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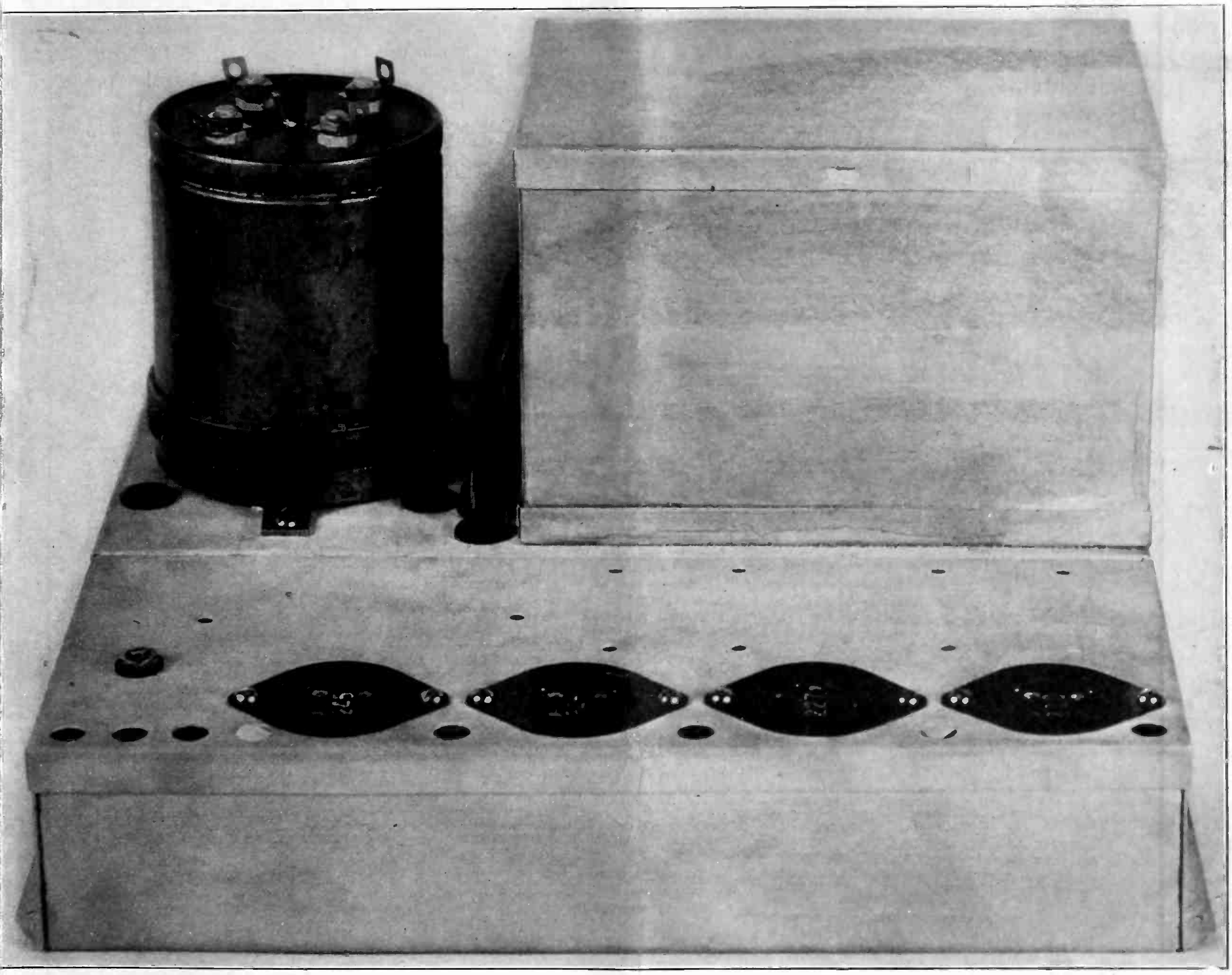
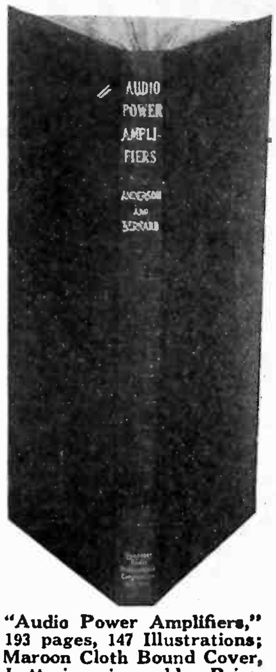


A 245 Push-Pull Power Amplifier—See Pages 16 and 17

RADIO WORLD, published by Hennessy Radio Publications Corporation. Roland Burke Hennessy, editor; Herman Bernard, managing editor and business manager, all of 145 West 45th Street, New York, N. Y.




**"Audio Power Amplifiers," 193 pages, 147 Illustrations; Maroon Cloth Bound Cover, Lettering in gold. Price, $3.50.**

# "AUDIO POWER AMPLIFIERS"

## By J. E. ANDERSON and HERMAN BERNARD

### *The First and Only Book on This Important Subject—Just Out*

IN radio receivers, separate audio amplifiers, talking movies, public address systems and the like, the power amplifier stands out as of predominating importance, therefore a full and authentic knowledge of these systems is imperative to every technician. "Audio Power Amplifiers" is the book that presents this subject thoroughly. The authors are

J. E. Anderson, M.A., former instructor in physics, University of Wisconsin, former Western Electric engineer, and for the last three years technical editor of "Radio World."

Herman Bernard, LL.B., managing editor of "Radio World."

They have gathered together the far-flung branches of their chosen subject, treated them judiciously and authoritatively, and produced a volume that will clear up the mysteries that have perplexed many.

What are the essentials to the reproduction of true tone values?

What coupling media should be used? What tubes? How should voltages be adjusted?

These are only four out of 1,400 questions raised and solved in "Audio Power Amplifiers."

The book begins with an elementary exposition of the historical development and circuit constitution of audio amplifiers and sources of powering them. From this simple start it quickly proceeds to a well-considered exposition of circuit laws, including Ohm's laws and Kirchhoff's laws. The determination of resistance values to produce required voltages is carefully expounded. All types of power amplifiers are used as examples: AC, DC, battery operated and composite. But the book treats of AC power amplifiers most generously, due to the superior importance of such power amplifiers commercially.

Rectification theory and practice in all the applied branches, grid bias methods and effects, push-pull principles, power detection, reproduction of recordings and methods of measurements and testing are set forth. And besides there is a chapter on the subject of motorboating, with which one of the authors is probably better familiar than any other textbook author. Then, too, there is a chapter on tubes, with essential curves and a full list of tables of tube data. Every tube that will be used in an audio amplifier—therefore virtually all tubes—is clearly diagnosed, classified and tabulated! These data on tubes should be at every radio engineer's hand.

"Audio Power Amplifiers" is a book for those who know something about radio. It is not for novices—not by a mile. But the engineers of manufacturers of radio receivers, power amplifiers, sound installations in theatres, public address systems and phonograph pickups will welcome this book. Engineers—even chief engineers—of the Bell Telephone Laboratories, Radio Corporation of America, Westinghouse Electric & Mfg. Co., Western Electric, Photophone, Vitaphone and the like needn't be afraid they won't learn something from this little book.

## Table of Contents



The book consists of 193 pages in type the size used in printing these words, known as 8 point, and therefore a great deal of text is contained in these 193 pages, and the book is small enough to be carried conveniently in the side pocket of a sack coat. It was purposely printed that way because busy engineers and other experimenters will want to consult this precious volume while riding in conveyances, as well as when in the laboratory, and compactness was therefore desirable.

The edition is strictly limited to 1,000, and the publishers recognize that the field of distribution is necessarily small, hence the price is $3.50. Those to whom such a volume is of any value would not be without it at any price.

The device of presenting no more information or greater number of illustrations, but of using larger type, and thicker and often cheaper paper, to present a bulkier appearance, was purposely avoided. The paper is finest super stock and the size of the page is 5 x 8".

## What Is Not As Well As What Is

*SOMETIMES it is more important to expose a fallacy than merely to state the fact. A crop of technical weeds has grown into the garden of audio amplification, and the authors have gone to the pains of exposing these.*

*The book "Audio Power Amplifiers" is free from traditional errors, except in citing them as fallacious conclusions. Each attack on a fallacy is abundantly supported by proof of the REAL facts.*

*As an example, take the theory that motorboating is due to grid blocking. The authors say: "Many explanations for this oscillatory condition (motorboating) have been made, some of which are wholly untenable. One of these is that the oscillation is due to blocking of the grids of the amplifiers . . . If blocking of the grid were the cause of the phenomenon, the wave form of the oscillation would be very irregular, but an oscillograph shows that it is very nearly of a sinusoidal form."*

*Then follows an exposition of motorboating, and oscillation at other frequencies, with expressions for predetermining the instability or stability of audio circuits.*

## Detailed Exposition of Chapter Contents

**Chapter I.** General Principles, analyzes the four types of power amplifiers, AC, DC, battery-operated and composite, illustrates them in functional blocks and schematic diagrams, and treats each branch in clear textual exposition. Audio coupling media are illustrated and discussed as to form and performance: transformer, resistance-resistance, impedance-impedance, impedance-resistance, resistance-autotransformer, autotransformer-resistance and non-reactive. Push-pull forms are illustrated, also speaker coupling devices. Simple audio ampifiers are illustrated and analyzed. Methods of connection for best results are stressed.

**Chapter II.** Circuit Laws, expounds and applies Ohm's laws and their special form known as Kirchhoff's laws. Direction of current flow in tube circuits is revealed in connection with the application of these laws to several circuits, including a DC 110-volt A, B and C supply, and series and parallel filaments in general. Special diagrams are published for Ohm's and Kirchhoff's laws.

**Chapter III.** Principles of Rectification, expounds the vacuum tube, both filament and gaseous types, electrolytic and contact rectifiers, and explains why and how they work. Full-wave and half-wave rectification are treated, with current flow and voltage derivation analysis. Regulation curves for the 280 tube are given. Voltage division, filtration and stabilization are fully illustrated and dissected.

**Chapter IV.** Practical Voltage Adjustments, gives the experimental use of the theoretical knowledge previously imparted. Determination of resistance values is carefully revealed.

**Chapter V.** Methods of Obtaining Grid Bias, enumerates, shows and compares them.

**Chapter VI.** Principles of Push-Pull Amplifier, defines the push-pull relationship, with keys to the attainment of desired electrical symmetry.

**Chapter VII,** Oscillation in Audio Amplifiers, deals with motorboating and oscillation at higher audio frequencies, explaining why it is present, stating remedies and giving expressions for predetermination of regions of instability. The trouble is definitely assigned to the feedback through common impedance of load reactors and B supply, and in some special instances to the load's relationship to the C bias derivation as well. The feedback is shown as negative or positive and the results stated.

**Chapter VIII,** Characteristics of Tubes, tells how to run curves on tubes, how to build and use a vacuum tube voltmeter, discusses hum in tubes with AC on the filament or heater, and presents families of curves, plate voltage—plate current, for the 240, 220, 201A, 112A, 171A, 227 and 245, with load lines. Also, plate-screen current characteristics of the 224, at five different control grid biases, at platevoltages 0-250. Then Table I gives the Average Characteristics of Amplifier and Detector Tubes 220, 200A, 201A, 112A, 171A, 222, 240, 226, 227, 224, 245, 210 and 250, stating use, filament voltage, current, and resistance, Det. B volts, Amplifier B volts, grid bias for amplification and detector, plate current, plate AC resistance, mutual conductance, mu, maximum undistorted power output, physical size. There is a composite table (II) of characteristics of Rectifier and Voltage Regulator Tubes, and individual tables, giving grid voltage, plate current characteristics over full useful voltage ranges for the 220, 201A, 112A, 171A, 222, 240, 227, 245 and 224.

**Chapter IX,** Reproduction of Recordings, states coupling methods and shows circuits for best connections.

**Chapter X,** Power Detection, explains what it is, when it should be used, and how to use it. A rectifying detector, designed by one of the authors, is expounded also.

**Chapter XI,** Practical Power Amplifier, gives AC circuits and shows the design of a sound reproduction system for theatres. A page is devoted to power amplifier symbols.

**Chapter XII,** Measurements and Testing, discloses methods of qualitative and quantitative analysis of power amplifier performance. A scale illustrates the audio frequencies in comparison with the ranges of voice and musical instruments. A beat note oscillator is described. Thirteen causes of hum, with remedies, are stated, also the estimation of power required for output and preliminary tubes.

You may safely order "Audio Power Amplifiers," either enclosing your remittance or ordering the book mailed C.O.D. Examine it for five days. If you are not completely satisfied with it for any reason, or for no reason, send it back in five days with a letter asking for a refund. A check refunding the purchase price will be sent to you immediately. We can not send the book on approval, without payment before receipt, so please do not ask us to do so.

