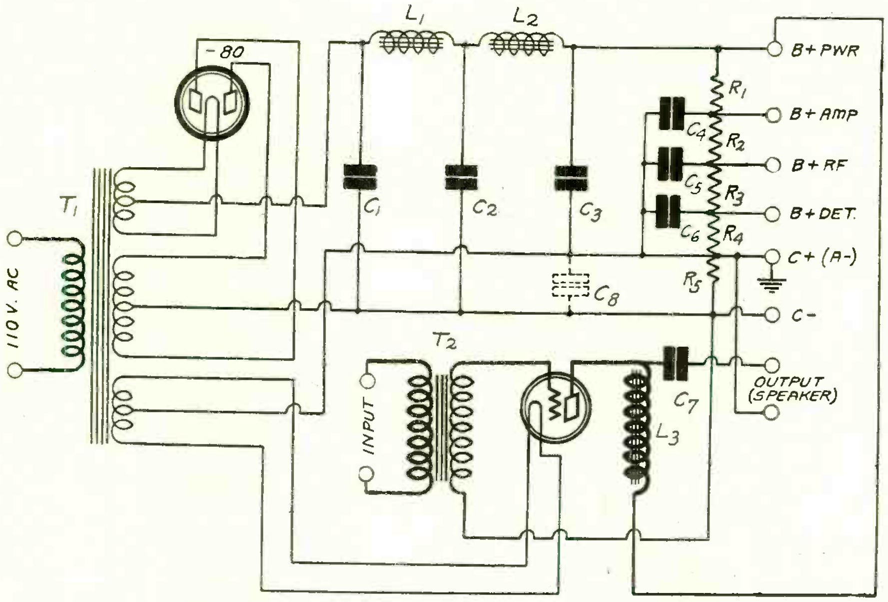


FIG. 1

HUM MAY BE GREATLY REDUCED, MOTORBOATING STOPPED AND LOW NOTE REPRODUCTION NATURALIZED BY CONNECTING THE LAST FILTER CONDENSER AND THE LOUD SPEAKER AS SHOWN IN THE DIAGRAM. WHEN THIS CONNECTION IS USED THE CONDENSER C8 ACROSS THE GRID BIAS RESISTOR R5 IS NOT ABSOLUTELY NECESSARY FOR IT HAS ONLY A MINOR EFFECT ON THE RESULTS. FULL WAVE RECTIFIER USED.

THERE have been many complaints that receivers operated with B battery eliminators hum. This trouble has been attributed to lack of filtering, overloading of the choke coils in the filter and to unbalance.

No doubt inadequate filtering and overloaded choke coils are responsible for the hum in some cases, but not in all. Often the hum is due to improper connection of the last condenser of the filter, of the loudspeaker, of the ground and of the receiver with respect to the eliminator. Connected improperly, even the best B battery eliminator will make any receiver hum.

Not only will the improper connection cause hum but it will affect the fidelity of the reproduction. The low notes in the signal may be suppressed to one-half the intensity that they would have if the proper connections were used.

What Should Be Grounded

It has been customary in B battery eliminators to ground the negative side of the circuit and then to insert a resistor in the line for given a negative bias to the amplifiers. This grounds the negative C instead of the filament circuit.

In battery operated sets it has always been held that the filament circuit or A battery should be grounded for best results. This is an experimental deduction, not a mere speculation. The same thing holds when B battery eliminators are used. The filament circuit be grounded for best results.

In receivers in which the power tube is heated with AC and the other tubes with DC it is possible to ground the filament circuits of all. And it should be done. Thus C plus, A minus and the effective B minus should be grounded. On the power tube the midpoint on the filament should be grounded, for this is plus C, minus B and zero A for that tube. This puts the ground where it ought to be for all of the tubes in the circuit.

The Last Condenser

The third, or last, condenser in the filter should not be connected to the negative side of the filter line as has been done in almost all cases in the past. It should be connected from the positive side of the line to the grounded point, where the ground is put as stated above. That is, the third condenser should be connected to the negative side of A and to the midpoint of the filament transformer on the power tube.

The loudspeaker return, in cases where choke and condenser type of output filter is used, also should go to the grounded point, that is to the same point that the third condenser is connected. When this connection of the third condenser and the loudspeaker return are used the signal current in the last tube does not flow through the grid bias resistor and there is no feed back from the plate of the power tube to the grid circuit of the same tube. Such feedback would cut the amplification down to half or less what it ought to be. This suppression is particularly severe on the low notes.

By-pass Condenser Unnecessary

If the third condenser and the speaker return were connected in any other way the signal current would be forced through the grid bias resistor there to mingle with the residual hum in the filter line. There is only one object of using the grid bias resistor, and that is to supply a

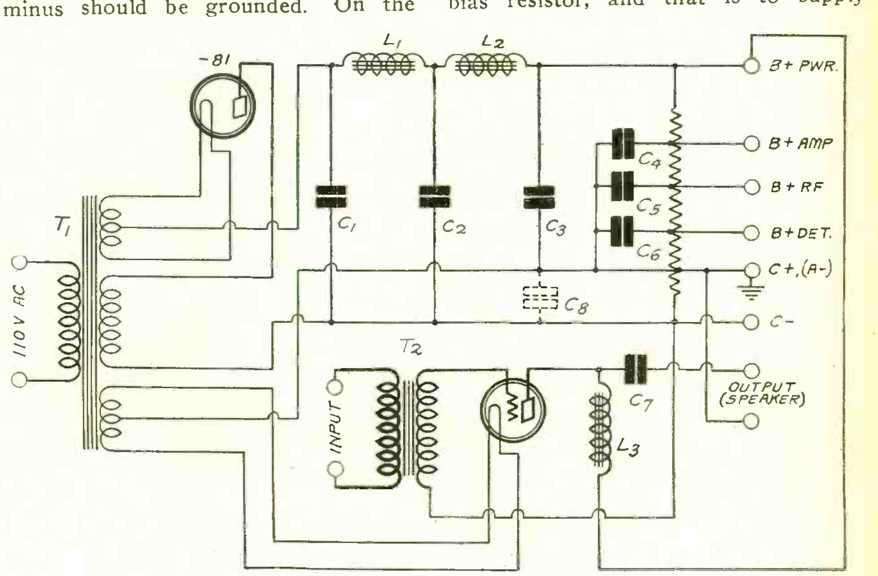


FIG. 2

THIS DIAGRAM SHOWS THE PROPER CONNECTIONS OF THE FILTER CONDENSERS, THE LOUD SPEAKER RETURN, THE GROUND AND THE GRID BIAS RESISTOR WHEN LEAST HUM AND BEST REPRODUCTION IS DESIRED WHEN USING A HALF WAVE RECTIFIER OF THE —81 TYPE.

to Connect Ground
pply for AC

ten Brunn

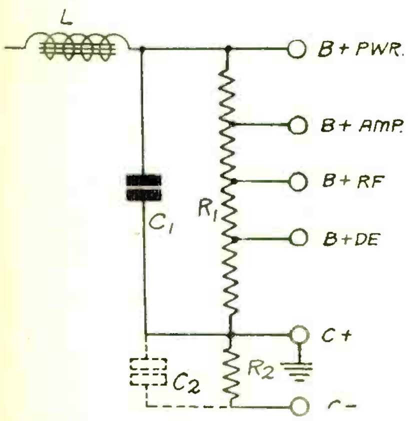


FIG. 2B

A SECTION OF THE CIRCUIT DIAGRAM OF A B BATTERY ELIMINATOR SHOWING THE PROPER CONNECTION FOR LEAST HUM. THE FINAL CONDENSER C1, C PLUS, A MINUS AND GROUND ARE ALL CONNECTED TOGETHER. CONDENSER C2 ACROSS THE GRID BIAS RESISTOR R2 IS OPTIONAL. IT IMPROVES LOW NOTE REPRODUCTION IF 6 MFD. OR MORE CAPACITY IS USED.

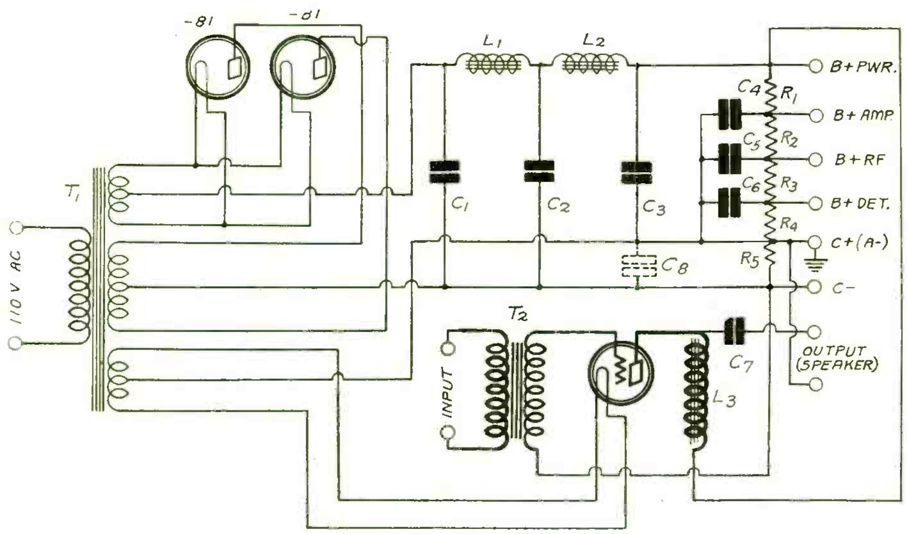


FIG. 3

WHEN A FULL WAVE TWO TUBE RECTIFIER IS USED THE LAST FILTER CONDENSER, THE LOUD SPEAKER RETURN AND THE GROUND SHOULD BE CONNECTED AS SHOWN IN THE DIAGRAM FOR LEAST HUM, BEST LOW NOTE REPRODUCTION AND LEAST TENDENCY TOWARD MOTORBOATING.

negative potential to the grid of the power tube. It should not be used as a common impedance between the grid and the plate circuit of the power tube, for such common impedance does not improve the operation of the circuit but it introduces distortion.