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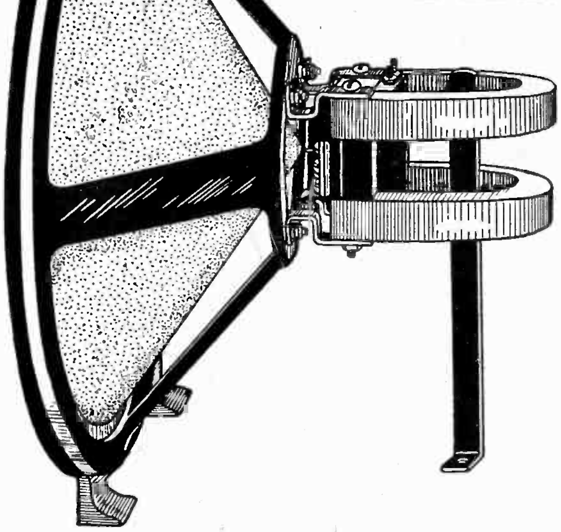

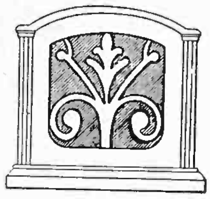

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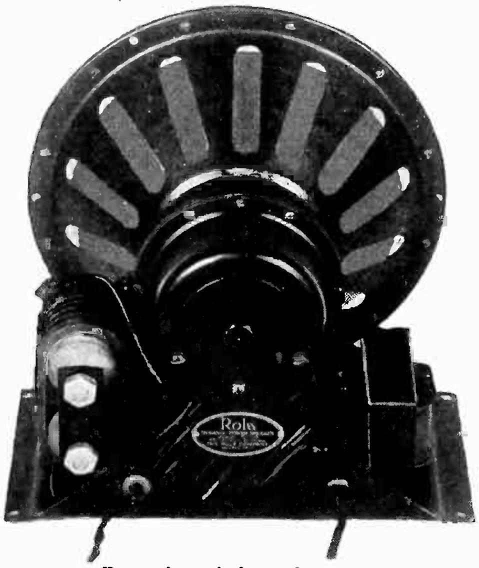


**Rear view of the Rola chassis**

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# The Latest in Tuning Equipment

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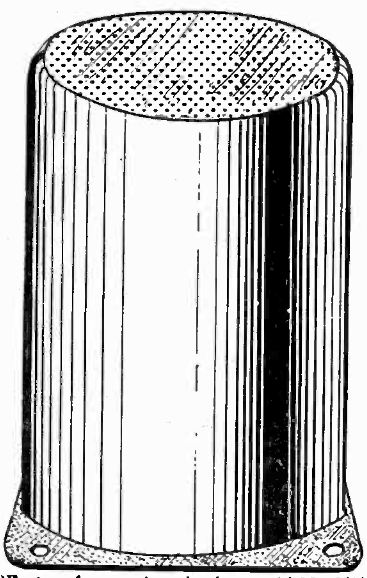
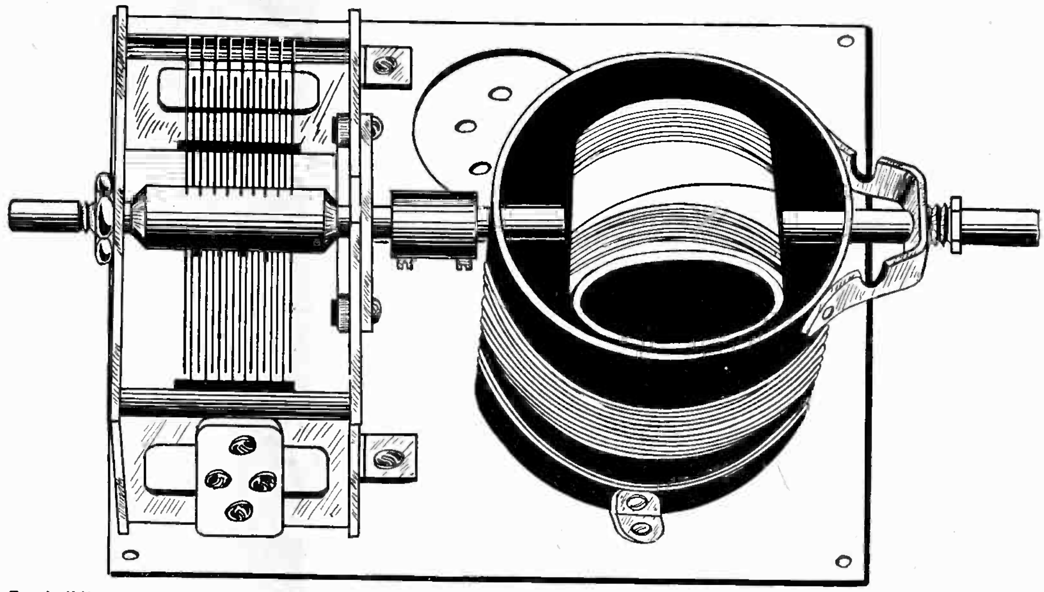


RF transformer in aluminum shield 2¾" square at bottom, 3¾" high. If metal sub-panel is used no extra base is needed. Coils have brackets on. You must assemble in shield yourself and solder winding terminals to built-in lugs. For all circuits and stages, including screen grid tubes.

Cat. No. SH3 for .00035 mfd. ..........$0.95
Cat. No. SH5 for .0005 mfd. ..........$1.00
Cat. SHB (extra base) ................$0.10

## BERNARD TWO-TUBE TUNER ASSEMBLY



For building a tuner consisting of a stage of screen grid radio frequency amplification and a detector, AC or battery-operated, use the Bernard two-tube tuner assembly. Suitable for single control with one drum dial or separately tuned stages with two flat-type dials. The assembly consists of antenna stage (BTL-AC or BTL-DC), having Bernard Tuner BT3A, a .00035 mfd. condenser, socket, link and aluminum base. The detector input stage (BTR-AC or BTR-DC) consists of the same parts, but the coil has a tuned primary with untuned input to detector. Assemblies are unwired but are erected.

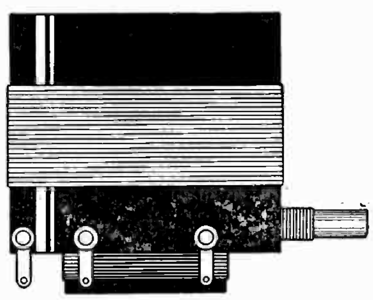
The condenser has shaft protruding at rear, so if two dials are used coil is put at front panel in either instance and condenser at front panel for the other.

For AC operation, 224 RF and 224, 227 or 228 detector, order Cat. No. BTL-AC and BTR-AC at $6.00 for both.

For battery operation of filaments, 222 RF and 222, 240, 201A or 112A detector, order Cat. No. BTL-DC and BTR-DC at $6.00 for both.

[Note: for drum dial single control an 80 mmfd. equalizing condenser is necessary. This is extra at $0.35. Order Cat. EQ-80.]

## ANTENNA COUPLER



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Moving primary and fixed secondary, for antenna coupling. Serves as volume control.
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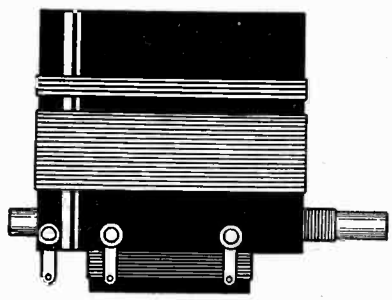
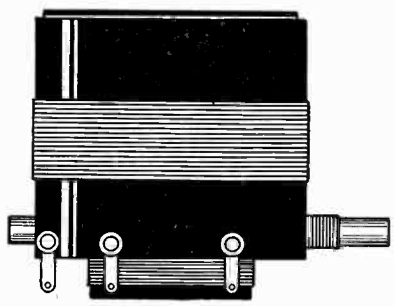
## BERNARD TUNERS



Cat. No. BT5A—$1.35
FOR .0005 MFD. CONDENSERS

Bernard Tuner BT5A for .0005 mfd. for antenna coupling, the primary being fixed and the secondary tuned. This coil is used as input to the first screen grid radio frequency tube. Secondary has moving coil.
Cat. No. BT3A for .00035 mfd. ..$1.35

Bernard Tuner BT5B for .0005 mfd. for working out of a screen grid tube, tuned primary, untuned secondary. Primary has moving coil.
Cat. BT3B for .00035 mfd. ..$1.35



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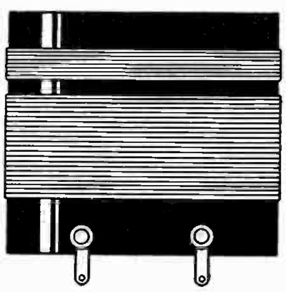
## SG TRANSFORMER



Cat. No. SGS5—$0.60
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Interstage radio frequency transformer, to work out of a screen grid tube, primary untuned.
Cat. No. SGS3 for .00035 mfd. ........$0.65

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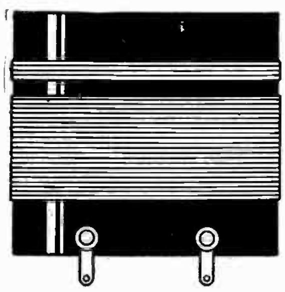

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Cat. No. RF5—$0.60
FOR .0005 MFD. CONDENSER

Antenna coil for any standard circuit, and one of the two coils constituting the Diamond Pair.
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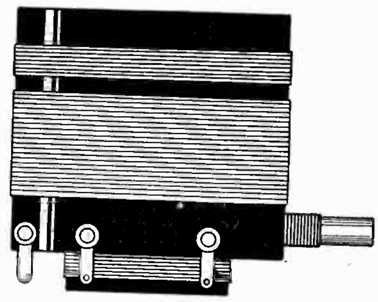
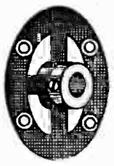
Order the Diamond Pair, Cat. DP3 for .00035 mfd. at ..................................$1.55

[Note: These same coils are for AC or battery circuit.]



Cat. No. SGT5—$0.85
FOR .0005 MFD. CONDENSER



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Order Cat. FL4 at ........$0.30
Equalizing condenser, 80 mmfd., for connection across any tuning condenser where ganging is resorted to, or for equalizing independently tuned circuits to make dials track.
Order Cat. EQ80 at ........$0.35

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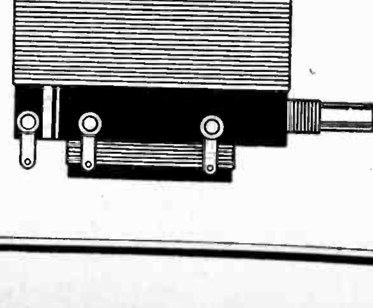

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- ☐ 227 AC det.-amp. .......... .90
- ☐ 280 AC rectifier ..........$1.13
- ☐ 222 battery screen grid ..........$1.88
- ☐ 112A power tube .......... .78
- ☐ 171A power tube .......... .78
- ☐ 201A battery tube .......... .53
- ☐ Matched pair of 245s for push-pull (for both) ..........$2.56
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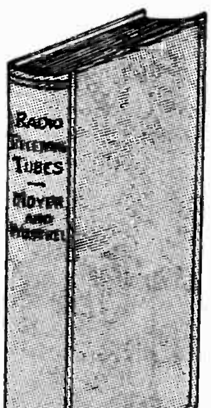

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# Practical NR Circuits

## Methods to Pursue in Non-Reactive Operation

*By Randolph MacNamara*

A PRACTICAL non-reactive detector and one-stage audio diagram is shown in Fig. 1. It is assumed there is a tuner available for connection thereto, the connection being made to the points marked "input."

The circuit was built of parts the author had on hand. The power transformer was intended for 112A output tubes in push-pull, and in full-wave rectification afforded 150 volts direct current, at the end of the filter system, but as can be seen this was changed, so that the 280 rectifier was used in half-wave fashion instead. This doubled the voltage. It was necessary to obtain higher voltage, since the total voltage is used in series distribution.

It can be seen from the diagram that the voltage drop across the total of the resistance chain is the full 300 volts. The apportionment of the voltages is one of the problems of this type of circuit. In other circuits the voltages are, in general, in parallel.

### FAMILIAR CIRCUIT MADE TO WORK

The tuner to be connected to this detector-amplifier circuit may be fed in the usual way, from the B supply shown, but the power transformer should have the filament winding for the 224 tube and for other tubes in the tuner. Otherwise a separate filament transformer for the 224 and 227 or other RF tubes used would have to be provided for total AC operation. Of course battery-operated filament tubes in the tuner could be used, with the B voltages for the tuner taken from the present B supply through drops in suitable resistors connected to the 300-volt post in one instance and to the plate returns and screen grid returns in the other. However, only two or three tubes should be used in the tuner, as the B supply depicted is not designed to carry high current and still retain satisfactory filtration. It is better for the present to obtain B voltages independent of this B supply.

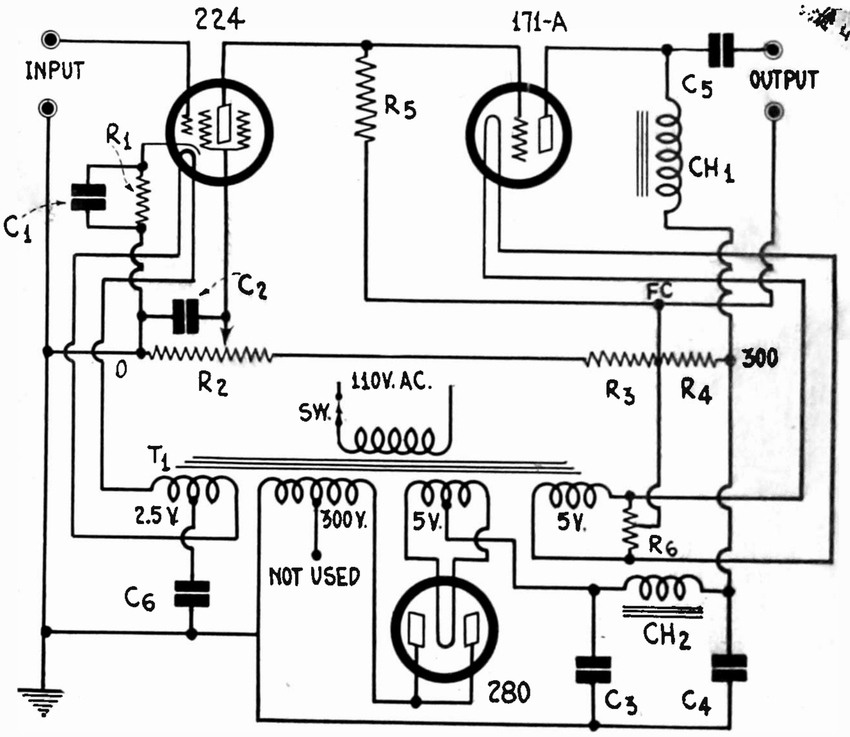
The idea embodied in the present circuit is a familiar one, as non-reactive circuits have been under discussion for years, but certain troubles have been encountered in them. Messrs. Loftin and White have been studiously engaged on the elimination of these troubles, and have demonstrated circuits to the satisfaction of discerning engineers.

### HOW MUCH VOLUME IS OBTAINED

As to performance, the circuit as shown amplifies much the same, in quantity, as other forms of one-stage audio following a detector. Therefore local stations may be tuned in with sufficient volume, if the RF amplification consists of two stages. The quality is good.

Hum is low, and is reduced considerably as the capacity of the reservoir condenser C4 is increased. In the experimental model 1 mfd. for C4 proved wholly inadequate, while 4 mfd. was a good value. Next to the rectifier is C3, which should be 1 mfd.