When the circuit is connected so that the signal current flows through the grid bias resistor the deleterious effects of it can be reduced somewhat by putting a condenser across it. But this condenser has to be very large in order to be effective at low frequencies. Unfortunately any condenser of a practical size is not large enough to have any appreciable effect at the lower audio frequencies, or even at the hum frequency.

When the circuit is connected so that the signal current does not flow through the grid bias resistor the by-pass condenser is not absolutely necessary for it has practically nothing to do. But if used it can do no harm and it may aid the operation of the circuit a little.

The type of rectifier has little to do with the connections. The rectifier may be of filament or gaseous type, it may be half wave or full wave. In the accompanying diagrams three different B battery eliminators are shown. One contains a full wave rectifier of the —80 type, another a full wave rectifier of the —81 type and the third a single wave of the —81 type. In all the third condenser is connected to the grounded point rather than to the negative side of the filter, and the ground is connected to minus A, the effective minus B and plus C. The speaker return is connected to the same point.

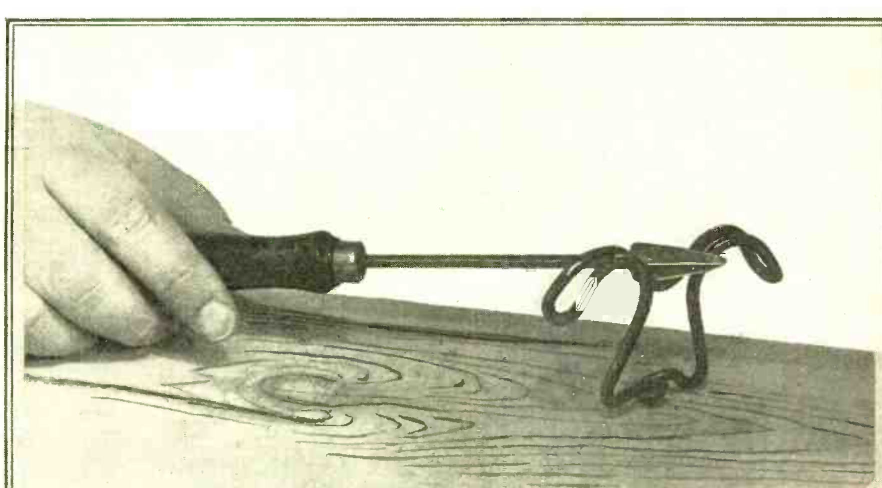
The connections shown in these diagrams have been found experimentally to give the best results both with respect to fidelity of amplification and with respect to minimum hum.

In these diagrams C3 is the third condenser which has been referred to as the last. C8, shown in dotted lines, is the condenser across the grid bias resistor R5.

Condensers C4, C5 and C6 which are connected to the various taps on the voltage divider are really supplementary to C3 and therefore they too should be connected to the grounded point. This is not done in other eliminator circuits, but they are connected to the negative side of the filter circuit, that is to C minus.

In some circuits the connections are so made that as far as the DC heated tubes are concerned the negative side of the filter is at the same potential as minus A on the amplifier. In that case the supplementary condensers should be connected down to C—.

LATEST FASHION FROM PARIS



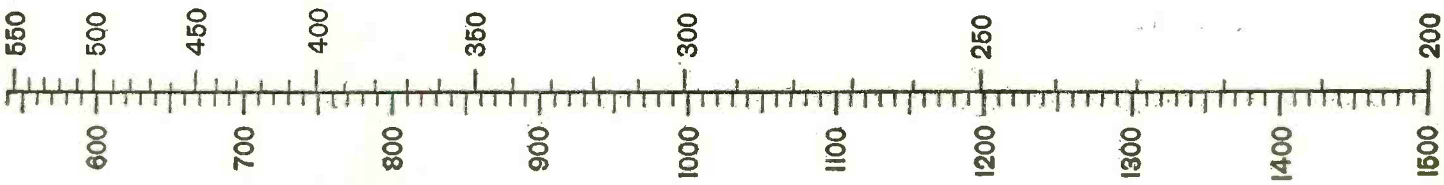
(Hayden)

CLOTHES HOOKS ARE NOW BEING WORN BY THE MOST FASHIONABLE SOLDERING IRONS. HOOKS OF THE FLAPPING WING DESIGN PREDOMINATE IN THE LATIN QUARTER

Frequency-Meter Conversion Scale

KILOCYCLE AND METER SCALE

This Scale is Reversible;—Thus—600 Meters Equal Approximately 500 Kilocycles or 500 Meters Equal 600 Kilocycles.



IN the early days of broadcasting, wavelengths were chosen fairly indiscriminately, within certain prescribed limits, and there was seldom interference between stations. But as time went on and the number of stations increased, it became evident that some definite system of allocation was essential in order to prevent stations operating on wavelengths so nearly alike as to cause "heterodyning" or interference one with another. The Geneva Conference was consequently formed, and representatives of American and European broadcasting companies met to deal with the difficult problem.

We generally speak of a station transmitting on a certain wavelength, but it would be equally correct to say that it used a certain frequency, and both figures are now quoted in the magazines and daily papers. The reason why frequencies are mentioned is that while a constant wavelength difference is not necessarily sufficient to prevent heterodyning, it is possible to arive at a frequency difference which will overcome the trouble. The Geneva Conference fixed the constant at a frequency difference of 10 kilocycles.

The use of kilocycles instead of wavelengths as a basis for allocations simplifies matters and obviates the need for decimals, but we are so used to "thinking in wavelengths" that the change to kilocycles is apt to be a little confusing. The accompanying conversion chart serves as a convenient reference, and will prove particularly useful to users of "mid-line" variable condensers.

For approximate calculation to obtain kilocycles divide 300,000 by the number of meters; to obtain meters, divide 300,000 by the number of kilocycles. For example, 100 meters equals approximately 3,000 kilocycles, 300 meters equals 1,000 kilocycles, 1,000 meters equals 300 kilocycles, 3,000 meters equals 100 kilocycles. The following table may be used for rapid and accurate conversion either from kilocycles to meters or meters to kilocycles.

For highly accurate conversion the factor 299,820 should be used instead of 300,000. The table below gives accurate values of kilocycles corresponding to any number of meters and vice versa. It should be particularly noticed that the table is entirely reversible.

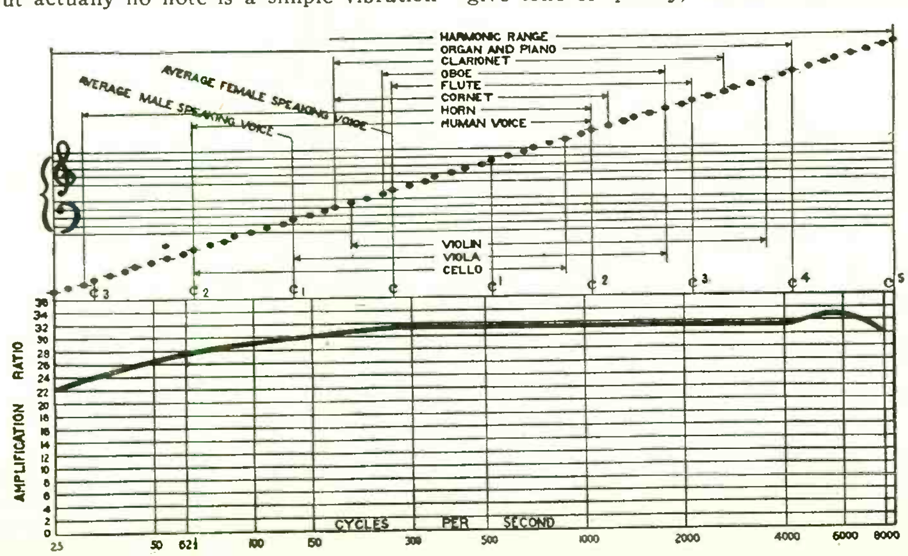
10	29980	160	1874
20	14990	170	1764
30	9994	180	1666
40	7496	190	1578
50	5996	190	1578
60	4997	200	1499
70	4283	210	1428
80	3748	220	1363
90	3331	230	1304
100	2998	240	1249
110	2726	250	1199
120	2499	260	1153
130	2306	270	1110
140	2142	280	1071
150	1999	290	1034
300	999.4	450	666.3
310	967.2	460	651.8
320	936.9	470	637.9
330	908.6	480	624.6
340	881.8	490	611.9
350	856.6	500	599.6
360	832.8	510	587.9
370	810.3	520	576.6
380	789.0	530	565.7
390	768.8	540	555.2
400	749.6	547.6	547.6
410	731.3	550	545.1
420	713.9	560	535.4
430	697.3	570	526.0
440	681.4	580	516.9
590	508.2	730	410.7
600	499.7	740	405.2
600	499.7	750	399.8
610	491.5	760	394.5
620	483.6	770	389.4
630	475.9	780	384.4
640	468.5	790	379.5
650	461.3	800	374.8
660	454.3	810	370.2
670	447.5	820	365.6
680	440.9	830	361.2
690	434.5	840	356.9
700	428.3	850	352.7
710	422.3		
720	416.4		

Screen Grid Voltage

The DC voltage applied to the screen grid tube's screen grid is usually recommended at 45, if the plate voltage is 135, but in some instances less than 45 volts works better, in other instances more than 45. A good plan is to connect a standard clarostat in series with B+ Amp. (usually 135 volts) and vary the setting until the voltage to the grid gives maximum volume consistent with stability.

Range of Audio from Thirteen Sound Sources

Sound is caused by rapid vibrations of air particles. The pitch of a note is fixed by the frequency, i.e., the number of vibrations per second. Instrumental notes have pitch frequencies from 25 to 3,500, but actually no note is a simple vibration of one frequency, but a combination of vibrations at frequencies which have a simple relation to one another. The lowest, called the "fundamental," gives the pitch, while the others, called "harmonics," give tone or quality, and cause the sound of one instrument to differ from that of another though producing a note of the same pitch. The frequency of the harmonics may be as high as 10,000 per second, and thus musical vibrations have a frequency range from 25 to 10,000.



Above the curve on this page is shown a musical scale corresponding to rates of vibration from 50 cycles to 8,000 cycles per second.