Note that the voltage is twice that which would be present in a full-wave rectifier, using the same high-voltage secondary. This doubling is obtained by use of the full winding, and disuse of the midtap. The plates of the rectifier are connected together, which improves regulation. If you intend to convert an existing full-wave B supply to the present use, it is necessary to have




NON-REACTIVE CIRCUIT CONSISTING OF DETECTOR AND ONE STAGE OF AUDIO, BUILT AS A POWER AMPLIFIER. BY SLIDING THE POTENTIOMETER AND MAKING ANOTHER ADJUSTMENT THE 224 TUBE MAY BE CONVERTED FROM DETECTOR TO AMPLIFIER.

### LIST OF PARTS

**R1—One .05 meg. resistor with mounting.**
**R2—One 5,000 ohm potentiometer, 5 watts or more.**
**R3—One 2,000 ohm resistor, 5 watts or more.**
**R4—One 13,000 ohm resistor, 1 watt or more.**
**R5—One 5 meg. leak with mounting.**
**R6—One 30 ohm center tapped resistor (not needed if power tube filament winding is center-tapped).**
**C1, C2—Two 1 mfd. condensers 200 volt DC type.**
**C3, C5—Two 1 mfd. filter condensers, 400 volt AC type or higher voltage rating.**
**C4—One 4 mfd. filter condenser, 400 volt AC type or higher voltage rating.**
**C6—One .01 mfd.**
**T1—One power transformer with full secondary wound to give 300 volts DC.**
**Ch1, Ch2—Two 30 henry choke coils.**
**Input, output—Four binding posts (two "input," one speaker plus, one speaker minus).**
**One UY and two UX sockets.**
**One 224, one 171A and one 280 tube.**

# Pointers for Getting Results

## Last Tube Should Be Regulated First, Then Its

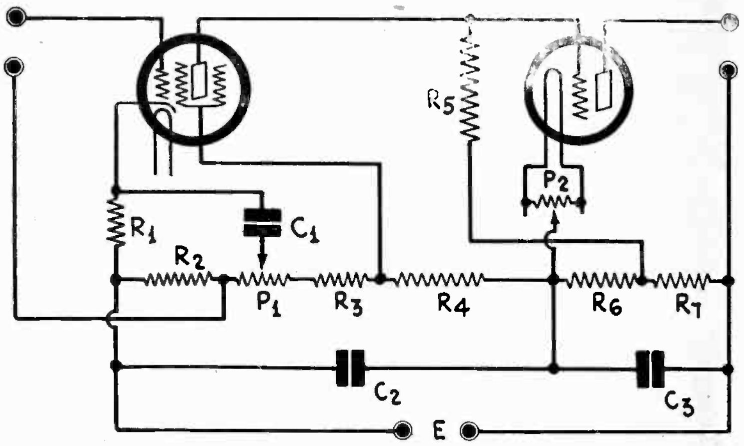



FIG. 2
THE CIRCUIT OF A TWO-TUBE NON-REACTIVE AMPLIFIER WHICH ILLUSTRATES HOW THE RESISTANCES MAY BE SELECTED FOR PROPER VOLTAGE DISTRIBUTION.

condensers that will stand the higher voltage. In many instances, however, the previously used filter condensers will stand 400 volts AC, so note the rating and act accordingly.

### GOOD DETECTION

The 224 is worked as a high gain detector. As is well-known, a detector tube will amplify, and an amplifier tube will detect. Nevertheless a tube must be worked primarily as a detector or as an amplifier, and its operation is on the basis of a selected point on its characteristic curve. So soon as an attempt is made to compromise between detection and amplification, so that there will be some action of both types, there is not much of either. Nevertheless some types of tubes are better detectors than others, also provide higher gain besides better quality. The choice in the present instance is of a power detector of the high-gain type for this sort of detection. The action is all in the direction of better detection, rather than being an attempt to compromise between detection and amplification.

As was said, the problem is to obtain the correct voltages. Those familiar with standard hookups may find it difficult to work with direct coupled amplifiers, because while the basis of reckoning is the same, the application is different. Hence an analysis of the circuit is interesting.

Bear in mind that the plate voltage is that between cathode and plate return or between filament center and plate return, each tube to be reckoned independently.

Let us start from the point of zero potential and work along toward the maximum voltage of 300.

### FIRST CRITICAL RESISTOR

First we have the 224 tube. Between its cathode and ground is connected a resistor, probably the most important resistor in the circuit, and surely one which, if improperly chosen, will defeat results. Low values will insure failure of operation. High values are necessary, because the higher the value, the higher the bias, the less the plate current through R5, and the lower the bias on the last tube, since its bias is derived from the voltage drop in R5. So if the drop is too much, the plate voltage on the last tube goes 'way up, while the current is reduced to almost zero, sometimes actually zero. This also upsets all the other voltages. For R1 use 50,000 ohms (.05 meg.).

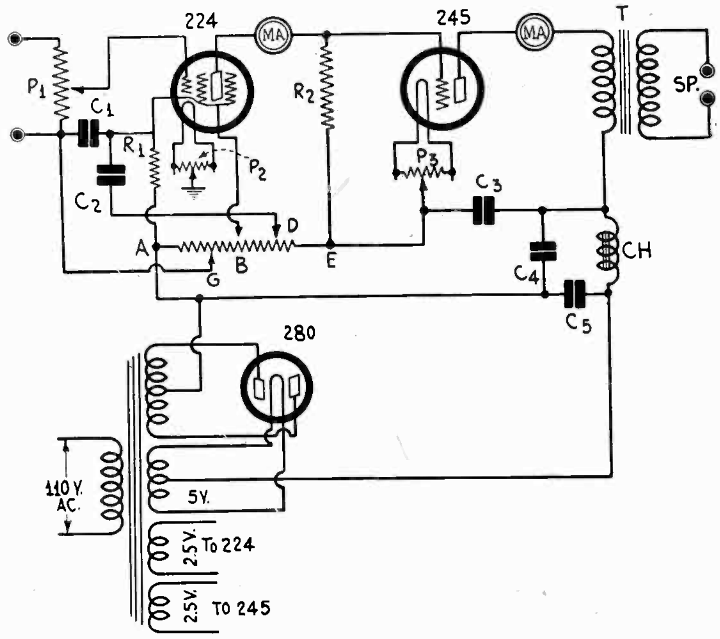



FIG. 3
A TWO-TUBE NON-REACTIVE AMPLIFIER USING ONE 224 AND ONE 245 TUBE.

R2 is a potentiometer, used for apportioning the screen grid and plate voltages of the 224 tube. It may be 5,000 ohms, while R3 is 2,000 ohms. R4 is 13,000 ohms, but is not critical, and may be generously more, or somewhat less than 13,000 ohms.

The total resistance across the chain composed of R2, R3, and R4 is 20,000 ohms, and the voltage across this total resistance is 300, therefore the bleeder current is 15 milliamperes.

The bleeder current flow through the chain is of course the same at all points, but the plate current of the last tube does not flow through R4 but only from the power tube's filament center (FC) to zero, or through 7,000 ohms. If the plate current of the last tube is 20 milliamperes, then R4 carries 15 milliamperes and R2 and R3 carry the power tube's plate current and the bleeder current, or 35 milliamperes. An exception exists, however, since the 224 tube is in parallel with R2 and R3 and the same current therefore is diverted according to the rule of parallel resistors.

It will be seen that the plate current of the last tube is utilized throughout the circuit, being diverted for use in the 224.

Now, to inquire about the voltages.

### SECOND CRITICAL RESISTOR

The bias on the first tube being the voltage drop in R1, and the screen grid voltage being adjustable, the degree of bias may be regulated by the potentiometer, since the screen current must flow through R1, and it will change according to the screen voltage. This potentiometer requires critical adjustment, since detection is attained by proper adjustment, and no signals, only a hum, will be heard otherwise. However, if you desire to feed a detector into the 224, you may convert the 224 to an amplifier by adjustment of the potentiometer R2.

The very high detecting bias being required for keeping the current low through R5, it still must be maintained low if the tube is used as an audio amplifier, and one solution in that case

## How to Adjust Non-Reactive Circuits for Operation

*Due to unfamiliarity with non-reactive (NR) circuits the experimenter may find difficulty in obtaining any results whatsoever. He will succeed in getting the filaments to light and the maximum voltage to register, easily enough, but that is no solution by a long shot. Hence follow these directions:*

*Test the output tube first. Get it to produce the rated plate current at rated plate voltage.*

*If the maximum voltage registers, increase the bias on the preceding tube, also increase the value of the coupling resistor. In this way plate current can be made to flow at the desired value in the last tube. Too high voltage and no current mean too low bias.*

*Next turn to the preceding stage and adjust the screen grid voltage or increase the bias on the tube to obtain detection.*

# From Non-Reactive Circuits

## Predecessor to Obtain Detection or Amplification

is to use a lower value for R5 than 5 meg., and another is to move the end of R5, whatever value is used, even if 5 meg. is retained, to the right, to the power tube's filament center tap. This decreases the bias on the last tube and increases the plate voltage on the 224.

Regarding the effectiveness of the voltages: the full 300 volts is effective nowhere except across the voltage divider itself, this divider consisting of the resistor units already discussed. Read on a tube tester, or other meter servicing equipment plugged into the socket, the voltage on the last tube will be lower than the applied voltage by the drop in the choke coil Ch1. On the 224 the effective voltage is too low to give a reading and so is the current.

The first tube as a detector draws very little plate current, so little that you probably have no meter sensitive enough to measure the current, unless you have a 0-1 milliammeter. The plate current would be about .6 of a milliampere and the screen current about .2 milliampere, so the total would be less than 1 milliampere if rated voltages are used, which may be done, but the rated voltages do not give the best results in this circuit in connection with the screen grid tube. If any bias experiments are to be conducted in connection with this tube, the return of R1 may be moved over to the right, being tied to the potentiometer arm, or put at the right-hand end of R2 or at the power tube's filament center. The stated values in the list of parts are practical not experimental, in connection with Fig. 1.

Only one filter choke, Ch2, is used, as the current is so low, not exceeding 35 milliamperes under correct operating conditions. Ch is a standard choke coil, 35 to 50 henrys, and all such will pass 35 mils.

### APPORTION VOLTAGES PROPERLY

Last week were published data on the non-reactive circuits that certainly started a great deal of interest in radio circles. Here is some additional information on the fundamental circuit.

There are many variations of this circuit, depending on the type and number of tubes used and on the voltages available. In Fig. 2 is shown a two tube circuit in which the tubes are supposed to be one 224 and one 245. To make a circuit of this type function satisfactorily it is essential that the voltages be distributed properly. This statement can not be made too convincing. In ordinary circuits voltages are not critical but in this type some of them are.

Let us take the circuit in Fig. 2 as a basis for discussion of the circuit and to show how the various voltages are interrelated and how they can be adjusted for satisfactory operation. It is well to state now that any particular values of resistors are not essential but the proper relation of them is necessary.

### INTERRELATION OF VOLTAGES

One thing that must be remembered in this circuit is that the voltages applied to the second tube are dependent on the grid, screen grid, and plate voltages on the first tube, and that it is this fact which makes it important to adjust the circuit properly. For example, suppose the screen grid voltage on the first tube is decreased from a certain value, keeping the grid and the applied plate voltages constant. This change causes an increase in the plate current and therefore an increased drop in the coupling resistor R5. The increased drop is equivalent to an increase in the grid bias of the second tube, and it may be that the new grid bias on that tube is so great that the plate current in the second tube is entirely stopped. On the other hand, if the screen grid voltage is increased the screen takes most of the current and the plate gets very little. Hence the drop in R5 is small and it may then be that the total effective bias on the second tube is so slow that the plate current is excessive. Indeed, the plate current may be so large that the plate of the tube turns bright red.

It is clear that changes in the grid bias on the first tube will have similar effect, for if it did not the circuit would not function when the grid voltage on that tube is varied by the signal. But the grid must have a definite fixed bias about which the signal voltage will fluctuate.

When only a moderate total voltage is available it is not possible to give the elements of the first tube as high values as in rated voltages, since most of the voltage should be applied to the power tube if any appreciable volume is to be obtained.

### DESIGNING THE CIRCUIT

Let us see how the various resistors in Fig. 2 may be determined so as to bring about the correct adjustment. Let us assume that we have a total available voltage of 450 volts. Of this voltage 250 volts should be applied to the plate of the 245 tube. This means that the voltage drop in R6 and R7 should be 250 volts. Now we are at liberty to choose almost any current through these resistors as long as we stay within the limits of the current supply. Let us choose a value of 10 milliamperes. This is convenient because the sum of R6 and R7 will be just 25,000 ohms.

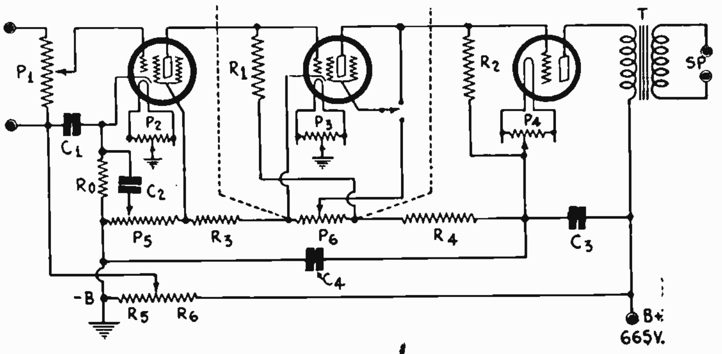



FIG. 4

A THREE-TUBE NON-REACTIVE CIRCUIT FEATURED BY A VOLUME-CHANGE SWITCH WHICH CONVERTS THE MIDDLE TUBE FRO MA SCREEN GRID TO A THREE-ELEMENT TUBE.