The audio amplifier in the Concertrola amplifies equally over the entire range.

The curve shows the amplification secured with a Ferranti AF-3 Transformer, using a tube having a resistance of approximately 19,000 ohms. It will be seen that the Type AF-3 Transformer gives remarkably even amplification between 100 and 6,000 cycles, and that it closely approximates the perfect curve over the entire range.

At a frequency as low as 50 cycles, the amplification ratio of the transformer, with a tube having the characteristics indicated, is slightly above 37. The effect of maintaining this high ratio over the lower frequency range is to bring out clearly the low tones of the organ, the bass orchestral instruments, kettle drums, the male speaking voice and other tones of low pitch, **which are never heard in radio sets using ordinary transformers.**

Radio University

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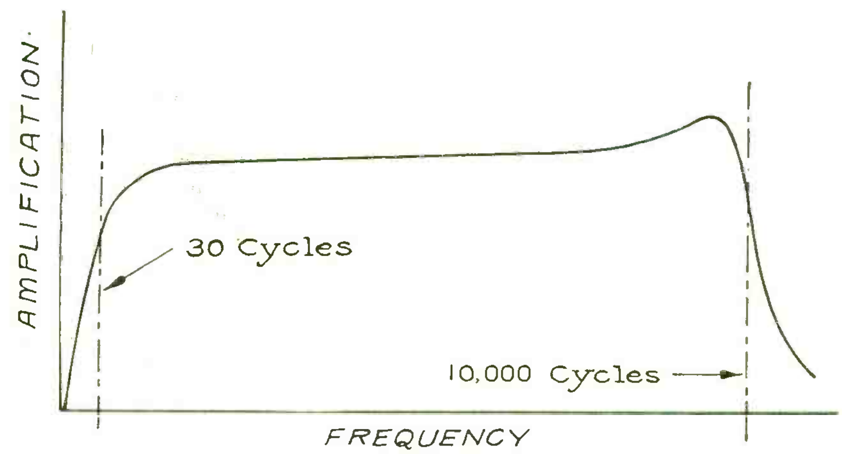

FIG. 616

THIS CURVE REPRESENTS THE AMPLIFICATION VERSUS FREQUENCY CHARACTERISTIC OF A REALLY FIRST CLASS TRANSFORMER. THE AMPLIFICATION IS PRACTICALLY UNIFORM BETWEEN 30 AND 10,000 CYCLES. IT IS NEITHER NECESSARY NOR DESIRABLE TO EXTEND THE STRAIGHT PORTION OF THE CURVE HIGHER OR LOWER THAN SHOWN IN THIS CHARACTERISTIC

PLEASE SUGGEST a simple method of eliminating motorboating in a resistance coupled amplifier.

(2)—Does motorboating have any connection with the size of the coupling condensers? If so what size is the best to use?

(3)—What should the coupling resistors and the grid leaks be to give best results?

(4)—What effect does the output filter have on motorboating?

BIRGER THORSON,
Bismarck, N. D.

(1)—The simplest way to eliminate motorboating is to use batteries in place of a B battery eliminator. The batteries need only be used on one or two of the resistance coupled amplifier tubes. The rest may be put on the eliminator. The same effect may be obtained by using a separate eliminator on one or two of the tubes in the AF amplifier.

(2)—The larger the coupling condensers are for a given value of the grid leak, the greater is the tendency to motorboat on very low frequencies. The condensers may be about .01 mfd.

(3)—The coupling resistors should be .25 megohm or larger for high mu tubes in order to get a high amplification out of the circuit. The grid leaks should be one megohm or more. Lower values will reduce the amplification on the low notes, and hence low values may be used to stop motorboating in an emergency.

(4)—The effect of the output filter on motorboating depends on how the loudspeaker is connected across the choke. If the loudspeaker and the series condenser are connected directly across the choke coil, the filter has no effect on motorboating. If the loudspeaker and the series condenser are connected from the plate of the tube to the filament, the effect depends on the sizes of the choke and the series condenser. The larger they are electrically, the less the effect on motorboating. They should be large.

* * *

I HAVE BUILT a high quality amplifier for phonograph reproduction and I use what I believe is one of the best pick-up units. The amplifier works all right on my radio set but it does not give good quality reproduction on the phonograph. There is a buzzing sound which is especially annoying on high notes and on fortissimo passages in the record. What might cause this trouble and how could I remedy it?

ALFRED F. ANDERSON,
Los Angeles, Calif.

The trouble is undoubtedly due to an unbalanced armature in the pick-up unit. It strikes the pole pieces and the jarring gives rise to the buzzing sound. Open up the unit and adjust the armature so that it is exactly in the center between the pole pieces. Also make sure that the unit is balanced on the needle when it is playing. This balance will prevent a recurrence of the unbalance in the armature. If necessary get a new unit which cannot be thrown out of balance so easily.

* * *

WILL YOU PLEASE EXPLAIN what is meant by the cut-off in an audio frequency amplifier or loud speaker? Does it mean that no notes above or below the cut-off frequencies can be heard?

2. What is the cause of the cut-off in amplification? Please explain very simply.

3. Does the cut-off frequencies have any relation to the radio frequency amplifier or tuner?

BRADLEY JONES,
Miami, Florida

1. The cut-off refers to the frequency at which the amplification or volume of reproduction takes a sudden drop. Below a low cut-off frequency the low notes are not amplified well, or the speaker does not reproduce notes well. Similarly above the high cut-off frequency the notes do not come through. The cut-offs may be very sudden or gradual depending on the construction of the amplifier and the reproducer.

In Fig. 616 is shown a transformer curve which indicates that the amplification falls off very rapidly below about 30 cycles and again at about 10,000 cycles. Between these two limits there is little variation in the amplification. This represents a first class transformer.

2. There are various causes for the drops in the amplification. The high cut-off is mainly due to capacity across the line. This may be the capacity of the transformer windings, the capacity of the tubes, and capacities connected for the purpose of cutting off the high frequencies. The low cut-off is largely due to insufficient load impedance on the amplifier tubes. For example, there may not be enough turns on the primary of a transformer, the core cross section may be too small, or the core may be made of unsuitable material. Choke coils across the line or stopping condensers in series with it will also contribute to the suppression of the amplification of the low notes.

3. The tuner tends to bring out the low notes better than the high. This is really brought about by suppressing the high frequencies. High selectivity produces this effect.

* * *

IN THE FOUR TUBE screen grid Diamond there are four binding posts near the right end of the subpanel, looking from the rear. Will you please state what each of these posts is for?

(2)—Is it necessary to shield the screen grid tube?

(3)—Is it necessary to use an output filter in the SG Diamond?

ROBERT DAVIS,
Pittsburgh, Pa.

(1)—The binding posts in the corner are for the loudspeaker. The third from the back edge is for the ground and the fourth is for the antenna.

(2)—It is advisable to use a Vac-Shield, Model 222.

(3)—It is not necessary to use an output filter unless a —71A or larger tube is used in the last stage.

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Industry Wants Slow Reduction of Stations

Washington.

More than 100 representatives of all branches of the radio industry met in a conference with the Federal Radio Commission for the presentation and discussion of the plan of broadcasting allocation submitted by the joint committee of the National Association of Broadcasters, the Radio Manufacturers' Association and the Federated Radio Trades' Association.

The plan was outlined to the Commission by the counsel for the three associations, Frank D. Scott. Specific details were expounded by William Hedges, of the Chicago "Daily News," chairman of the broadcasters' subcommittee, and R. H. Langley, of the Crosley Radio Corporation, of Cincinnati, Ohio.

The chairman of the manufacturers' subcommittee which drew up the plan was L. E. Noble, of the Federal Radio Corp., Buffalo, N. Y. The chairman of the distributors' subcommittee was Harold Wrape, of St. Louis, Mo.

Bases for Evolving System

Establishment is proposed of a broadcasting system which, Mr. Scott asserted, will "give greatly improved radio service." The goal should be attained "by natural evolution rather than by radical sweeping changes."

Mr. Scott described the joint plan as a "method of procedure" rather than a "completely evolved plan" for equal distribution of station licenses, power and frequencies, in conformity with the recently amended radio law.

A "common denominator" method of allocating licenses, powers and frequencies is suggested. The initial common denominator for licenses granted to the five zones, it is proposed, should be one-fifth of the existing stations, or approximately 140 to each zone.

It was urged that an "ideal" to be set as the goal by the Commission should be 110 stations per zone, or 550 in all, instead of the present total of nearly 700 stations throughout the country.

Present Power Divided

The industry recommends that the "common denominator" of power for each zone should not be less than one-fifth the aggregate power now used in all zones, but points out that even more power—perhaps up to 250 kilowatts for each zone—might be authorized. Wavelengths, it is proposed, should be classified in five groups, namely, those used in only one zone and those shared in two, three, four and five zones.

The "method of procedure" was laid before the Commission by Mr. Scott with the explanation that it was "extremely flexible" and permits of necessary changes—particularly as to the reduction of stations—gradually, rather than immediately.

Most of the members of the committee of engineers from the industry, which proposed a plan of its own to the Commission two weeks previously, were present at the conference. General discussion followed the presentation of the plan.

Terrell Asks Question

The supervisor of radio of the Department of Commerce, William D. Terrell, inquired how the plan would prevent heterodyne interference.

Mr. Hedges replied that the plan contemplated enabling stations to give interference-free service within their service areas but was not designed to prevent interference in the intervening area.

The question of good radio, said Mr. Hedges, is not the heterodyning that takes place outside the normal ranges of the stations. Mr. Noble remarked that the basis of the plan was the engineers' own plan, but stated the industry did not feel the "ideal" contemplated by the engineers should be approached too abruptly.

Opposition From Felix

Consideration of public interest rather that that of the stations, was urged by Edgar A. Felix, of "Radio Broadcast," who opposed the proposal. He warned against overcrowding wavelengths and said he was opposed to allocation based on a premise that a station serves only its high grade service area and not beyond.

Mr. Langley declared that, under the law, complete reallocation and improvement of service to the listener can not be effected at the same time.