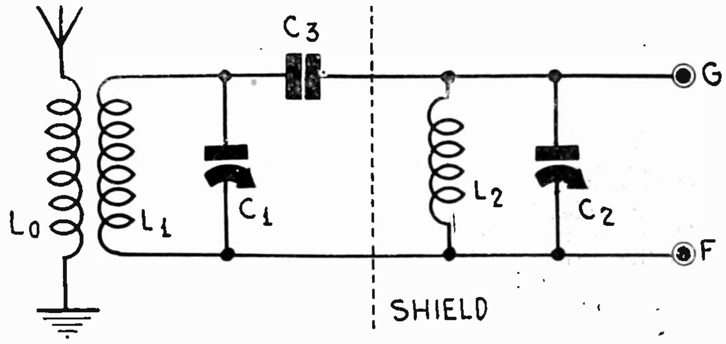



FIG. 5

A SIMPLE TUNER FOR AMPLIFIER. THIS TUNER HAS TWO EQUAL TUNED CIRCUITS COUPLED TOGETHER WITH A SMALL CONDENSER.

It is true that more current flows through R7 than through R6, but the difference is only the plate current of the first tube, which is negligible in comparison with the assumed current of 10 milliamperes.

We have used 250 volts of our available supply so that we have 200 volts left. This, however, does not mean that the plate voltage on the first tube is limited to something less than 200 volts. We can use more as we shall see. Now the question may arise as to the need of a higher voltage on the plate of the screen grid tube. Readers of RADIO WORLD who have followed articles concerning screen grid tubes in resistance coupling will know why it is desirable to use much higher applied plate voltages, as the need for high voltage has been pointed out repeatedly. It is also discussed at length in "Audio Power Amplifiers" by Anderson and Bernard. It is a fact that in non-reactive circuits it is sometimes necessary to compromise regarding that need.

### QUESTION OF BIAS

Suppose the plate resistance R5 in Fig. 2 is 1 meg. and that the voltages on the first tube have been adjusted so that the plate current in the tube is 100 microamperes. The drop in R5 will then be 100 volts, 50 volts more than required for the bias on the second tube. But if the low end of R5 be returned to a point on R6R7 50 volts higher than voltage at the filament of the power tube, the effective value of bias on the second tube will be 50 volts, the correct value. This return not only adjusts the grid bias on the second tube but it adds 50 volts to the plate voltage on the first. Now, then, we have 250 volts for the plate of the first tube. This is all right, although it could be much higher if more voltage were available.

We shall now skip to the other end of the circuit. There is a resistance R1 in the cathode lead, used for bias, for stability, and for a hum-bucking arrangement. We have assumed that the plate current in this tube is 100 microamperes. When the tube is operating properly we may assume that the screen current is one-third of this value. Both of these currents flow through R1. Hence if R1 is 50,000 ohms the drop in it will be 6.65 volts. This would probably be too high a bias for the screen grid tube under best operating conditions, but the bias needed depends on the screen grid voltage applied to the tube, the other values being as assumed and as deduced. If the screen grid voltage is too high for the plate voltage and plate load resistance used, the only thing that will make the first tube function is to increase the grid bias. But then the tube functions more as a grid bias detector than as an amplifier. True, it amplifies but it does so with a good deal of distortion.

(Continued on page 15)

# Reactance Explai

## Why a Condenser is Like a Rubber Band;

By J. E.
Technical

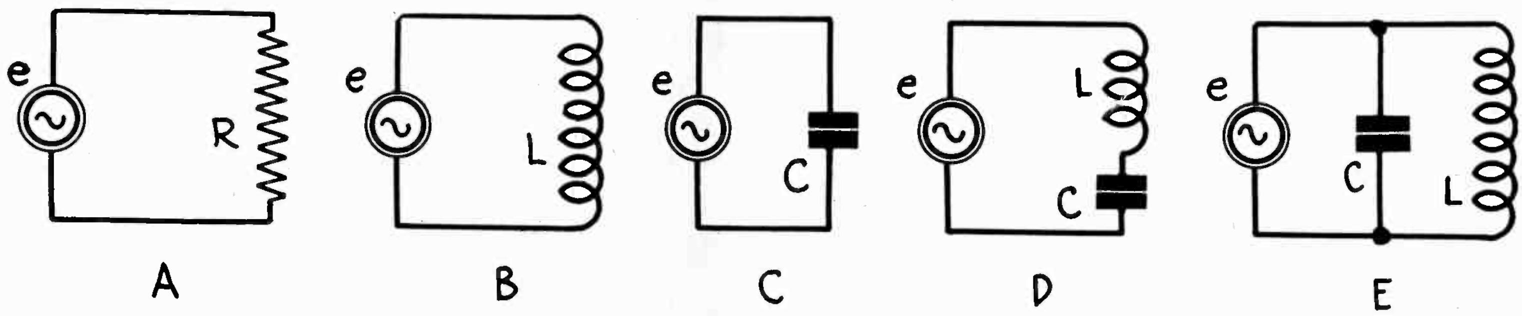



FIG. 1
FIVE DIFFERENT SIMPLE CIRCUITS. (A) IS A NON-REACTIVE CIRCUIT, (B) A CIRCUIT HAVING INDUCTIVE REACTANCE, (C) ONE HAVING CAPACITIVE REACTANCE, (D) A CIRCUIT HAVING BOTH INDUCTIVE AND CAPACITIVE REACTANCE WITH THE COIL AND THE CONDENSER CONNECTED IN SERIES, AND (E) IS A CIRCUIT HAVING BOTH TYPES OF REACTANCE BUT IN WHICH THE CONDENSER AND THE COIL ARE CONNECTED IN PARALLEL.

THE present interest in non-reactive, direct-coupled amplifiers has brought up the question as to when a circuit is reactive and when non-reactive. We shall try to explain under what conditions a circuit is non-reactive, that is to say, when it has no reactance.

There are two types of reactance, inductive and capacitive. Inductive reactance is akin to inertia reactance and is due to electrical inertia. Capacitive reactance is akin to compressive reactance or elastic reactance and is due to electric elasticity.

These statements are scarcely explanatory since the analogous concepts may not be any better understood by some than the electrical concepts. But let us try to expatiate on the statements.

Inertia is that property of a massive body by which that body tends to remain in its present state of motion or immobility when acted on by a force of any kind. Consider, for example, a person riding on a train. The person has mass and therefore inertia. When the train is at rest the person also is at rest and tends to remain in that state of immobility. If the train suddenly starts the person tends to remain stationary and therefore will tend to fall in the direction opposite to that in which the train started.

Now suppose the train has been speeding at a constant rate for some time. The person has been moving at the same speed. But if the train should suddenly stop the person moves forward in the direction he was going. The inertia tends to keep him going with the same speed and only force can prevent him from continuing. Sometimes this force may be fatal to the person.

### RESISTS CHANGE OF VELOCITY

Inertia does not enter only when the train starts and stops but whenever there is any change in the speed of the train or in the direction in which the train travels. For example, whenever the train slows down the person lurches forward and whenever the train accelerates he lurches backward. Likewise when the direction of the train changes one way or the other the person lurches sidewise in the direction opposite to the new direction of the train. In every case the person tends to remain in his original state of motion or immobility. This statement includes changes of direction as well as absolute motion.

What is true of a person is true of every other body, living or dead, that has mass, or that weighs something when put on a balance.

Inductance in electricity is analogous to mass in mechanics, and electric current is analogous to velocity. If there is inductance in a circuit it requires a force, or electromotive force, to start or stop a current in that circuit. It also requires an electromotive force to change the direction, or the intensity, of the current. The greater the inductance (electric mass) the greater the electromotive force required to produce a given change in the intensity of the current.

If the electromotive force is alternating rapidly, that is, acting first in one direction and then in the other, and there is an inductance in the circuit, the intensity of the alternating current resulting will be small because of the electric inertia. The larger the inductance the smaller the current.

### THE MECHANICAL ANALOG

We might take a machanical analog for illustration of this effect. Suppose we take a heavy ball or other body and swing it back and forth. The force exerted by the hand in swinging the body corresponds to the alternating electromotive force and the resulting motion of the body corresponds to the electric current. The heavier the body, that is, the more massive, the more difficult it is to swing the weight. If an attempt be made to swing the weight rapidly to and fro a distinct reaction is felt, and the reaction is the greater the more rapidly it is attempted to shake the weight or the greater the weight. The rapidity with which the weight is shaken corresponds to the frequency of the electrical current.

### ELASTIC REACTANCE

Capacitive reactance was likened to elastic reactance. Elasticity is the property of a body by which it resists changes in shape or volume provided that after the body has been deformed by a force it returns to its original shape or volume after the deforming force has been removed. A well known example of an elastic body is a rubber band. It may be stretched to several times its normal length by exerting a force, and when the force is removed it returns to its normal length. A steel wire helix is another well known elastic body. If the turns of the helix are close, the spring may be stretched and it will return to its normal form as soon as the stretching force is removed. If the spring is not wound closely it may also be compressed, and after the compressing force has been removed the spring will lengthen to its normal length.

Even a straight steel wire may be stretched by exerting a force, and as soon as the force is removed the wire will assume its original length, provided that the stretching has not been overdone. Steel and other elastic substances also resist bending, twisting, and compression. When one of these bodies has been deformed by force in any one of these ways, within limits, it will return to its original shape or volume after the deforming force has been removed.

### ELECTRIC ANALOGY

Gases are well known examples of substances which resist change of volume. It takes force to put more air, for example, into a confined space, such as an automobile tire. After the compression has taken place and the compression force is removed the excess gas in the confined space will immediately escape so that afterwards the gas occupies the same volume as it originally did.

An electric condenser is a device into which electricity may be forced or compressed. It is a sort of vessel for storing electricity, but electric charge has the property of elasticity. It requires an electric force to charge a condenser or to force more electricity into it than would normally be contained therein if there were no electric force. The amount that can be forced into the condenser depends directly on the intensity of the force, that is, voltage, and on the capacity of the condenser, its electric dimensions.

One who has pumped up an automobile tire by hand will know that at the beginning the work is easy. There is very little reactance. But as the pumping proceeds and the pressure increases in the tire, more force is required at each stroke. The amount of air that can be pumped in depends on the volume of the tire and on the force that is exerted. The analogy between the pneumatic and the electrical cases is

# ...ned by Analogies

## ... Resistance, a Brake, a Coil, a Weight

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very close. If electricity is regarded as a gas the two become practically identical.

### FURTHER SIMILARITY

Suppose air has been pumped into a bottle and the cork is suddenly removed. There is a pop which has a more or less definite pitch. That is, a sound of a certain frequency is produced a short period. This would not be possible were not the air also possessed of inertia or mass. The air rushes out when the cork is first pulled out. The inertia of the moving air keeps the air flowing after the pressures inside and outside have become equalized. It keeps flowing outward until the pressure inside is less than the pressure outside. Then it begins to rush in again. This inward and outward motion of air keeps up for a moment, giving use to the musical quality of the pop. This oscillation is only possible because the air possesses both elasticity and inertia.

An electrical circuit comprising capacity and inductance behaves in the same way. The current rushes in and out of the condenser for a moment after the first discharge and it keeps up for a time depending on the amount of resistance in the circuit. The greater the resistance the shorter the time of oscillation.

### SIMPLE CIRCUITS

In the figure above are five different simple electrical circuits. In each there is a source of alternating electromotive force **e**. This electromotive force drives a current through each circuit, but in each case the current has a different intensity because the reactances of the circuit are different.

In (a) we have a non-reactive circuit because there is only a pure resistance in series with the electromotive force. There is no reactance in the circuit since there is neither inductance (inertia) or capacity (elasticity). The energy is all dissipated in the resistance R and for that reason a non-reactive circuit is called a dissipative circuit.

In (b) we have an inductance in series with the electromotive force. This circuit has inertia reactance, the coil resists any changes in intensity or direction of current. For this reason the current will be small and it will be smaller the higher the frequency and the higher the inductance. It is the fact that the current is dependent on the frequency, which makes reactive circuits undesirable in audio frequency amplifiers.

In (c) we have a simple reactive circuit comprising a condenser in series with the electromotive force. Since there is elastic reactance in this circuit the current will depend on the intensity and frequency of the alternating electromotive force. The larger the condenser the larger the current will be and also the higher the frequency the higher the current. Direct current will not flow at all and currents of very high frequency will flow just as if the condenser were not in the circuit. Since the current depends on the frequency a circuit having condensive, or elastic reactance, is not desirable in an audio frequency amplifier.

### MIXED CIRCUITS

The circuit in (d) contains both capacity and inductance in series with the electromotive force. What the current will be in this circuit depends on the frequency, the inductance and the capacity. For low frequencies the current will be mainly determined by the condenser, since the coil will not offer much reactance compared with the reactance of the condenser. At high frequencies the current will be mainly determined by the inductance, since the condenser will offer very little reactance.

When the frequency is such that the inductive reactance is equal to the capacitive reactance resonance will obtain and the current will be determined by the electromotive force and any resistance which may exist in the circuit, especially in the coil. At resonance the circuit is non-reactive and dissipative. The current will be very large in comparison with the current at frequencies off resonance.

A circuit like that in (d) is used for tuning, that is, for selecting a current of one frequency and rejecting currents of all other frequencies. It cannot be used in audio frequency circuits where all audible frequencies are to be received with the same intensity. In the ordinary tuned circuit of this kind the electromotive force is usually introduced by induction into the coil L rather than as indicated. In either case the response of the current is practically the same.

### PARALLEL RESONANCE

The circuit in (e) is known as the parallel tuned circuit when the capacity and the inductance are so related to the frequency of the electromotive force that the inductive reactance is equal to the capacitive reactance. When this condition obtains the current through the source of electromotive force is zero or minimum and the current in the condenser and the coil maximum. The impedance presented by the condenser and the coil to the source of electromotive force is a pure resistance of exceedingly high value. The voltage across either the condenser or the coil is very high.

The reason the currents in the coil and the condenser can be very large and the current in the source of electromotive force very small is that the currents in the coil and the condenser are out of phase. They neutralize each other as far as the current through the generator is concerned.

The circuit in (e) is used frequently in radio receivers. In fact it is used in all tuners, either in the primary of the secondary. Suppose **e** is the effective signal voltage in the plate circuit of an amplifier tube. Then the circuit represents the tuned plate method of coupling in receivers. If **e** represents the voltage developed across the secondary of a radio frequency transformer and if the secondary is connected to the grid circuit of a tube, the figure represents the ordinary tuned circuit in most receivers.

### EXAMPLES OF REACTANCES

Tuning in radio receivers is done exclusively by reactances. In every case an inductive reactance is balanced against a capacitive reactance, and in most cases the capacitive reactance is varied to bring about resonance. If the receiver contains many tuners in tandem there are also many pairs of reactances that must be equalized to effect tuning. This is sometimes done by adjusting the capacitive reactances one at a time and sometimes all at once, as in gang controlled receivers.