He insisted that the industry's idea was to look toward establishment of better reception conditions without too sudden changes.

Revocation of licenses of stations which violate the radio law or the regulations of the Commission under the law was urged by the secretary of the Radio Protective Association, Oswald Schutte. He warned against letting broadcasting get into the hands of a monopoly.

Favors "Independents"

Precedence, he said, should be given "independent" stations, not affiliated by chains or license agreements or otherwise with large radio or electrical interests. He said the Commission could refuse licenses to companies operating stations whose practices conduce to monopoly.

Representing the American Federation of Labor, Edward N. Nockels, of WCEL, Chicago, asserted that all present stations have a right to exist and that the problem can be solved by divisions of time among stations. He declared the Commission should not adopt any policy of station reduction.

Joseph Gouston, of WAHT, Newark, N. J., advocated the separation of frequencies by six instead of 10 kilo-cycles, and a maximum wattage for any station of 10,000 watts. This power, he said, can be duplicated on the same wavelength without causing serious complications. He also urged greater divisions of time among stations.

Cleared Channels Advocated

The vice-president of the National Electrical Manufacturers' Association, Louis B. F. Raycroft, said that, in his opinion, 28 of the 39 stations now using 5,000 watts or more of power are entitled to exclusive channels. Without naming the stations he urged leaving them on their present wavelengths by themselves.

He saw no need, he said, for clearing more than this number of channels. Mr. Raycroft also advocated the use of the maximum amount of power on cleared channels.

The Commission was urged by Daniel G. Murphy, of WCAV, Philadelphia, to eliminate some stations.

Charles E. Campbell, president of the Comith Corp., Jersey City, N. J., operators of WKBO, pointed out that elimination of stations will mean financial loss to some stations. He proposed that the number of channels be increased to 130 by separating the major part of the broadcast spectrum by six kilocycles. He would also require all stations, regardless of size, to "Split time" three ways.

Louis G. Caldwell, representing WGN-WLIB and four other stations in the Chicago area, suggested a specific definition of "public service." Under such a definition he proposed elimination of portable stations, all stations under 50 watts not equipped to give radio service of merit, and all which use separate call letters but the same transmitter.

"Common denominator" procedure proposed in the industry's plan, he said, should be followed because it is flexible, reduces to a minimum the danger of extensive litigation and permits of the elimination of stations gradually "for cause."

George C. Furness, of the National Carbon Co., New York, supported the industry plan, asserting it was not seriously at variance with the engineers' recommendations. It involves a minimum possible litigation and a minimum of frequency changes in the existing structure, he said.

Wants 50 Cleared Channels

Robert H. Marriott, of New York, consulting radio engineer, a member of the committee of engineers which had previously submitted a plan, declared the engineers were convinced that 50 cleared channels were needed for the best quality of reception and the least interference. He opposed the proposed 6-kilocycle separation, asserting that 20 kilocycles was desirable as an ideal for obtaining the full musical range.

He urged power increases generally in order to overcome both artificial and man-made noise levels.

The final speaker was William Hedges, who had introduced the industry proposal. He asserted the report was not drawn to protect any vested interest, particularly as to its flexibility permitting higher power. He pointed out that its denominators did not contemplate simultaneous operations, but looked to reduced interference by reason of time divisions between stations.

Popularity Winners

UNCLE GEEBEE, WHOSE KIDDIE KLUB BROADCASTS EVERY EVENING AT 6:00 O'CLOCK THROUGH GIMBEL BROTHERS' NEW YORK STATION, WGBS, IS SHOWN AWARDING CUPS TO TOMMY SCANLAN AND SYLVIA CONNORS. THE WINNERS WERE SELECTED AS THE MOST POPULAR CHILD BROADCASTERS BY A VOTE OF THE RADIO AUDIENCE IN A BALLOT LASTING FOUR WEEKS.

NEXT WEEK—A very inexpensive B Supply that uses no step-down transformer; also full discussion of why AC detectors burn out.

High Power Held Vital for Cleared Channels

Washington.

To cut the wattage of a broadcaster on a clear channel is clearly an "outrageous waste of a precious public resource," O. H. Caldwell, a member of the Federal Radio Commission, wrote S. C. Dunning, General Manager, WICC, Bridgeport, Conn., in a letter made public by the Commission. Mr. Dunning had applied for an increase in power to 2,500 watts. The letter follows in full text:

"Answering your application for increase in power to 2,500 watts, let me call your attention to the fact that 2,500 watts would be an uneconomic power in the public interest, since it will consume an entire channel, so far as interference is concerned, and yet cannot be heard at a fraction of the distance as would the full power which might be used on such a clear channel.

"Under the circumstances, if any increase were to be granted, certainly larger power would be indicated in the public interest.

"This subject of adequate power for the efficient and economical use of our clear channels has been largely misunderstood by laymen not familiar with radio principles.

"We have only 90 broadcasting wavelengths or channels, and all stations to be licensed must operate on these. Two or more broadcast stations can use the same channel without causing interference only under the following conditions: Two 500-watt stations if 1,250 miles part; two 1,000-watt stations if 2,000 miles apart; two 2,000-watt stations if 3,500 miles apart; two 5,000-watt stations if 5,000 miles apart.

Channel Tied Up

"For, while a 500-watt station provides high-grade radio service for a distance of only 10 to 20 miles, it ties up its channel with carrier-wave interference for a distance 100 times as far, by causing a whistle and ruining reception of any other station located within a distance of 1,200 miles. Until we adopt generally new technical methods and refinements among stations, no escape from this waste appears in sight.

"In other words, to give good radio to a single county the authorities must reserve that wavelength or channel against any other station coming on within the surrounding circular area of roughly a million and a quarter square miles. This ratio of 300 square miles of useful area to a 1,250,000 square miles of normally wanted area—or through to 12,500—is the fundamental difficulty in broadcast allocation. No other communication medium or national resource is worked at such a low efficiency of use.

Why High Power?

"This simple engineering fact, the far-reaching waste area always surrounding the relatively tiny reserve area of every broadcasting station, explains why in the public interest, the power of every station on a clear channel should be increased to an amount, such that the service area will cover as large an area of populated continent as possible, while its proportional waste area is spread over the two convenient oceans.

"It also explains why there is a sharp limit to the number and power of stations which may share a single channel.

"For good radio, only three 500-watts stations can be placed in the continental United States on the same channel. If next we go to 1,000-watt stations, only two—on opposite coasts—can successfully share a channel. And this is about the limit of duplicating stations without heterodynes.

Needs Own Channel

"A 2,500-watt station should have a channel to itself. Our continent is not wide enough to permit a second such station without carrier-wave interference.

"But since the 2,500-watts station can give high grade service only for a radius of 25 miles, and yet ties up a whole wavelength, public interest demands that it should utilize that wavelength by giving service over as large an area as possible of the channel which its interference pollutes and makes otherwise unusable. Such a station should, therefore, be urged to go to 5,000 or 10,000 watts, or higher. In this way its useful service area is multiplied accordingly, while its interference area merely expands over the waste waters of the Atlantic and Pacific oceans.

"In fact, the public interest demands that stations occupying exclusive waves be required to have very high powers—instead of medium powers—which simply ruin a whole channel with interference and yet cannot be heard for many miles on it. In this respect, a 50,000-watt station is far more efficient in utilizing this public resource than is a 5,000-watt. A 100,000-watt station would give even better economy and public service, as experiments in New York State last summer clearly showed.

"The authorities, in the interest of public conservation, should actually require these high powers, were it not for the tremendous expense and investment involved which prevents many stations from using such powers.

"But certainly when the owners are willing, such powers should be encouraged, and broadcasters who offer to make the investment for the service and pleasure of the public should not be refused, nor millions of listeners denied the service and satisfaction which such high-power brings.

"To limit or cut the wattage of a broadcaster on a clear channel is clearly as outrageous a waste of a precious public resource as it would be to permit only water wheels capable of utilizing 10 feet or 20 feet out of the total drop of a 200-foot waterfall, while the remaining 180 or 190 feet of fall thundered away, wasted and unusable by any one else. No public official from any mountain state would dare stand before his constituents and demand such waste of a precious public resource.

Need Clear Channels

"We also need a number of clear or exclusive channels to bring radio programs to the 50,000,000 of our population who live more than 100 miles from any broadcasting station—on the farms, the plains, the mountains, and in the towns and villages. Without cleared channels these remote listeners will be deprived of hearing anything but a spectrum of squeals and howls, as they have mostly had for the past two years.

"Certainly, radio can have no greater usefulness than to serve these 50,000,000 isolated listeners. To reach them, we shall have to have a sufficient number of clear channels, and then sufficient power on those channels. Only by setting up a sound engineering structure can we hope to have the maximum of radio service under the present law, or accomplish our goal of delivering good radio programs to every home in America."

ANSWERS TO 7 SERVICE QUESTIONS

What have been the most frequently asked service questions in radio? Fada lists seven of them and the answers as follows:

(1) "The tubes in my set light up o. k. I have checked all accessories and still the set won't work. Why?"

In ninety-five per cent of such cases defective tubes are found, or rundown batteries, or eliminators not giving correct voltages, or broken connections.

(2) "What is wrong with my set when I get only four or five months' service out of B batteries when using a set from three to four hours a day?"

Nothing.

(3) "I put a power tube in my set last week and now the tube is no good. Why?"

Probably this is due to a defective tube. A question of this sort is asked in 27 different ways with regard to both six volt and AC tubes.

(4) "What type of antenna and ground should I install to obtain the best results?"

Considerable stress should always be laid on workmanlike installations.

(5) "I had my eliminator hooked up in accordance with instructions but still the set does not work properly."

The voltages as indicated by the manufacturer of the eliminator are not always the true voltages delivered to the set. Set and eliminator should, of course, be hooked up in accordance with the instruction sheets and then the voltages checked at the set with a high resistance voltmeter, while the set is operating.

(6) "I find it very difficult to tune in stations on the lower wavelengths." Or, "There is a lot of whistling noise, etc. with reception on the lower waves."

In some few cases the set is slightly out of balance and this can be remedied, but in the majority of cases the trouble is due to conditions on the air, heterodyning whistles, etc., and not to the set.