In audio frequency amplifiers there should not be any reactances of either kind, because any reactance will introduce frequency discrimination which will mar the quality. Yet in nearly all cases some reactances must be used to make the circuits practical.

There should, for example, be a small by-pass condenser in the plate circuit of the detector. This lowers the output at the high audio frequencies to some extent. Then in many circuits stopping condensers are used between the plate of one tube and the grid of the next, or between the plate of the power tube and the loudspeaker. These condensers lower the output of the low frequencies. The smaller these condensers the more do they suppress the low notes. In some circuits now being popularized most of the stopping condensers are eliminated with considerable gain of the low note output.

When choke coils and transformers are used for coupling, additional reactances are introduced into the amplifier, both inductive and capacitive, the capacitive reactances being due to stray capacities across the windings. The coupling reactances discriminate against the low notes and the distributed capacity reactances against the high. The effect is much the same as tuning, only that the selectivity, that is to say, the discrimination, is not so great.

### BY-PASS CONDENSERS

Even in the so-called non-reactive circuits by-pass condensers should be used for best results, but these introduce reactance which is discriminatory to some extent. But it is better to use them and suffer the discrimination than to omit them and have a circuit that does not amplify well. It is well to remember then the larger any condenser the lower is its reactance.

The condensers and chokes in the B supply have reactance and consequently affect the frequency characteristics of any amplifier connected to it. These reactances have much to do with the frequency at which a circuit motorboats or at which it blasts in case the feedback is not sufficient to sustain oscillation.

# Repeat Tuning on TRF

## Amplifiers Act as Stray Detectors and Sensitive

*By Neal*

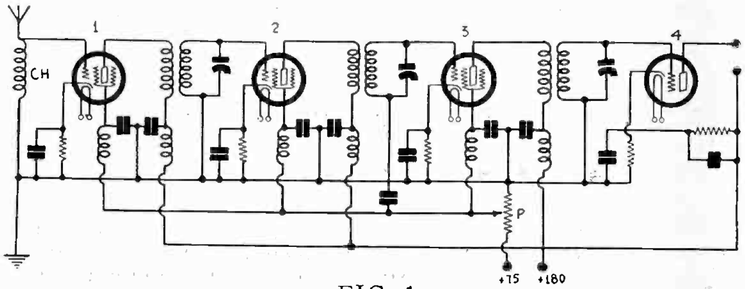



FIG. 1
A RADIO FREQUENCY TUNER AND AMPLIFIER IN WHICH THE ANTENNA IS COUPLED TO THE CIRCUIT BY MEANS OF A CHOKE COIL Ch. RECEPTION OF THE SECOND HARMONIC MAY BE QUITE STRONG.

THOSE who have operated Superheterodyne receivers are familiar with repeat tuning. They know that every station usually comes in on at least two different points on the tuning dial, and frequently at a larger number of different points scattered over the dial.

Tuned radio frequency receivers are not supposed to be subject to this difficulty and operators of such receivers do not expect dual or multiple response. But the fact is that many modern receivers do pick up stations at two points on the tuning dial, one point where the station is normally expected, and another near the low wave-length end of the scale.

"I receive WGY at two points on the dial," is a common complaint. "What can be done about it?"

Of course, all do not complain fo receiving WGY at two settings, for any station that has high field strength about the receiving antenna is likely to come in at two points. Naturally the station that sends out a strong wave in the first place will come in rather than a weak station at two different points, and any station close to the receiver is likely to come in strong at two different points.

### THE CAUSE OF REPEATS

What is the cause of the dual reception? Certainly we cannot ascribe it to the oscillator as is done in the Superheterodyne, because receivers which do not oscillate at all are subject to the condition just as often as receivers which contain an oscillator as a nessential or incidental part. There must be another explanation for the phenomenon.

The fact is that every reeciver brings in most of the stations in two places on the dial. The only question is how strong the signal is at the abnormal point. If the signal is weak the second tuning point is not noticed. If the signal is strong it is received audibly on most receivers, provided that the volume control is turned up high and the circuit tuned accurately to the point where the second point happens to be.

It has been observed that in receivers in which the input circuit is untuned the signal at the second point is stronger than in those circuits which have a sharply tuned input. Apparently there is some relation between the selectivity of the receiver and the intensity with which any station is received at the abnormal point. But many who have noticed the phenomenon have also noticed that extremely selective receivers are subject to the trouble. Indeed, in this respect the circuit behaves like a Superheterodyne, the most selective circuit of all, and the one that is most subject to repeat tuning. Hence lack of selectivity alone does not explain the situation.

### THE EXPLANATION

As a matter of theory there are two possible explanations for the dual reception. It is known that all broadcast stations send out some energy on the second harmonic of the carrier frequency. This energy is contained in a wave exactly like the carrier except that its frequency is twice as great. Therefore if any receiver is tuned accurately to a frequency twice as great as that of the carrier of any station, the signal of that station should come in, provided that the receiver is sensitive enough. It has been found that it is only on the most sensitive receivers that the dual tuning is noticed and only when the sensitivity is turned up to maximum.

If the second harmonic transmitted by the station were alone accountable for the dual tuning there would be no difference between those rceivers which have sharply tuned input circuits and those which have untuned input circuits. If anything, the receiver with the tuned input should be more subject to the trouble than the other type of receiver.

Moreover, the energy sent out on the second harmonic by the better broadcast stations, which include stations that cause most of the trouble, is so small that not even the most sensitive receiver made will pick it up and make it audible, except possibly when the receiver is very close to a broadcast station. Therefore there must be another effect which gives a better explanation. And there is.

We know that every amplifier tube, no matter how well it has been adjusted to amplify without distortion, causes a certain amount of detection. Whenver there is detection there is frequency doubling—harmonic generation. Therefore the amplifier tubes operating at radio frequencies take the carrier frequency of a station and double it. If the tuner is adjusted to the double frequency the second harmonic is singled out and amplified by the tubes just as if the receiver were tuned to the carrier. Therein lies the explanation of most of the trouble.

### TRACING THE CAUSE

Suppose the input circuit of the receiver is untuned. All carrier frequencies are then impressed on the grid of the first tube with practicall ythe same intensity that exists about the antenna. Since the first tube detects a little, besides amplifying considerably, there will be a current of the second harmonic frequency in the plate circuit of the tube.

Now for the first time does the tuner come into play, but now it is too late, since the harmonic frequency already has been generated.

When the receiver is tuned to the second harmonic it receives this just as if the plate circuit of the first tube were the antenna. The first tuner singles out the second harmonic and the second tube amplifies it. The second tuner continues the selection and the third tube the amplification. And so the process continues until the detector tube, where the second harmoniac is detected in the usual way and sends an audio frequency signal on through the amplifier to the speaker.

It is not to be supposed that the first tube alone is responsible for the frequency doubling. Every tube, including the detector, contributes to the process, and every tuner helps in the selection.

So there is no wonder that by the time the signal gets to the audio amplifier the second harmonic of a strong station is loud enough to be comparable with the first harmonic or fundamental of other station. Naturally the first tube contributes most to this condition, since it is placed so that its output is magnified by all the succeeding radio frequency tubes.

### SCREEN GRID TUBES DETECT

It has been asserted that receivers incorporating several screen grid tubes are more subject to the dual response effect than receivers having an equal number of three-element tubes and th same number of tuned circuits. That this assertion is well-founded is clear from the fact that screen grid tubes are normalyy operated as amplifiers so that th stray detection is prolific. Then, again, screen grid tubes amplify more, so that any second harmonic component that may have gotten into the circuit will attain a much higher intensity than in a circuit of three-element tubes.

Just what broadcast stations may be expected on two points on the dial? The lowest broadcast frequency is 550 kilocycles and the frequency of its second harmonic is 1,100 kilocycles. Thus this should appear not far from the center of the dial, the center being on an average at about 930 kilocycles. If the receiver tunes up to 1760 kilocycles, which it well may, the second harmonic of a station operating on 880 kilocycles will be received at the extreme end of the dial, since twice 880 is 1,760.

### RECEPTION ON THIRD HARMONIC

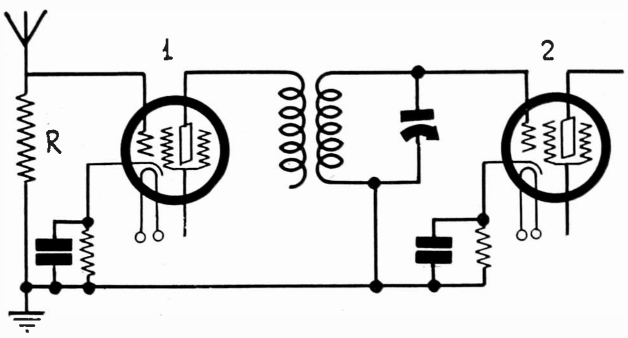
It is quite possible to receive some broadcast stations on the third harmonic as well as on the second, for the third is often more intense than the second. Suppose, for example, that the tuning range of the receiver is from 550 to 1,770 kilocycles. One-third of 1,770 is 590 and therefore there are no less than five channels which could be picked up on the third harmonic if the sensitivity of the receiver and the intensity of the carrier are great nough. However, few tuners can go up to 1,770 kilocycles. But even if a set tunes up to only 1,650 kilocycles one broadcast channel could be tuned in on the third harmonic.

The second tuning point on the ordinary receiver is not likely to cause much interference unless it should happen that

# Receivers and Its Cures

## ircuits Pick Up Odd Interference

*tzalon*





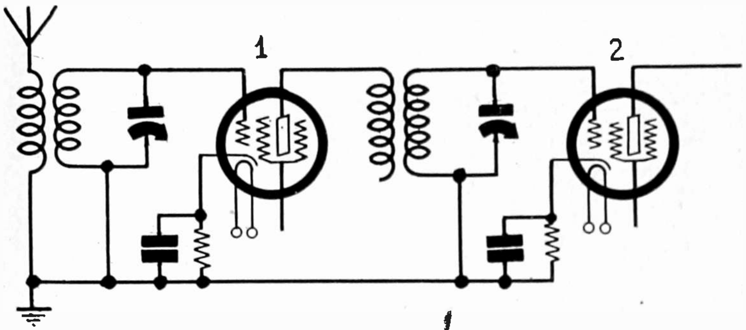




FIG. 2
LEFT: THE FIRST PART OF A CIRCUIT SIMILAR TO THAT IN FIG. 1 EXCEPT THAT A RESISTANCE IS USED FOR COUPLING THE ANTENNA TO THE SET. FREQUENCY DOUBLING IS QUITE STRONG. RIGHT: THIS SHOWS TUNED INPUT FOR MINIMIZING DOUBLING.

two stations, one operating on the second harmonic of the other, should operate in the same locality. When such is the case there may be a heterodyne whistle on both stations.

In a receiver subject to double tuning of the type discussed it is possible that code stations operating on wavelengths longer than the broadcast waves will interfere with broadcast reception. Take, for example, the 600 meter wave on which many ships' stations transmit continually. The frequency of the signal of these stations is 500 kilocycles, the second harmonic of which is 1,000 kilocycles. This lies almost in the middle of the broadcast band and much interference can be expected. Interfernce of this kind might be expected from stations operating on wavelengths as low as 273 meters.

### EXAMPLES OF CIRCUITS

In Fig. 1 is a diagram of screen grid tube radio frequency amplifier and detector in which the input circuit is untuned. The coupling to the antenna is effected by means of a radio frequency choke coil Ch. This is a typical circuit when the tuning condensers are ganged. The object of the untuned input is to insure that all the tuned circuits be alike by the removal of the effects of the antenna constants on the first tuned circuit. This type of circuit is subject to dual reception.

The first part of a similar circuit is shown in Fig. 2, left. Here a non-reactive resistance is used for coupling the antenna to the set. As far as operation is concerned this is in no way different from the circuit in Fig. 1. The first tube detects some and the detected, or doubled frequency, results in dual response.

In Fig. 2, right, is the first part of a receiver in which the antenna input is tuned. In this circuit there is so much discrimination between the desired frequency and the harmonic that very little interference will result from frequency doubling. This kind of input circuit is to be preferred whenever it is practical to use it. It is difficult, however, to gang the condensers in a receiver of this kind except by the use of an accessible trimmer in the first tuned circuit. When such a trimmer has to be used it is just as well to provide a knob for the main tuning condenser. A control is a control whether it is called a trimmer or something else.

The advantage of single control is so great that any trouble caused by dual reception which may result from the use of an untuned input is insignificant. In nearly all cases there is really no interference between stations. The objection to dual reception hinges on the belief that the st, which is supposed to be very sharp. is not selective enough to separate two stations widely apart in the frequency scale, and that belief leads to annoyance. But the remedy is simply the realization that the circuit performs normally and that it does not lack selectivity.

### BEHAVIOR OF SUPER

In the Super-heterodyne repeats are not alone due to frequency multiplication but arises also from the fact that the intermediate frequency can be produced both by setting the oscillator above and below the frequency of the desired carrier by an amount equal to the intermediate frequency. There is frequency doubling and trebling in the Super-hetrodyne, too, and every frequency produced gives one chance for bringing in a signal at a point on the dial where that signal does not normally belong. This property of the Super-heterodyne is well known and most fans expect this behavior.

There are exceptions. There has been so many claims for "one-spot" Super-heterodynes that a few fans have been led to believe that repeats can be eliminated completely. Now most of these "one-spot" supers have been nothing more than ordinary supers with the oscillator condenser tied to the same shaft as the other tuning condensers. Of course this does not make a circuit a "one-spot." It merely eliminates half the chances of getting the stations free of interference.

There is no "one-spot" super, although there are circuits which approach the condition quite closely.

# Adjustments to Make in Non-Reactive Circuits

(*Continued from page* 11)

Just as the grid bias was reduced on the second tube to a value which would put that tube in the best operating condition so the bias on the first tube may be reduced in the same man-voltage divider higher than the negative end of R1. Hence in Fig. 4 is returned to the high point of R2.

The value of R2 in Fig. 2 can be determined approximately by assigning a desired grid bias and using the known current in the resistor. Suppose we want a bias of 1.5 volts. The drop in R2 must then be 6.65 less 1.5, or 5.15 volts. Now the current through R2 is practically the current in the plate circuit of the power tube plus the current through R6 and R7, that is, 42 milliamperes. The currents diverted by the plate and the screen of the first tube is negligible. Hence the value of R2 should be about 12 ohms.

The voltage on the screen is the sum of the drops in R2, P1 and R3 diminished by the drop in R1, or according to the figures derived above, it is less by 1.5 volts than the sum of the drops in R3 and P1. We may assume a screen grid voltage one-third the effective voltage on the plate, and this voltage is about 150 volts. Hence the screen voltage should be 50 volts or somewhat less. Let us call it 45 volts. For simplicity we can call the sum of the drops in P1 and R3 45 volts also. From this and the current flowing through the resistors we can determine the values of P1 and R3. The current, as we have assumed, is 42 milliamperes. Therefore the sum of these two resistors should be 1,071 ohms, or 1,000 for simplicity. The potentiometer P1 can account for 200 volts of this resistance and R3 the rest.

It now remains to determine the value of R4. We know that the voltage drop across R2, P1, R3 and R4 is 200 volts, and we have assumed a total current of 42 milliamperes. Hence the sum of all these resistors should be 4,762 ohms. But we have found the sum of R2, P1 and R3 to be 1,012 ohms. Hence R4 should be 3,750 ohms.

Now it is a reasonable certainty that when these resistors are put into the circuit the adjustment will not be perfect but it will fairly close and they will give a good start, toward experimental adjustment. Difference in tubes will make such adjustment necessary in any case, and possibly the best two values to adjust experimentally are those of R3 and R6, that is to say, those that determine the screen grid voltage on the first tube and the grid bias on the second.

While the screen is shown to return to a fixed point it should preferably be returned to a potentiometer slider, just as C1 is returned. Likewise R6 and R7 could be two sections of a 25,000 ohm potentiometer with R5 returned to the slider.

# The Popular PPPA I

## Chassis Construction Lends Beau

*By Capt. Pe*

**Contri**

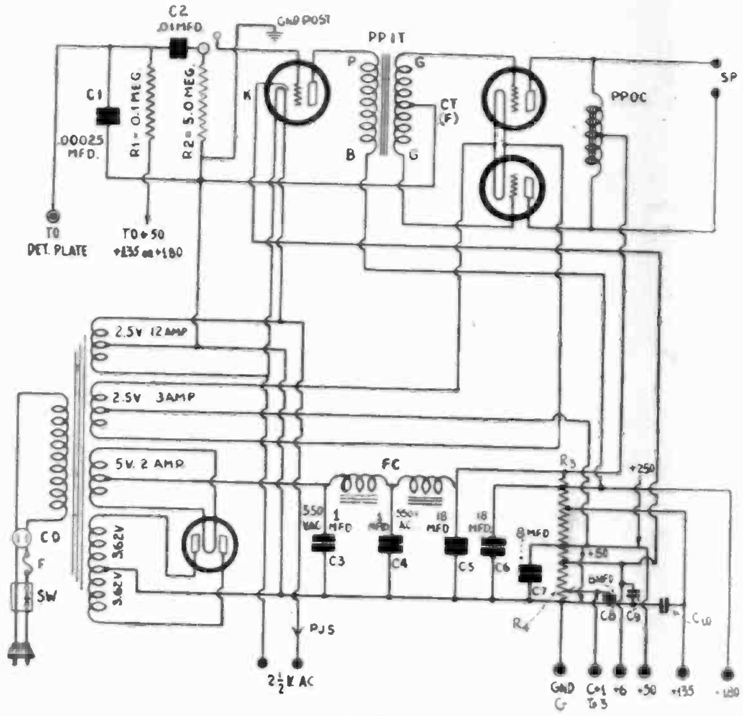



FIG. 1
THE CONNECTIONS DIAGRAM OF THE PPPA AMPLIFIER AND POWER SUPPLY

THE standard push-pull power amplifier using a resistance coupled first stage of audio and a transformer-coupled 245 push-pull output is shown in a new physical dress. The circuit is an A, B and C supply of well-established authenticity, and the dress is made good-looking at last.

### LIST OF PARTS

**C1—One .00025 mfd. mica condenser.**
**C2—One .01 mfd. mica fixed condenser.**
**C3, C4—Two 1 mfd. filter condensers, 1,000 volts DC continuous working voltage, rating, 550 volts AC (root means square) continuous working voltage rating.**
**C5, C6, C7, C8—Four Mershon condensers in one copper casing, two of 8 mfd. and two of 18 mfd., with low bracket. Cat. Q2-8, 2-18B.**
**C9, C10—Two 1 mfd. bypass condensers, 200 volts DC continuous working voltage rating.**
**T1—One Polo Filament-Plate-Choke Supply; 110 volt 50-60 cycle primary, 724 volt secondary center-tapped, 5 volt 2 amp. secondary center-tapped; 2.5 volt 3 ampere secondary center-tapped, and 25 volt 12 ampere secondary center-tapped. Cat. PFPCH. Note, for 25 cycles use Cat. PFPCH-25, for 40 cycles use PFPCH-40).**
**PPOC—One Polo output choke for push-pull (Cat. PPOC).**
**PPIT—One push-pull input transformer (select one you prefer).**
**SW—One AC pendant through-switch, with 12-ft. AC cable and male plug.**
**F—One 2 ampere fuse, with holder.**
**CO—One convenience outlet (for dynamic speaker AC cable).**
**PJ, PJS—Phonograph pick-up jack with automatic switch.**
**R1—One Lynch metallized resistor, 0.1 meg.**
**R2—One Lynch metallized grid leak, 5.0 meg.**
**R3—One Multi-Tap Voltage Divider, 13,850 ohms, fourteen taps.**
**R4—One 30 ohm Clarostat Humdinger.**
**Two resistor mountings.**
**Six binding posts (Det., five blanks).**
**Speaker output jacks in bakelite assembly.**
**One cadmium plated steel chassis, with self-bracketing flanges, one five-prong and three four-prong sockets built in; sockets marked to identify tubes that go in them; subpannel drilled and insulated where necessary.**
**One base cover for chassis, with six bolts and six nuts.**
**Four tubes one 280, one 227, two 245.**

The height is 7 inches, the width or direction in which the sockets run, is 12 inches, and the depth is 10 inches. These are overall dimensions.

On top are the power transformer, Mershon condenser of two 8 mfd., and two 18 mfd., the sockets, output device and binding posts. Beneath are the filter and bypass condensers, and voltage divider.

Thus the assembly is decidedly attractive to the eye, and the tone quality will be no less attractive to the ear, provided a good push-pull input transformer is used. This transformer you are asked to select for yourself, or you may use one you have.

#### Five Voltages Selected

Five positive voltage binding posts are provided, and these may be used for bringing out the voltages you need, since the voltage divider provides a plentiful assortment. Of the group, 3, 6, 10, 16, 22, 50, 75, 90, 135 and 180, ten different voltages, the diagram suggests 3, 6, 50, 135 and 180 as the five, since these are most suitable for high-gain screen grid receivers.

The bias of 3 volts is really 1 to 3, being taken care of by a resistor adjustable from the top of the subpanel with a screwdriver. This resistor is a Clarostat "humdinger," one terminal connected to the low end of the voltage divider, the other Clarostat terminal to grounded B minus. This bias is used for 224 RF tubes.

#### Advantages Listed

The PPPA has the following features:

(1)—Filament voltage for 245s in push-pull and for 280 rectifier; heater voltage for 224s and 228s, up to six such tubes, including the 227 in the PPPA.

(2)—Plate voltage of 250 for the power tubes, with 50 volts bias to spare, total 300 volts at 80 wa., with intermediate B voltages.

(3)—All the bias voltages you will require.

(4)—Phonograph pick-up jack.

(5)—Post for detector (input) and two posts for speaker (output).

(6)—About 60 mfd. of filter and bypass capacity.

(7)—As good an audio channel as can be built in a reactive circuit, with large undistorted power output.

(8)—Good appearance.

# Right or

(1)—In the Loftin-White direct-coupled circuit the grid of the second tube is positive because it is connected to the same point as the plate of the preceding tube.

(2)—When a screen grid tube is used in resistance coupling with a moderately high voltage on the plate the screen grid voltage should be high in order to make up for the difference.

(3)—In a screen grid tube the voltage drop in the coupling resistor is of no practical importance, the applied voltage alone being important.

(4)—AC hum in a receiver can be balanced out, under certain conditions, by introducing a suitable amount of hum into the grid circuit.

(5)—A hot soldering "iron" is the best assurance of good soldered joints.

(6)—Overheating of the soldering "iron" is one of the chief reasons why melted solder will not flow into the joint.

(7)—Equality of all inductance coils and equality of rate of change of all condenser capacities are essential for successful ganging of several tuned circuits.

(8)—To make ganging of several tuned circuits really effective there should be one capacity trimmer and one inductive trimmer in each circuit.

(9)—In order to check the frequencies of broadcast stations against a standard piezo oscillator it is necessary to have one standard for each channel.

#### ANSWERS

(1)—Wrong. The grid is negative by the amount of steady drop in the coupling resistor or by a less amount depending on the return of the plate of the first tube relative to the cathode of the second.

(2)—Wrong. The screen grid voltage must be lowered rather

# a New, Pretty Dress

## o A, B, C, Supply for 245 Output

*V. O'Rourke*

**Editor**

(9)—Compactness, enabling installation in "tight" consoles or even in a table model receiver that has 12 inch cabinet depth (front to back) or accommodation to 10 inch cabinet depth if there is room to put the 12 inch stretch in the direction of the front panel.

(10)—Economy.

The filter system uses a 1 mfd. paper dielectric condenser of 1,000 volts DC continuous working voltage rating, 550 volts AC, root mean square, next to the rectifier and another at the midsection of the filter chokes FC. The first condenser has an effect on the output voltage, and only 1 mfd. is used here because the voltages are satisfactory under the circumstances and the hum is less. Anyone desiring to increase the voltage applied to the push-pull pair may put another 1 mfd. condenser in parallel with the prescribed capacity, making certain, however, that it is of the same high voltage rating. Do not put a 200-volt DC bypass condenser in this position, as it will break down at once.

**Chassis Ground and Negative B**

The filter chokes, two windings to be interconnected to constitute the mid-section, is inside the power transformer case.

As the chassis should be grounded, this connection is most easily made by putting a lug on the machine screw that holds down one side of the bracket of the Mershon condenser, and connecting a wire from one of the terminals of the paper condenser to the lug.

The Mershon condenser provides almost all of the capacity used in the filter. This particular Mershon is the one having two anodes of 8 mfd. each and two of 18 mfd. each. The catalogue number, including bracket, is Q 2-8, 2-18B.

The different capacities of the Mershon condenser may be distinguished easily. The smaller capacity is nearer the edge of the copper casing. In all instances the copper casing is negative. The anodes, represented by lugs on the insulated top of the casing, are positive. Attachment of the bracket to the chassis, which is steel, takes care of grounding the Mershon properly to negative, provided negative of the B supply is connected to the chassis.

One 8 mfd. section is used as the condenser across the AF bias (1 to 3 volts), one 18 mfd. as the "reservoir" condenser at the filter output, the other 18 mfd. to bypass 180 volts and the remaining 8 mfd. across the 50-volt bias section.

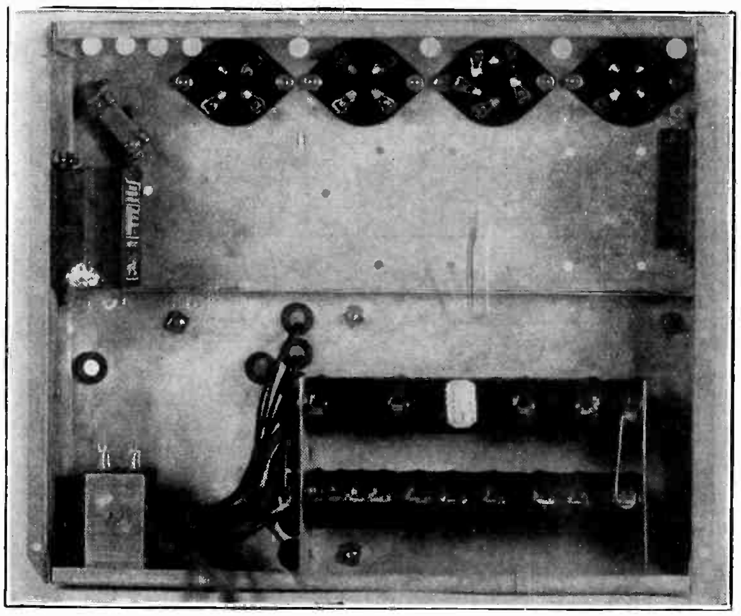


FIG. 2
UNDER-THE-PANEL VIEW OF THE PPPA AMPLIFIER AND POWER SUPPLY

This same voltage of 50, used negatively for biasing these particular tubes, is available as a positive screen voltage for screen grid tubes, or for plate voltage for the grid-leak-condenser detector tube. This seeming double utility arises from the fact that the heater circuits are independent of the cathode, grid and plate circuits of the 227, 224 and 228 tubes, and of course are independent of the filament circuit of the two 245s.

The intermediate voltages (other than 50) are bypassed by 1 mfd. 200 volt condensers, of which four are used. If substitute intermediate voltages are preferred, move the bypass condenser over to the next section of the divider, or if additional output voltages are required, bypass each of such with 1 mfd., also, obtaining the extra condensers and binding posts additionally.

**Voltage Determinations**

By using a high resistance voltmeter you may determine the voltages by simple measurement, and without calculation of voltage drop on the basis of known values of resistance and the current flowing through each section of the divider. The values of current are different in each section. Through all sections flows the bleeder current, a little less than 22 milliamperes, when the power amplifier is worked with an average tuner.

If the bleeder current is measured when there is no load on the rectifier except the Multi-Tap Voltage Divider itself, the reading will be in excess of 22 milliamperes, because the voltage is higher than 300 across the divider. This is due to the low total current. The more current drawn, the lower the voltage, principally because of the regulation of the rectifier tube, the resistance of which increases with increase in current.