(7) "How can I get rid of this or that noise that interferes with reception?"

Mostly individual conditions must be dealt with. This is a service problem that no general rule covers.

Newspapers Request Short Wave License

Washington

The position of newspaper publishers who are anxious to make use of short-wave radio allocations for the transmission of news was explained to the Federal Radio Commission by representatives of the American Publishers Committee. Joseph Pierson of Chicago appeared on behalf of this Committee, which is composed of the New York "Times," The New York "World," The New York "Herald-Tribune," International News Service, Universal Service, "Christian Science," United Press Association, the Boston "Monitor," the Chicago "Tribune" and the Philadelphia "Public Ledger."

Others present at the hearing were: Joseph D. Costello, San Francisco, representing the Los Angeles "Examiner," International News Service and other Hearst publications: Louis N. Lobe and Fred E. Mineholtz, representing the New York "Times"; and Volney D. Hurd, radio editor, "Christian Science Monitor," Boston.

A THOUGHT FOR THE WEEK

TOO few say there are too many stations, too many say there are too few stations, few stations say they want to be one of the many, and many stations say they want to be one of the few. This is the problem the Federal Radio Commission is asked to solve.

RADIO WORLD

The First and Only National Radio Weekly

Radio World's Slogan: "A radio set for every home."

TELEPHONES: BRYANT 0558. 0559
PUBLISHED EVERY WEDNESDAY
(Dated Saturday of same week)
FROM PUBLICATION OFFICE
HENNESSY RADIO PUBLICATIONS CORPORATION
145 WEST 45TH STREET. NEW YORK, N. Y.
(Just East of Broadway)
ROLAND BURKE HENNESSY, President
M. B. HENNESSY, Vice-President
HERMAN BERNARD, Secretary
Kansas City, Mo.: E. A. Samuelson, 300 Coca Cola Bldg.
Los Angeles: Lloyd Chappel, 611 S. Coronado St.
European Representatives: The International News Co., Breams Bldgs., Chancery Lane, London, Eng.
Paris, France: Brentano's, 8 Avenue de l'Opera.

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TECHNICAL EDITOR, J. E. Anderson
ART EDITOR, Anthony Sodaro
CONTRIBUTING EDITORS:
James H. Carroll and Capt. Peter V. O'Rourke

SUBSCRIPTION RATES

Fifteen cents a copy. $6.00 a year. $3.00 for six months. $1.50 for three months. Add $1.00 a year extra for foreign postage; Canada, 50 cents.

Receipt by new subscribers of the first copy of RADIO WORLD mailed to them after sending in their order is automatic acknowledgment of their subscription order. Changes of address should be received at this office two weeks before date of publication. Always give old address; also state whether subscription is new or a renewal.

ADVERTISING RATES

General Advertising

1 Page, 7¼"x11"	462 lines	$300.00
½ Page, 7¼"x5½"	231 lines	150.00
½ Page, 8¼" D. C.	231 lines	150.00
¼ Page, 4⅛" D. C.	115 lines	75.00
⅛ Page, 4⅛" S. C.	57 lines	37.50
1 Column, 2¼"x11"	154 lines	100.00
1 Inch		10.00
Per Agate Line		.75

Time Discount

52 consecutive issues	20%
26 times consecutively or E. O. W. one year	15%
13 times consecutively or E. O. W.	12½%
4 consecutive issues	10%

WEEKLY, dated each Saturday, published Wednesday. Advertising forms close Tuesday, eleven days in advance of date of issue.

CLASSIFIED ADVERTISEMENTS

Ten cents per word. Minimum 10 words. Cash with order. Business Opportunities, 10 cents per word. $1.00 minimum.

Entered as second-class matter March 23, 1922, at the Post Office at New York, N. Y., under the Act of March 3, 1879.

2XE Now on 1,000 Watts

The power of the new Grebe short wave station 2XE, which is rebroadcasting the WABC programs on 58.5 meters, will be boosted to 1,000 watts on May 15. 2XE opened recently with a power of 250 watts. Before that time 2XE was used on 63 meters in conjunction with WGMU, the Grebe Mobile broadcasting station and WRMU, Marine broadcasting cruiser, also owned by that company.

R. C. A. TUBE PRICES LOWER

The Radio Corporation of America announced the suggested list price of Radiotron UX-112-A is reduced to $3.00, of UX-171-A to $3.00, of UX-226 to $2.50, of UY-227 to $5,00, and of UX-280 to $4.50.

The Modern Sesame

By Constance Collier

English Actress; former broadcast star in London; now featured in "Our Betters," a play in New York City

The Almighty took pity on human beings in out-of-the-way places and let us have the radio.

Farmers' wives in the great stretches of the land among the upper border of the United States lived frightfully lonesome lives. Now they have the concerts of the cities and all the entertainment features that we enjoy in the crowded centers.

Statistics show that for many years the percentages of suicides in the farm districts of the northwest of North America was something appalling, and it has now decreased to less than half. Lonesomeness was the cause and now radio has relieved lonesomeness and made the farmers' wives happy. This is true of all outlying districts throughout the length and breadth of this mighty land.

To the Far Corners

In every hole and corner of the earth there are radio receiving sets, and the best in arts, literature and music is given to all freely through the God-given power of radio. I suppose within the last few years it became the greatest power for good or evil that has been discovered by man in the whole world's history. One thought flying was the greatest achievement, until radio was invented, but the unknown voice that can speak out of the ether into the heart of your home is more wonderful still.

People who live in this generation are standing in history! A hundred years ago imagine the astonishment if anyone had said you could live beneath the sea, fly in the air like a bird and beyond all an unseen voice could speak to you across the world.

It is like magic! Indeed, like Aladdin's cave! But instead of "Open Sesame" the word is "Radio" and—lo and behold!—all the treasure of mind, art and inspiration, collected from the four corners of the earth, is yours by turning that little switch.

Aladdin Outclassed

There before you is a vaster wealth than Aladdin's wonderful jewels. The treasure of knowledge told you in the very voice and with the brain and mind and heart of the greatest men of our time.

Imagine how wonderful it would have been if Lincoln or Washington could have spoken to all America!

Perhaps if the radio had been in practical use we could have avoided the terrible World War.

If the great men and leaders of the different countries, friends and enemies alike, had been able to speak and exchange their views over the radio and the proletariat could have heard them, the whole world might have understood and perhaps averted the disaster, before it could even germinate.

The sound of a voice, the personal contact of mind, the quick thought, the inspiration of the moment, coming over the ether, is so much more vital than any written word. But alas—there were hundreds of miles between them and hundreds of days—and the written word is so cold.

The Wider Scope

What a brilliant generation will succeed us! Education of the finest type is within everybody's reach. With the aid of the radio, one can know music, deeply and truly, not with the superficial knowledge the majority possesses. One can have lessons in foreign languages, one can have a knowledge of poetry, one can keep "au font" with every vital question of the day, not the next day, but the actual day, as it is happening.

Think of radio's extraordinary significanc to the people who are suffering in hospitals and who are invalids. It colors their life afresh. And for the lonely farm men and women who live alone out on the prairies! They say it has saved many a one from madness. Out on the lonely desert they can have all the culture of the world brought into their little parlor.

How carefully it must be guarded with its capacity for good and evil! But humanity should see it is a power for good, for a better and truer understanding of life, for a sincerer appreciation of our fellow men and women, for a greater and more human understanding of the aims and ideals and difficulties of those who have the hardest task of all—the government of nations.

Better Understanding

It should teach us the rules and laws and constitution of the different countries.

Then each man and woman can help in the government of his country, upholding the laws they fully understand, and aid the men they have elected to rule our countries for the betterment of civilization.

People have rebelled in the past so often because they did not understand, but in the future all will be made clear. There is no question too obscure to be discussed and the greatest brains of our time can speak freely, so that we can understand. The heaviest responsibility will be on the men who control this unlimited power.

Weigh Each Word

When one speaks over the radio one is speaking into the minds of little children, of youth, filled with rebellions and enthusiasms; speaking also to ardent maturity and old wise men and women.

Every word should be carefully considered. There is a wonderful old saying in my country: "There are three things one can never recover or recall—the spoken word, the unkind deed, the neglected opportunity." Therefore, every word spoken should have some significance.

General Electric Spent $10,000,000 on Tests

Cambridge, Mass.

Radio developmental expenditures by the General Electric Company have totaled approximately $10,000,000 in nine years, E. P. Edwards, manager of the radio department of the General Electric Company, informed the Harvard Business School in the course of a talk on "Research and Manufacture in the Radio Art."

"It is our belief," Mr. Edwards said, "that research is the basis for successful quantity production and this is tangibly indicated by our developmental expenditures, which in 1919 amounted to but slightly over $100,000, while nine years later, or in 1927, they amounted to nearly $2,500,000."

Steel Aerial Masts Developed by Army

Washington.

A new type of steel mast for mobile army radio sets is under test at nine military posts, it was announced at the Department of War. The new mast is designed to replace portable masts of hollow spruce, which frequently collapsed because of weakness.

Ten models of a new tubular mast for portable antenna for the most powerful of the mobile radio sets in use in the army have been manufactured and sent to the following stations for a service test:

The Signal Corps Board at Fort Monmouth, New Jersey, Second Signal Company at Fort Sam Houston, Texas, First Signal Troop at Fort Bliss, Texas, Sixty-first Coast Artillery at Fort Monroe, Virginia, Fifty-second Coast Artillery at Fort Eustis, Virginia, Sixty-third Coast Artillery at Fort Winfield Scott, California, Langley Field, Virginia, Chanute Field, Illinois, Wright Field, Ohio.

Spruce Masts Unreliable

For the radio sets for which this mast was developed, it is necessary to provide an antenna system which is rather large in both ground area and height. In order to secure the required height for these antennas, an 80-foot mast must be used.

Heretofore there has been used a sectional mast made up of hollow spruce sections fifty inches long, having a steel tube coupling inserted between sections. The method of erection was to lift the mast bodily high enough to slip a section on to the bottom, this process being repeated until the desired height had been attained.