When the plate current of the audio amplifier tubes or of the audio and radio amplifier tubes and detector is drawn from the power amplifier, it is impossible to read the bleeder current separately, as there is only one current flowing through each section of the voltage divider. This is the sum of the bleeder current and plate currents.

However, with the voltage across the two extreme terminals known, and the total resistance of the Multi-Tap Voltage Divider being 13,850 ohms, the current is calculated as 300 divided by 13,850, or about .022.

The Multi-Tap Divider consists of two enamelled wire-wound resistors, on separate cores, mounted one above the other on supporting end-brackets, and connected in series. This connection is made at the factory. The entire unit is tapped in resistance steps as follows: 3,000 ohms, 4,500, 2,000, 800, 700, 600, 550, 500, 450, 400, 200, 100 and 50. The zero lug is the fourteenth and goes to the Clarostat. The "low" end is therefore the one where the tops are closer together.

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# rong?

an increased. If the screen grid voltage is high it may be gher than the effective value on the plate, and when it is the be does not function.

(3)—Wrong. This is true in a three-element tube but not in screen grid tube. In a screen grid tube the screen voltage ust always be considerably less than the effective voltage on e plate of the tube.

(4)—Right. One way of doing this is to use a grid bias re-stor and adjusting this as is done when measuring the amplification constant of a tube. Any hum introduced in the plate rcuit is also introduced in the grid circuit but in opposite phase far as the effect is concerned. It can also be done as in the oftin-White circuit.

(5)—Wrong. The "iron" may be too hot. If the "iron" is t and at the same time clean and well tinned the high heat advantageous, but when the "iron" is too hot it is difficult keep it tinned.

(6)—Right. Oxide of tin forms on the surface of the iron in e form of a film and this prevents solder from flowing readily.

(7)—Right. Equality of the inductances is essential in order at matching may be done throughout the tuning range and uality of rate of change of capacities is essential in order at matching may be done at all.

(8)—Right. The capacity trimmers are used to bring about uality of capacity at the low setting of the tuning control and luctive trimmers are useful in equlizing the inductances.

(9)—Wrong. It is possible to use one frequency standard and harmonics for checking many different broadcast frequencies. en if an exact harmonic is not available it is possible to in-polate and thus get a very close measure on the broadcast quency.

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# RADIO UNIVERSITY

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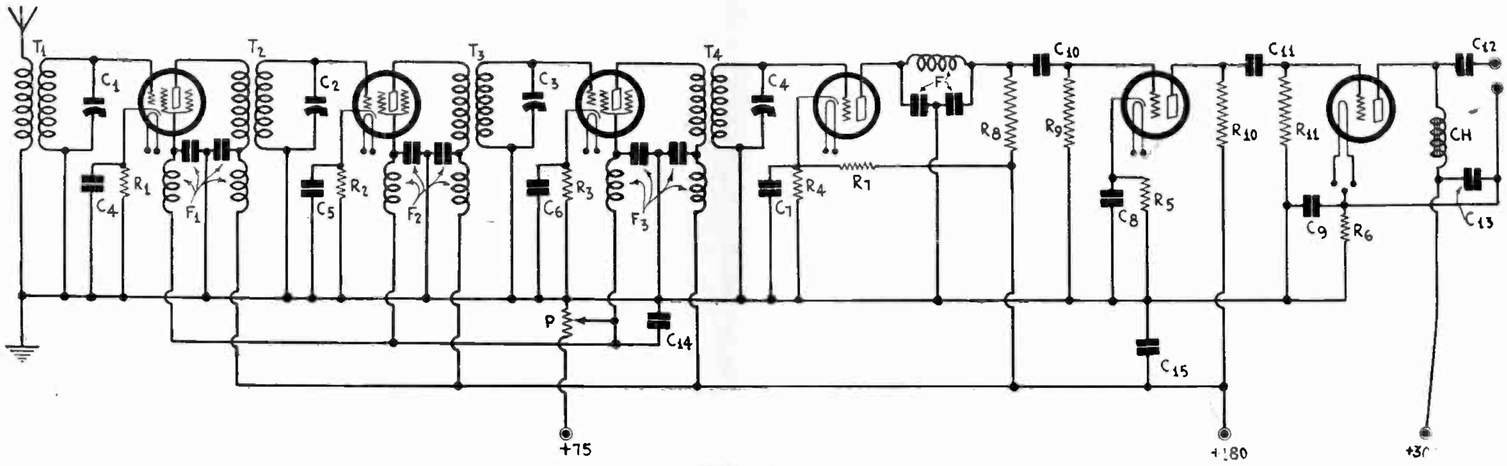


FIG. 824
WHEN SEVERAL STAGES OF SCREEN GRID TUBES ARE USED IN A RECEIVER THOROUGH FILTERING IS DESIRABLE AND THIS CIRCUIT SHOWS HOW IT SHOULD BE DONE TO BE EFFECTIVE

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The circuit in Fig. 824 illustrates a case of thorough filtering to prevent feedback both at radio and audio frequencies. This might serve as a model.

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Possibly you read a statement that resistance coupled circuits are *probably* the most stable because the coupling resistors are non-reactive. The other, and opposing, statements were undoubtedly more positive and based on experimental evidence. There is scarcely a resistance coupled amplifier that does not oscillate at some frequency, unless special precautions have been taken. Transformer and impedance coupled amplifiers are quite often stable without special treatment. It is assumed that all the amplifiers are operated by the same B supply, one at a time, in making this comparison. So the conclusion would seem to be that resistance coupled amplifiers are the most unstable. This conclusion is not based on the probable effect of a reactance but on general experience.

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I HAVE BEEN informed that the capacity between the primary and the secondary of a radio frequency transformer reduces the amplification and that only when this capacity is negligibly small can full gain be obtained. If that is true, will you kindly tell how to reduce the capacity between the windings?—J. A. F.

It is true, as was abundantly proved by a well-known radio frequency transformer. Since the capacity depends on the dimensions of the conductors involved, one way of reducing the capacity between the windings to make the primary, if untuned, of very fine wire. Since capacity also depends on the distance between conductors and decreases with the distance, another way of reducing the capacity is to put the two windings far apart. This is limited practically by the fact that the farther the windings are apart the more is the amplification reduced by virtue of loose coupling. One way is to bunch the primary wires in a slot in such a manner that each turn is coupled inductively most effectively to the secondary, that is, putting the primary near the center of the secondary, with an appreciable distance between the turns of the two. Still another way is to put the primary turns in a flat coil, pancake form, and placing it in the middle of the secondary.

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The only object of building a C supply would be to obtain the C potential required without robbing the plate circuits of voltage. For example, suppose the total available voltage is only 250 volts and 245 power tubes are used. These tubes should have 250 volts on the plates and 50 on the grids. Obviously, a total of 250 will not supply both. In this case it would be worth while to build a C supply, provided that the 250 volt power supply is large enough to handle the circuit. Otherwise it would be necessary to get another B supply, one which gave a total of 300 volts. With this it would not be necessary to use a separate C supply. The situation is somewhat the same with 250 power tubes. These require 450 volts on the plates and 84 volts on the grids, a total of 534 volts. Few B supply units give this voltage, so when the total voltage available is less than 500 volts it would pay to use a separate C supply. It should be noted that it costs practically nothing to operate a C supply giving 84 volts or more and it costs an appreciable amount to get 84 volts from the regular high power B supply. For example, suppose the receiver contains two 250 tubes, which draw a plate current of 110 milliamperes. Since the bias required is 84 volts the power consumption for the C supply alone is 9.24 watts. The same voltage could be obtained from a C supply with less than a watt.

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If it is the station you want to get rid of, you have two courses open, move the station or move the set. If neither is practical you might try to eliminate the signal from the station. One way of doing this is to get a more selective set. Possibly the simplest remedy in the case is to install a wavetrap in the antenna circuit. Wind some heavy magnet wire on a 3-inch bakelite tube, or other insulating tube, and connect a .0005 mfd. condenser in series with the coil. Connect this in the antenna circuit and tune the trap to the interfering signal. An alternative connection is to put a second winding of about 10 turns on the form and connect this small winding in series with the antenna, tuning the trap to the interfering signal. Close tuning is necessary. The trap will help a great deal. You should use about 40 turns.

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The difference, of course, is due to the voltage drop in the leads between the transformer and the tubes and the remedy is to reduce the resistance in these leads. This reduction may be effected either by making the leads of heavier wire or by making them shorter. Making both of these changes would be desirable.

### SPEAKER HUM REMOVED

RECENTLY I bought a receiver in which there was provision for the field of a 90-volt dynamic speaker. I connected a Jensen dynamic to the binding posts provided and the result is a terrific hum which can be heard even above loud signals. I had used the same speaker before, taking the field current from a special B supply unit, and there was hardly any hum. What little there was could only be heard close to the speaker. What is the trouble and how can it be remedied?—H. A. D.

The field current supplied by the new receiver is not filtered well enough. It may be that the filter in the B supply becomes overloaded when the extra current is taken. The remedy is to provide additional filtering. A large by-pass condenser across the field winding may be sufficient, but it may be that you also have to use a choke coil in series with the field winding. Why not continue to use the B supply unit that did provide adequately filtered field current?

### COMBINING AC AND DC

IS IT POSSIBLE to build a receiver so that DC is used on the filaments of the radio frequency amplifier and the detector and AC on the filaments of the audio frequency tubes? Would there be any advantage in arranging a circuit in this way?—W. H. C.

It is perfectly feasible to arrange a circuit that way, and many receivers are so built. Using DC up to and including the detector may make it easier to eliminate hum, but otherwise there is no advantage. It would be much simpler to use AC throughout.

### POLARITY TESTS

CAN YOU SUGGEST any methods of testing the polarity of voltage sources, such as that of the DC power supply?—W. J. S.

One of the simplest polarity testers is a glass of water in which a small quantity of salt has been dissolved. Put the two terminals in the water, as far apart as practicable. Bubbles will appear around both terminals but there will be twice as many around the negative. Another simple test is one involving the use of a raw potato. Cut a potato in two and insert the terminals into one of the cut surfaces. Around the positive terminal a green spot will form. There is also a tester available which works on the principle of the neon cell. The device has two neon cells, and it is arranged so that when the device is connected across a DC voltage source one cell lights up, indicating the polarity. If the device is connected across an AC voltage both cells light up. This is one of the handiest devices gotten out.

### RESISTANCE-COUPLED RF

WOULD IT BE practical to use resistance coupling and screen grid tubes in the radio frequency amplifier? I am desirous of building an amplifier of this type provided that it would be satisfactory.—E. A. B.

It would not be satisfactory. In the first place even screen grid tubes do not work efficiently in resistance coupled circuits at high frequencies and in the second there would be no selectivity. There would be a good deal of detection in the RF amplifier which would give rise to repeat tuning.

### IMPEDANCE-COUPLED AMPLIFIER

IS IT POSSIBLE to get as good quality with impedance-coupled audio amplifiers as with resistance coupled circuits? Are there any advantages of impedance aside from quality over resistance couplers?—W. C. C.

There is very little difference between the quality of output of the two types of couplers provided that the impedances of the impedances are high. The quality from a resistance coupler is slightly better at the low frequencies. Impedance couplers have no advantages. Both types of amplifiers are subject to the same disadvantages and impedance coils cost much more than resistances. They also occupy more space in the set and an impedance coupled circuit takes more plate current.

### THE MORGAN AMPLIFIER

SOME TIME AGO you published a type of circuit which you call the Morgan amplifier. Have you tested this amplifier thoroughly and is it as good as claimed? Have you had any reports on the circuit, favorable or otherwise?—J. J. R.

The circuit was developed by Prof. Morgan who knows his subject thoroughly. The circuit is correctly designed. We have had no unfavorable reports whatsoever, but we have had some very enthusiastic reports. One who built the circuit reported that before he could get satisfactory results he had to make minor changes in the voltages but after he had made these changes the circuit was by far the best he had ever listened to. That changes are necessary at times is clear from the fact that tubes are not equal. It is necessary to make small changes in the voltages to compensate for these differences. But they are easily made.

### GET A NEW B SUPPLY

I HAVE A B supply unit which I used with an old five-tube receiver. It gave good service on the old set and I am now wondering whether it will work the MB-29 tuner and an audio frequency amplifier using two 245s in the last stage. What do you say?—A. B. Q.

Since you said nothing as to what B supply unit you had we can only guess as to its adequacy in the new receiver. Our guess is that it will be sadly lacking in power and that the results with the new combination will not be as good as those with the old. By all means get a B supply which is able to handle the MB-29 and the power amplifier. Since you have the old B supply, you might try it on the new combination before you get the new B supply. Undoubtedly you will find that a substantial B supply is a good investment.

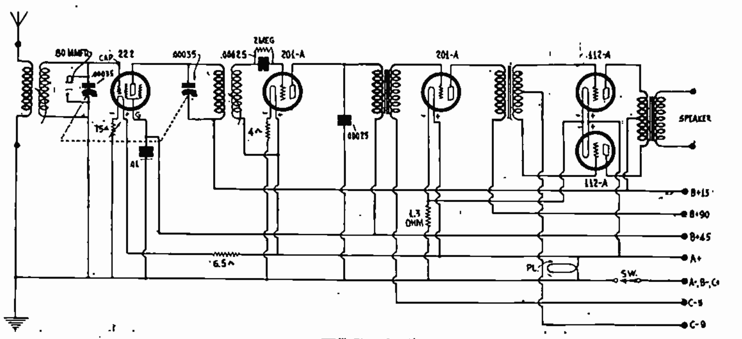


FIG. 825

A SIMPLE FIVE-TUBE RECEIVER EMPLOYING SCREEN GRID AMPLIFICATION IN THE FIRST STAGE AND PUSH-PULL IN THE OUTPUT. GANG CONTROL OF THE TWO TUNED CIRCUITS IS A FEATURE.

### GANG TUNING DESIRED

WILL YOU PLEASE publish a diagram of a circuit as follows: One screen grid tube of the 222 type, one 201A detector, one 201A amplifier, one stage of push-pull with 112A tubes, transformer coupling, and gang control of the two tuned circuits.—J. A. J.

See Fig. 825 above for the circuit you request.

### BEST INSULATORS

WILL YOU KINDLY name some of the best insulators for radio purposes? Also please name some of the best conductors.—A. G. M.