For mast heights up to forty feet this method has proven very satisfactory, but for the larger antennas described above it was found to have two serious faults. First, the weight of the larger mast was such that it was necessary to provide a derrick for raising the mast in order to insert the new sections, and second, the eighty-foot mast of this type was susceptible to rather frequent failure because of weaknesses.

The New Mast

In an attempt to overcome these deficiencies for the larger size antennae the Signal Corps has developed a new steel tubular mast. This is of 80 feet, made in sections eight and one-half feet long to facilitate transportation. The mast is completely assembled on the ground and then raised into position by means of a short gin pole and a block and tackle.

The mast is guyed in four directions. During erection the two side guys steady the mast, the front guys are fastened to the gin pole to lift the mast, and the rear guys arrest the movement of the mast at the vertical position.

The antenna forms an umbrella pattern with 12 wires. These wires are 98 feet long with a ball connector fastened into the mast cap. The other end is connected through four insulators in series to 150 feet of sash and cord rope.

Uses Counterpoise

Each antenna has a counterpoise instead of a ground. They are 175 feet long with ball connector fitted into a fixture near the bottom of the mast and the other end connected through four insulators in series to 60 feet of sash cord rope.

Upon completion of the tests, each organization will render a report covering the suitability of the equipment for adoption; disadvantages or defective features of the equipment; and suggestions as to improvements that may be made in the present design.

Enter the New Era of 5,000,000 Meg.!

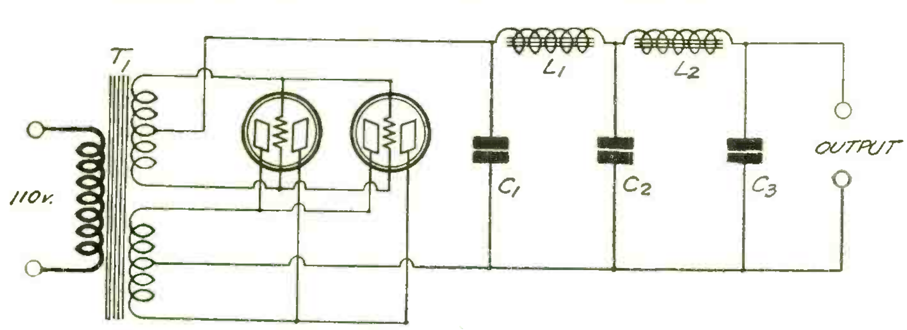
S. B. Darmstader, Western sales manager of the International Resistance Company, manufacturers of Durham resistors and Powerohms, is now traveling the West looking over the radio situation for the coming season.

Mr. Darmstader registers much enthusiasm over the new Durham power resistor line, known as Powerohms. In his talk with jobbers he states that, in line with demand created by radio television and other recent developments, his company is producing and marketing resistors of hitherto unheard of ranges, from 20 megohms to as high as 5,000,000 megohms. These units run as large as 24 inches in order to attain accuracy in the higher resistances.

TWO FORMS OF DISTORTION

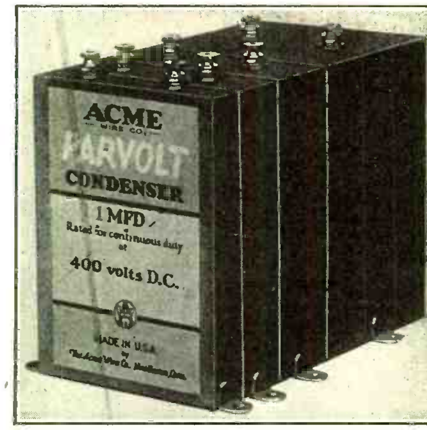
As the percentage modulation increases the production of harmonics of the modulating frequency by the detector increases. For this pianissimo passages in the signal comes over much clearer than the fortissimo passages. This distortion is independent from that introduced by overloading of tubes. The two forms of distortion are additive.

RECTIFIER TUBES IN PARALLEL



THE CIRCUIT DIAGRAM OF A B BATTERY ELIMINATOR IN WHICH TWO TYPE —80 RECTIFIER TUBES ARE CONNECTED IN PARALLEL TO IMPROVE THE VOLTAGE REGULATION OF THE CIRCUIT. CIRCUIT REQUESTED BY ROGER W. NORTON

NEW BASE MOUNT



THE UNIFORM SIZE AND SQUARE CONSTRUCTION OF THE ACME PARVOLT CONDENSERS PERMIT A COMPACT ASSEMBLY OF ANY NUMBER OF THEM. THE SUBSTANTIAL MOUNTING LUGS ARE PLACED AT THE ENDS WHERE THEY DO NOT INTERFERE WITH THE ASSEMBLY. THIS MOUNTING DEVICE IS A NEW FEATURE OF THE PARVOLT CONDENSERS.

Custom Set Club Gets More Prospects

More encouragement as to the popularity of a custom set builders' club, now forming, is offered by the fact prospective members still are asking that their names be listed, although no request has been published for such names for four weeks. Following are some of names and addresses of new applicants:

Vincent J. Hoier, 4343 Hirsch St., Chicago, Ill.
C. M. Merrill, 361 Wilhoit Bldg., Stockton, Calif.
J. W. Bannister, Delhi, Ontario, Canada.
Benjamin Snapper, 110 Wyona St., Brooklyn, N. Y.
Charles F. McCullough, 215 Meadow Lane, Edgeworth, Pa.
Santiago L. Coatza, Box 291, El Cajon, Calif.
Edward F. Holl, 179 Precita Ave., San Francisco, Calif.
Lester Lively, 6506 Curtis Pl., St. Louis, Mo.
C. L. Nolen, 637 W. 20th, Houston, Tex.
E. F. Lusk, 1701 E. Park Ave., DesMoines, Iowa.
A. J. Busicco, 330 Van Nostrand Ave., Jersey City, N. J.
W. F. Edwards, 2202 L, Galveston, Texas.
Kistler & Louttit, 2301 Bellfield Ave., Youngstown, Ohio.
Felix F. Januss, 9719 Flatlands Ave., Brooklyn, N. Y.
Earl O'Daniel, 431 So. Racine Ave., Chicago, Ill.
E. A. Holloway, 2338 Aqueduct Ave., New York, N. Y.
Harry C. Armstrong, 318 Crescent St., Long Island, N. Y.
Howard E. Innon, Wellsbury, New York.
M. J. Kennedy, 1314 McGee St., Kansas City, Mo.
J. J. McFaull, 2294 Washington Ave., Bronx, New York, N. Y.
Dave T. Bradford, 1822 Green Ave., Detroit, Mich.
Urban McLean, R. F. D. No. 1 Box 81, Butte, Mont.
H. Rumyer, 1835 Sycamore, Detroit, Mich.
T. G. Hall, 5300 4th Ave., Sioux City, Iowa.
H. L. Mischlich, 2744 Bedford Ave., Brooklyn, N. Y.
W. U. Enterline, 12 Lawrence St., Yonkers, N. Y.
Harold F. Zane, Box 291, Farmington, Iowa.
E. J. Shafer, Box 126, South Miami, Fla.
J. N. Schmiz, Y. M. C. A., Columbus, Ohio.
G. J. Stenzel, 97 Euclid Ave., Brooklyn, N. Y.
S. C. Bruce, 182 Meagher Ave., Toronto, Ont., Canada.
Wm. Hausell, Ottumwa, Iowa.
Jas. W. Urquhart, 280A Vestal Ave., Binghamton, N. Y.
Edward Svoboda, 22-58 41st St., Long Island City, N. Y.
W. C. Heilmann, 1854 Myrtle Ave., Brooklyn, N. Y.
L. A. Martin, 1622 Voorhies Ave., Sheepshead Bay, N. Y.
H. M. Blohm, 145 Van Wyck Ave., Brentwood Boro, Mt. Oliver, P. O., Pa.
C. J. Cook, 1716 Champaigan Ave., Mattoon, Ill.
A. L. Sutton, 1435 Liverpool St., Pittsburgh, Pa.
George G. Wise, N. Maine, Herndon, Pa.
John H. Bruck, 110 Carolina Court Apts., Seattle, Wash.
H. C. True, 808 Alvarado St., San Francisco, Calif.

Literature Wanted

THE names and addresses of readers of RADIO WORLD who desire literature on parts and sets from radio manufacturers, jobbers, dealers and mail order houses are published in RADIO WORLD on request of the reader. The blank below may be used, or a post card or letter will do instead.

RADIO WORLD,
145 West 45th St., N. Y. City.

I desire to receive radio literature.

Name ....

Address ....

City or town ....

State ....

L. A. Hunker, 2838 8th Ave., Long Island City, N. Y.
Rosymond Latten, 3 Clifton Ave., Ansonia, Conn
G. E. Rawson, 3068 S. 34th St., Omaha, Nebr.
David Zimmerman, 1308 Water St., Stevens Point, Wisc
E. P. Kohl, 300 Fidelity Bldg., Tacoma, Wash.
M. Moone, Poplar St., Mayfield, Pa
Joseph G. Blanck, 515 W. 158 St., New York, N. Y.
S. Seligson, 112 E. 19, New York, N. Y.
John P. Gawel, 30 Reservation St., Buffalo, N. Y.
Sam Nebb, 352 Glennview Ave., Brooklyn, New York.
Louis P. Gersch, 2815 Archer Ave., Chicago, Ill.
Frank C. Landa, 12 So. Reid St., Elizabeth, N. J.
W. L. Collier, Marionville, Mo.
F. W. Carr, 5846 McAndrews Dr., Oakland, Calif.
Charles Hecht, 4736 Pimlico Road. Baltimore, Md.
Earle E. Hazelton, P. O. Box No. 1064, Westwood, Calif.
Arthur Hunker, 498 Brook Ave., Bronx, New York, N. Y.
S. Tizian, 680 E. 139th St., New York, N. Y.
C. S. Lindgren, 1257 No. 8th St., Marshfield, Ore.
W. V. Hyatt, 1824 S. 54th St., Philadelphia, Pa.
Geo. Rieker, 613 Eisenbrown St., Reading, Pa.
Clarence C. Townsend, 246 Colman St., New London, Conn.
Peter Newby, 1937 W. 47th St., Cleveland, Ohio.
W. E. Houston, 1725 Milnor Ave., Jacksonville, Fla.
Thos Radio Shop, 336 Island Ave., McKees Rock, Pa.
H. A. Phillips, 117 Willow Plan, Oakmont, Pa.
E. C. Dickerson, Adrian, Mich.
W. S. Doyle, 1932 S. Salford St., Philadelphia, Pa.
A. I. Murray, 115 10th Ave., Dayton, Ky.
George A. Young, 6358 Linzee Ave., Detroit, Mich.
Harry Gronoff, 2827¾ W. Boulevard, Los Angeles, Calif.
Eugen Enteman, 78 22nd St., Irvington, N. J.
Charles A. Bouffier, 532 East 172nd St., New York City
George A. Rauh, 2 Lincoln Circle, Crestwood, New York
Walter Schaffer, 1918 Harcum Way, S. S. Pittsburgh, Pa.
Henry H. Koch, Jr., 48 West 120th St., New York City
James O. Vester, 303 Coolidge St., Paris, Tenn.
Geo. W. Smith, 447 Albermarle Rd., Newtonville, Mass.
Arthur A. Annis, 44 Warrenton St., Springville, Mass.
A. F. Stewart 205 Monroe St., Cleburne, Texas.
E. Cooney, 571 38th St., Oakland, Calif.
A. Salmon, 1468 Seabury Place, New York, N. Y.
R. G. Evans, 10337 Woodward Ave., Detroit, Mich.
Harry Gibson, 936 Highland Ave., Chester, Pa.
J. D. Avery, 1270 Dakota Ave., Huron, So. Dak.
Jack I. Ellerstein, 27 East Monroe St., Chicago, Ill.
John Leclaire, 482 64th Ave., West Allis, Wis.
Gus W. Law, 611 Cedar St., Rockford, Ill.
Fred J. Haas, 395 33rd St., Milwaukee, Wis.
Esthel R. Fish, 1312 Harmer St., Ft. Wayne, Ind.
R. W. Stone, 7538 American, Detroit, Mich.
Jack Goldstein, 1353 Sterling Place, Brooklyn, N. Y.
C. E. Fike, Roanoke Radio Co., Ahoskie, N. C.
G. W. Blackburn, 3723 Garrison Ave., Baltimore, Md.
William Petersen, Cedar Bluffs, Nebraska
W. A. Gilpin, Box 40, Mt. Washington, Mo.
Fred E. Dodge, Redfield, So. Dakota
O. D. McClure, 883 Preston St., Philadelphia, Pa.
A. F. Kroeger, 1536 Walnut St., Hillsboro, Ore.
Russell Thomas, 906 Jefferson Ave., Portage, Penna.

The Radio Trade

Thompson to Welcome Trade Show to Chicago

The Fourth Annual Convention and Trade Show of the Radio Manufacturers Association will be held at Chicago, June 11th to 15th, at the Stevens Hotel. Representatives of all branches of the industry—manufacturers, jobbers and dealers, and also broadcasters, 25,000 to 30,000 strong—are expected there.

C. C. Colby, of Canton, Mass., president, will preside at the opening, Tuesday, June 12th. Mayor Thompson will welcome the gathering. Among other speakers will be Ira E. Robinson, chairman of the Federal Radio Commission; Earle C. Anthony, president of the National Association of Broadcasters, and Harold J. Wrape, president of the Federated Radio Trades Association.

A great show is promised.

New Phonovox Pickup Announced by Pacent

A new magnetic phonograph pick-up, the Model 105-A Phonovox, complete with a balanced tone arm, mounting support, and volume control, is announced by Pacent Electric Company, 91 Seventh Avenue, New York City, pioneers in the development and marketing of the magnetic type device. The combined unit is the result of more than a year's research and laboratory work to determine the best applied weight for uniform coverage of the frequency range. It was found during this experimental work that the dead weight principle was the only way to apply a constant and exact weight to the record.

The new 105-Phonovox, with its balanced tone arm, is announced as 30 per cent. more efficient in coverage of the musical range than the original Pacent design. In addition, it is equipped with a new form of needle holder which takes either fibre or steel needles. The use of the fibre needle tends to reduce needle scratch greatly, and gives a much wider control of volume and tone range on certain records.

NATIONAL
Velvet Vernier Drum Dial
TYPE F

NEW in design, but with the familiar NATIONAL Velvet-Vernier Tuning. Made to USE and to last. Full 360 degree motion.

Visible portion of dial inclined upward for easier reading.

Easily attached. Ask for Type F.—Price $4. Type 28 Illuminator 50c

Send for Bulletin 121-RW

NATIONAL COMPANY, INC.
MALDEN, MASS. W. A. READY, President

NATIONAL
RADIO PRODUCTS

Boucheron Advises Year-Round Advertising By Manufacturers

Cambridge, Mass.

Pierre Boucheron, advertising manager of the Radio Corporation of America, addressing the Business Policy Class of the Harvard Graduate School of Business Administration, said:

"One-time successful manufacturers who advertised solely during the selling season and who stopped when business slowed up, or who did not advertise on a year-round basis, continuously, are today either far down the list of leading concerns or out of the running entirely."

For that A-C Tube Receiver!

You want the best results, of course. All right. Be sure to include line-voltage control, plate voltage control, proper grid leak, correct grid bias—in short use

CLAROSTAT
REG. U. S. PAT. OFF.

Do away WITH Crackling Static

Great news for RADIO FANS! At last, the even tones of phonograph-like reception are possible with this amazing SUBANTENNA. *It practically eliminates STATIC in all kinds of weather.*

SUBANTENNA completely replaces the old-style, up-in-the-air type of aerial, eliminates the lightning risks and all hazards so common with an outside antenna.

It filters the true-toned ground waves and diminishes all interfering noise. DX Stations come in with the volume and clarity of local broadcasts.

Astounding Results Guaranteed

Plan to enjoy your set all summer, under all atmospheric conditions and have better reception than you have ever known. The SUBANTENNA challenges any type of aerial, either overhead or underground *and carries our money-back guarantee.*

Quickly, Easily Installed

A ten-year old boy can install the SUBANTENNA in a few minutes. Set it in the ground outside the window nearest your Radio. Attach lead-in wire to the aerial post on your set. That's all. You will enjoy clearer tone, greater distance, much stronger volume and amazingly improved selectivity.

Test the SUBANTENNA ~Prove it to Yourself FREE

Try it for ten days at our expense. Tune in stations that have never been anything but squeaking static and "noise" in the past. You'll get everything you expected when you bought your set PLUS the almost perfect illusion of the artists presence in your home.

Write NOW! Just say "I want to test the SUBANTENNA." We'll send you particulars.

CLOVERLEAF MFG. CO., 2714-O S. Canal St., Chicago, Ill.

Newspapers Favor Program Space Cut

At the convention of the American Newspaper Publishers' Association ,held recently at the Hotel Waldorf-Astoria, the publication of radio programs was discussed.

B. T. McCanna, of the Chicago "Tribune," said newspapers were beginning to curtail the amount of space given to programs, "feeling that the detailed listing of merely average radio programs day after day provide little that is new and of intrinsic interest." These papers, he said, were giving space to "radio high spots."

Mr. McCanna said the "Tribune" recently had eliminated radio programs from its news columns and had received only 100 letters of complaint, which was regarded as an indorsement of its policy by its readers.

Mr. McCanna, in a report said that the associations radio committee, of which he is chairman, had studied surveys of "fan mail," sales of receiving sets and radio magazine circulation.

"The data on fan mail," he went on, "indicates that despite diminished receipts of fan mail by many stations, public interest in broadcasting is as high as ever and may even be said to be on the increase.

"Sales of receiving sets as reported by McGraw-Hill jumped from 1,500,000 in 1923 to 6,500,000 in 1927. Their estimate of the radio audience shows an increase from 3,000,000 in 1923 to 26,000,000 in 1927. They report 250,000 factory-built receiving sets in 1923 and 1,700,000 in 1927. Their 1923 figures for tubes is 4,500,000, and in 1927 this figure swelled to 35,000,000.

"The circulation of the various radio dealer trade journals for a period of the last five years shows a very decided drop both in the total circulations, individual circulations and the number of publications. The radio fan magazines during the last five years reached a peak in 1924, declined through 1925 and 1926 and recouped somewhat in 1927.

"Interest in radio evidently may now be said to have moved distinctly away from its former status as a mechanical toy or a phenomenon in physics."

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4-Tube Model Using
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As Designed by H. B. HERMAN

$1.25

This circuit uses TWO screen grid tubes. One is the RF amplifier, the other the detector. The RF tube is used in regular screen grid fashion. The detector operates on the space charge method, as explained in February 18th issue. Audio consists of one resistance coupled and one transformer coupled stage. Copy of this issue, 15 cents extra.

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SCREEN GRID DIAMOND $39.50
BLUEPRINT FREE WITH EACH KIT!
Kit consists of Hammarlund HR 23 coils, Karas tuning condensers and audio transformers, four Amperites, Clarostat, Yaxley switch and pilot bracket with lamp, aluminum subpanel with sockets on, drilled front panel, Lynch leak, Aerovox fixed condensers, Mar-co dials, Pee-wee clip, Vac-Shield, binding posts, as specified by Herman. [Space charge detector kit, $40]
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They prevent interstage coupling, eliminate stray capacities, stop tubes from vibrating and howling and increase distance.

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MEMBERS OF THE TRADE—Write for proposition on blueprints of 4-tube Diamond (standard tubes), 5-tube Diamond (standard tubes), and 4-tube Shield Grid Diamond (one SG tube). Guaranty Radio Goods Co., 145 W. 45th St., N. Y. City.

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4-TUBE SHIELD GRID DIAMOND OF THE AIR BLUEPRINT FREE WITH EACH SUCH SUBSCRIPTION!

At 15c per copy, each week for seven weeks, Radio World costs you $1.05, but if you subscribe for seven weeks at $1.00 you will also get the official blueprint of this circuit FREE! The blueprint was designed by H. B. Herman from the original laboratory receiver. Size of blueprint, 27 x 27 inches. All connections, leads, parts, etc., shown actual size. Very simple to follow.

Home constructors of radio receivers, and custom set builders, by following the blue print, can build a distance-getting and voluminous set, the parts for which list remarkably low.

The new shielded grid tube is used as the radio frequency amplifier. That is why the amplification finally is boosted forty times over and above what it would be if an —01A tube were used instead.

Such simplicity of construction marks the receiver that it can be completely wired, skillfully and painstakingly, in two and a half hours.

DISTANCE JUST ROLLS IN THOUGH SET IS EASY TO TUNE!

All you have to do is to follow the official blueprint, and lo! a new world of radio achievement is before you! Distant stations that four-tube sets otherwise miss come in, and come in strong. No tuning difficulty is occasioned by the introduction of this new, extra powerful, startling tube, but, in fact, the tuning is simplified, because the signal strength is so much greater.

The circuit consists of one shield grid stage, detector and two transformer audio stages, with 112A in the last stage.

When you work from the official wiring diagram you find everything so delightfully simple that you marvel at the speed at which you get the entire receiver masterfully finished. And then when you tune in—more marvels! 'Way, 'way up, somewhere around the clouds, instead of only roof high, will you find the amplification!

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Enclosed please find:
☐ $1.00, for which enter my name on your list of mail subscribers for seven weeks and send me FREE at once one official blueprint of the Four-Tube Shielded Grid Diamond of the Air, as designed by H. B. Herman, and described by him in the February 4th, 11th and 18th issues of Radio World. No other premium this offer. ☐ 45c extra for Feb. 4th, 11th and 18th issues.
Renewal ☐ Present subscribers may renew for seven weeks under this offer. Put a cross next to word "Renewal."

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Great stability! No neutralization required! No shielding necessary!

You'll be overjoyed. But you should place every part in exactly the right position. Stick to the constants given, and, above all, wire according to the blueprint!

When you work from this blueprint you find that every part is shown in correct position and every wire is shown going to its correct destination by the ACTUAL ROUTE taken in the practical wiring itself. Mr. Herman's personal set was used as the model. This is a matter-of-fact blueprint, with solid black lines showing wiring that is above the subpanel, and dotted lines that show how some of the wiring is done underneath.

Everything is actual size.

EVEN A NOVICE CAN BUILD THIS CIRCUIT SUCCESSFULLY!

Not only is the actual size of the panel holes and instruments given, but the dimensions are given numerically. Besides, it is one of those delightful blueprints that novice and professional admire so much—one of those oh-so-clear and can't-go-wrong blueprints.

Be one of the first to send for this new blueprint, by all means, and build yourself this outstanding four-tube receiver, with its easy control, fine volume, tone quality, selectivity and utter economy. It gives more than you ever expected you could get on four tubes—and the parts are well within the range of anybody's purse.

Complete official list of parts given on each blueprint; also the schematic wiring diagram (besides the picture diagram of the wiring.)

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A Fenway Concertrola Coil, type 368-B, will improve selectivity, bring in greater DX stations, make the locals sound more wonderful and simplify tuning. This coil is well made and carefully wound with enameled wire. It has the special Concertrola winding on the primary. Price, postpaid **$3.50**

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Fenway Triple-Shielded Metal Concertrola Case, $20.00

This case is exactly identical to the one described in April 28 Radio World. Complete parts for the Model F-5 Concertrola in stock. Send for your copy of the Concertrola Manual—it's free.

LEO FENWAY for DX! Inc.

831 EIGHTH AVENUE
(Opposite Madison Square Garden)
NEW YORK, N. Y.

How the Concertrola Is Kept Hum-Free

(*Continued from page* 10)

iron should be used. A small amount of paste may be used on each connection, if desired, except on fixed condensers. Resin flux may be used anywhere.

Assuming the receiver to have been wired, it is ready for test. The additional material required is, the four McCullough tubes, one rectifier tube, either Raytheon type BH, QRS, CRA or, in the event of a Fenway power transformer is used, an RCA 280. A 171 power tube completes the list. The current supply should be 105 to 125 volts AC, 50 or 60 cycle only. Do not attempt to operate this set on 25 cycle current, nor on DC. Above all, find out the exact type of current used in the place where you plan to operate the set. Many an AC set and eliminators have been ruined because connected into the wrong current outlet. Don't guess at the current coming into your home.

Eradicating Hum

Little need be said concerning the operation of the set. It is not complicated, not tricky. Stations come in immediately, provided that the set has been constructed according to instructions, and provided that the tubes are in good working condition. A slight hum in the set can be caused by too low a voltage on the detector, a poor detector tube, or to improper setting of the 75 ohm potentiometer.' This little Carter potentiometer might be called the "hum-ometer," so efficiently does it control the hum in the set.

When the set is in operation for several hours it will be noticed that the first audio tube gets quite warm, much warmer than the others. This is a natural condition and does not affect the operation of the set or tend to shorten the life of the tube.

At the present time there are five different makes of heater-type tubes which

(*Continued on next page*)

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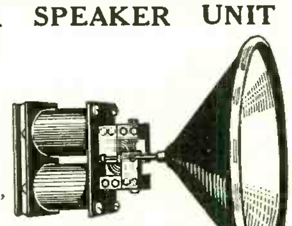
ELECTROMAGNETIC POWER SPEAKER UNIT

Operates on 6-Volt "A" battery or Trickle Charger. Draws fourtenths of an Ampere. For Cones, Balsa Wood, Airplane Cloth, etc.



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AMPERITE alone keeps tube filament voltage constant despite variations in "A" supply. Tube efficiency demands it. Indispensable with battery eliminators. Eliminates hand rheostats. Simplifies wiring. *FREE—Amperite Book of latest construction data and circuits. Write Dept.* R.W.9

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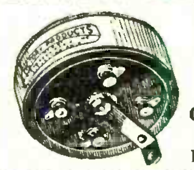
REG U S PAT OFF
The **"SELF-ADJUSTING"** *Rheostat*



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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.

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EVERY FRIDAY at 5.40 P. M. (Eastern Standard Time) Herman Bernard, managing editor of Radio World, broadcasts from WGBS, the Gimbel Bros. station in New York, discussing radio topics.

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.

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.

(*Continued from preceding page*)

can be used in the Concertrola—McCullough, Kellogg (not the same tube as McCullough); Perryman, Sonotron and Sovereign. Some of these tubes have the heater terminals on the side of the tube, some have the terminals on top, but both types are identical in characteristics, and can be used in the set if flexible heater connections are made.

A set built up from the specifications given in these three articles has been operating continuously for sixty days. The set was turned on the first part of March and is still running. The same tubes are still operating day and night, although the line voltage varies from 110 to 120 volts.

Keep Voltage Down to Three

The shielding case as furnished ready made is all drilled for the instruments listed. It ought not take an unskilled radio man longer than two hours to mount all the parts. Two hours more will be required for the wiring of the set and eliminator, unless the builder obtains one of the cables which are available. These cables consist of many colored wires all bound together with string. Every connection is represented by a color.

When the set is all wired it should work immediately, without fuss. No hum will be present unless bad tubes are used. The current for the AC tubes must be kept low. The voltage should never exceed 3 volts. If the line voltage is higher than 105 volts, the set builder should place an amperite in series with one leg of the AC that goes to the -71 tube, otherwise this tube is likely to go west long before its time.

Will Be Satisfied

Having digressed thus far, the set builder is probably thinking that after all this set is far from being a wonder set. If he is one of the gullible variety he is doubtless unimpressed with such a trite circuit. And the Concertrola is hardly expected to make a favorable impression on the chap who talks in terms of the 250 tube. And yet, some day or other, both of these fellows may build a simple circuit like this very one, and be satisfied that at last they had found the Wonder Set.

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Tuning coil, with adjustable third winding. Useful in any 3-circuit design. Used as antenna coil in High Mu Tuner $3.00

Interstage coupler for screen grid tubes. Large primary, high impedance. Enormous gain per stage. No 99 RF Model SG. $1.75

Set of three coils for Hayden's set, $6.00. These coils are 80% air dielectric. Wound on quartzite. Moulded bakelite rings.

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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.

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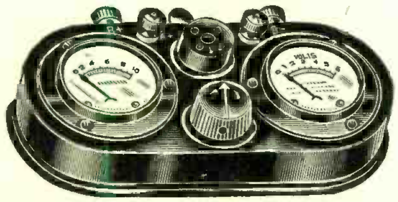
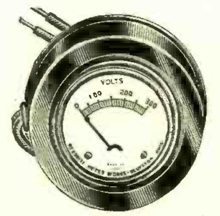
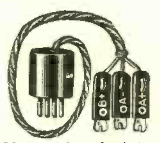


No. 210 Tube Checker consists of 0-6 volts D.C. Voltmeter, 0-10 D.C. Milliammeter, Grid Bias Switch, Rheostat, Socket, Binding Posts (with instruction sheet) in handsome noire case....$6.50



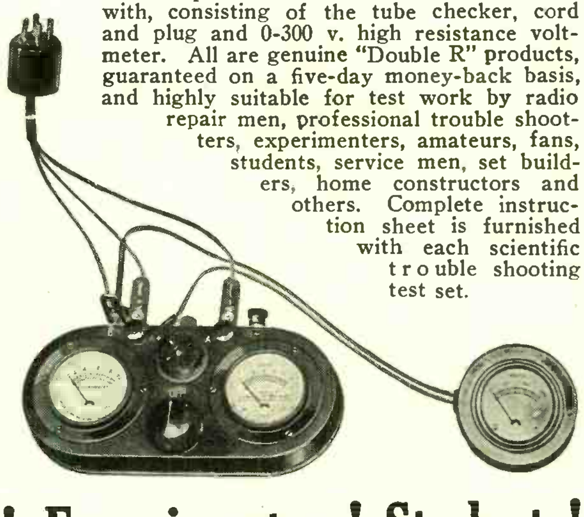
No.346—High resistance voltmeter, for reading any and all DC voltages, including B eliminators, up to 300 volts. Portable type, full nickel finish, long connecting cords and tips $4.50

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. 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.



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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.

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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.

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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.

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