Fused quartz and ceresin wax are two of the best insulators known, each having a resistivity of 5 billion billion ohms per centimeter cube. Next comes hard rubber with a resistivity one-fifth as great. Colorless mica and sulphur come next. Rosin and paraffin also rank high as insulators.

The best conductors are silver, copper, aluminum and gold and are good conductors. The poorest conductors of the metals or alloys are bismuth, Nichrome, mercury, cast iron and German silver, in the order named.

# The Popular PPPA

## Chassis Construction Lends Beau

*By Capt. Pe*

**Contri**

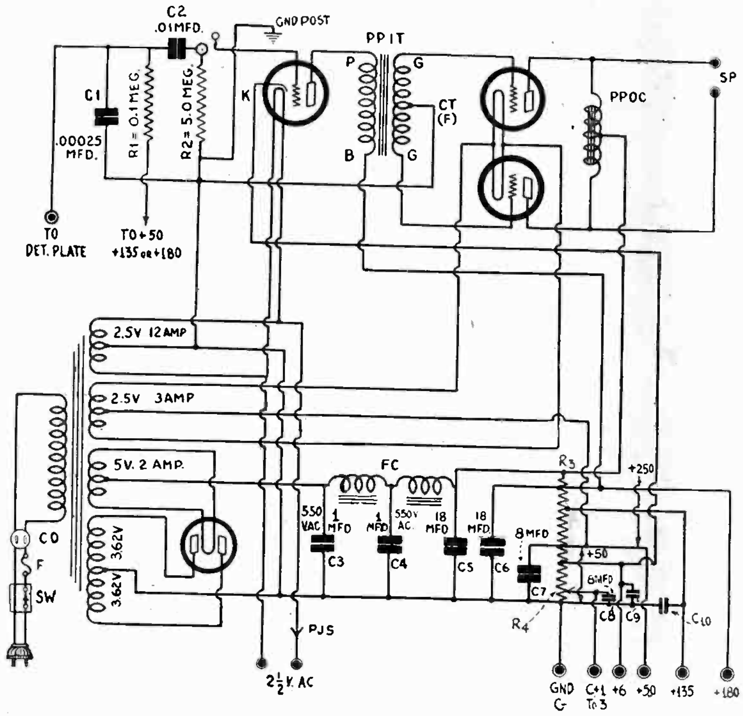


FIG. 1
THE CONNECTIONS DIAGRAM OF THE PPPA AMPLIFIER AND POWER SUPPLY

THE standard push-pull power amplifier using a resistance coupled first stage of audio and a transformer—coupled 245 push-pull output is shown in a new physical dress. The circuit is an A, B and C supply of well-established authenticity, and the dress is made good-looking at last.

### LIST OF PARTS

**C1—One .00025 mfd. mica condenser.**
**C2—One .01 mfd. mica fixed condenser.**
**C3, C4—Two 1 mfd. filter condensers, 1,000 volts DC continuous working voltage, rating, 550 volts AC (root means square) continuous working voltage rating.**
**C5, C6, C7, C8—Four Mershon condensers in one copper casing, two of 8 mfd. and two of 18 mfd., with low bracket. Cat. Q2-8, 2-18B.**
**C9, C10—Two 1 mfd. bypass condensers, 200 volts DC continuous working voltage rating.**
**T1—One Polo Filament-Plate-Choke Supply; 110 volt 50-60 cycle primary, 724 volt secondary center-tapped, 5 volt 2 amp. secondary center-tapped; 2.5 volt 3 ampere secondary center-tapped, and 25 volt 12 ampere secondary center-tapped. Cat. PFPCH. Note, for 25 cycles use Cat. PFPCH-25, for 40 cycles use PFPCH-40).**
**PPOC—One Polo output choke for push-pull (Cat. PPOC).**
**PPIT—One push-pull input transformer (select one you prefer).**
**SW—One AC pendant through-switch, with 12-ft. AC cable and male plug.**
**F—One 2 ampere fuse, with holder.**
**CO—One convenience outlet (for dynamic speaker AC cable).**
**PJ, PJS—Phonograph pick-up jack with automatic switch.**
**R1—One Lynch metallized resistor, 0.1 meg.**
**R2—One Lynch metallized grid leak, 5.0 meg.**
**R3—One Multi-Tap Voltage Divider, 13,850 ohms, fourteen taps.**
**R4—One 30 ohm Clarostat Humdinger.**
**Two resistor mountings.**
**Six binding posts (Det., five blanks).**
**Speaker output jacks in bakelite assembly.**
**One cadmium plated steel chassis, with self-bracketing flanges, one five-prong and three four-prong sockets built in; sockets marked to identify tubes that go in them; subpannel drilled and insulated where necessary.**
**One base cover for chassis, with six bolts and six nuts.**
**Four tubes one 280, one 227, two 245.**

The height is 7 inches, the width or direction in which the sockets run, is 12 inches, and the depth is 10 inches. These are overall dimensions.

On top are the power transformer, Mershon condenser of two 8 mfd., and two 18 mfd., the sockets, output device and binding posts. Beneath are the filter and bypass condensers, and voltage divider.

Thus the assembly is decidedly attractive to the eye, and the tone quality will be no less attractive to the ear, provided a good push-pull input transformer is used. This transformer you are asked to select for yourself, or you may use one you have.

#### Five Voltages Selected

Five positive voltage binding posts are provided, and these may be used for bringing out the voltages you need, since the voltage divider provides a plentiful assortment. Of the group, 3, 6, 10, 16, 22, 50, 75, 90, 135 and 180, ten different voltages, the diagram suggests 3, 6, 50, 135 and 180 as the five, since these are most suitable for high-gain screen grid receivers.

The bias of 3 volts is really 1 to 3, being taken care of by a resistor adjustable from the top of the subpanel with a screwdriver. This resistor is a Clarostat "humdinger," one terminal connected to the low end of the voltage divider, the other Clarostat terminal to grounded B minus. This bias is used for 224 RF tubes.

#### Advantages Listed

The PPPA has the following features:

(1)—Filament voltage for 245s in push-pull and for 280 rectifier; heater voltage for 224s and 228s, up to six such tubes, including the 227 in the PPPA.

(2)—Plate voltage of 250 for the power tubes, with 50 volts bias to spare, total 300 volts at 80 wa., with intermediate B voltages.

(3)—All the bias voltages you will require.

(4)—Phonograph pick-up jack.

(5)—Post for detector (input) and two posts for speaker (output).

(6)—About 60 mfd. of filter and bypass capacity.

(7)—As good an audio channel as can be built in a reactive circuit, with large undistorted power output.

(8)—Good appearance.

## Right or

(1)—In the Loftin-White direct-coupled circuit the grid of the second tube is positive because it is connected to the same point as the plate of the preceding tube.

(2)—When a screen grid tube is used in resistance coupling with a moderately high voltage on the plate the screen grid voltage should be high in order to make up for the difference.

(3)—In a screen grid tube the voltage drop in the coupling resistor is of no practical importance, the applied voltage alone being important.

(4)—AC hum in a receiver can be balanced out, under certain conditions, by introducing a suitable amount of hum into the grid circuit.

(5)—A hot soldering "iron" is the best assurance of good soldered joints.

(6)—Overheating of the soldering "iron" is one of the chief reasons why melted solder will not flow into the joint.

(7)—Equality of all inductance coils and equality of rate of change of all condenser capacities are essential for successful ganging of several tuned circuits.

(8)—To make ganging of several tuned circuits really effective there should be one capacity trimmer and one inductive trimmer in each circuit.

(9)—In order to check the frequencies of broadcast stations against a standard piezo oscillator it is necessary to have one standard for each channel.

#### ANSWERS

(1)—Wrong. The grid is negative by the amount of steady drop in the coupling resistor or by a less amount depending on the return of the plate of the first tube relative to the cathode of the second.

(2)—Wrong. The screen grid voltage must be lowered rather

# a New, Pretty Dress

## to A, B, C, Supply for 245 Output

*V. O'Rourke*

**Editor**

(9)—Compactness, enabling installation in "tight" consoles or even in a table model receiver that has 12 inch cabinet depth (front to back) or accommodation to 10 inch cabinet depth if there is room to put the 12 inch stretch in the direction of the front panel.

(10)—Economy.

The filter system uses a 1 mfd. paper dielectric condenser of 1,000 volts DC continuous working voltage rating, 550 volts AC, root mean square, next to the rectifier and another at the midsection of the filter chokes FC. The first condenser has an effect on the output voltage, and only 1 mfd. is used here because the voltages are satisfactory under the circumstances and the hum is less. Anyone desiring to increase the voltage applied to the push-pull pair may put another 1 mfd. condenser in parallel with the prescribed capacity, making certain, however, that it is of the same high voltage rating. Do not put a 200-volt DC bypass condenser in this position, as it will break down at once.

**Chassis Ground and Negative B**

The filter chokes, two windings to be interconnected to constitute the mid-section, is inside the power transformer case.

As the chassis should be grounded, this connection is most easily made by putting a lug on the machine screw that holds down one side of the bracket of the Mershon condenser, and connecting a wire from one of the terminals of the paper condenser to the lug.

The Mershon condenser provides almost all of the capacity used in the filter. This particular Mershon is the one having two anodes of 8 mfd. each and two of 18 mfd. each. The catalogue number, including bracket, is Q 2-8, 2-18B.

The different capacities of the Mershon condenser may be distinguished easily. The smaller capacity is nearer the edge of the copper casing. In all instances the copper casing is negative. The anodes, represented by lugs on the insulated top of the casing, are positive. Attachment of the bracket to the chassis, which is steel, takes care of grounding the Mershon properly to negative, provided negative of the B supply is connected to the chassis.

One 8 mfd. section is used as the condenser across the RF bias (1 to 3 volts), one 18 mfd. as the "reservoir" condenser at the filter output, the other 18 mfd. to bypass 180 volts and the remaining 8 mfd. across the 50-volt bias section.

This same voltage of 50, used negatively for biasing these particular tubes, is available as a positive screen voltage for screen grid tubes, or for plate voltage for the grid-leak-condenser detector tube. This seeming double utility arises from the fact that the heater circuits are independent of the cathode, grid and plate circuits of the 227, 224 and 228 tubes, and of course are independent of the filament circuit of the two 245s.

The intermediate voltages (other than 50) are bypassed by 1 mfd. 200 volt condensers, of which four are used. If substitute intermediate voltages are preferred, move the bypass condenser over to the next section of the divider, or if additional output voltages are required, bypass each of such with 1 mfd., also, obtaining the extra condensers and binding posts additionally.

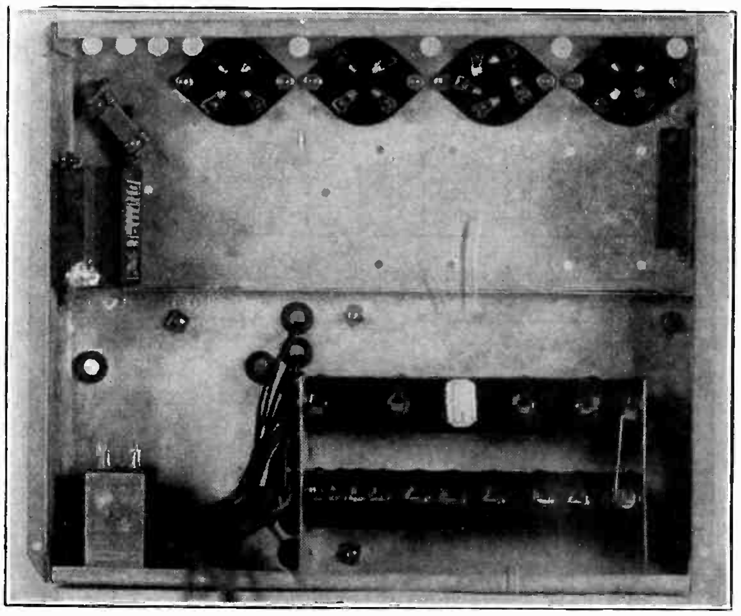


FIG. 2
UNDER-THE-PANEL VIEW OF THE PPPA AMPLIFIER AND POWER SUPPLY

**Voltage Determinations**

By using a high resistance voltmeter you may determine the voltages by simple measurement, and without calculation of voltage drop on the basis of known values of resistance and the current flowing through each section of the divider. The values of current are different in each section. Through all sections flows the bleeder current, a little less than 22 milliamperes, when the power amplifier is worked with an average tuner.

If the bleeder current is measured when there is no load on the rectifier except the Multi-Tap Voltage Divider itself, the reading will be in excess of 22 milliamperes, because the voltage is higher than 300 across the divider. This is due to the low total current. The more current drawn, the lower the voltage, principally because of the regulation of the rectifier tube, the resistance of which increases with increase in current.

When the plate current of the audio amplifier tubes or of the audio and radio amplifier tubes and detector is drawn from the power amplifier, it is impossible to read the bleeder current separately, as there is only one current flowing through each section of the voltage divider. This is the sum of the bleeder current and plate currents.

However, with the voltage across the two extreme terminals known, and the total resistance of the Multi-Tap Voltage Divider being 13,850 ohms, the current is calculated as 300 divided by 13,850, or about .022.

The Multi-Tap Divider consists of two enamelled wire-wound resistors, on separate cores, mounted one above the other on supporting end-brackets, and connected in series. This connection is made at the factory. The entire unit is tapped in resistance steps as follows: 3,000 ohms, 4,500, 2,000, 800, 700, 600, 550, 500, 450, 400, 200, 100 and 50. The zero lug is the fourteenth and goes to the Clarostat. The "low" end is therefore the one where the tops are closer together.

# /rong?

ıan increased. If the screen grid voltage is high it may be igher than the effective value on the plate, and when it is the ıbe does not function.

(3)—Wrong. This is true in a three-element tube but not in screen grid tube. In a screen grid tube the screen voltage ıust always be considerably less than the effective voltage on ıe plate of the tube.

(4)—Right. One way of doing this is to use a grid bias restor and adjusting this as is done when measuring the amplifiıation constant of a tube. Any hum introduced in the plate rcuit is also introduced in the grid circuit but in opposite phase far as the effect is concerned. It can also be done as in the oftin-White circuit.

(5)—Wrong. The "iron" may be too hot. If the "iron" is ot and at the same time clean and well tinned the high heat advantageous, but when the "iron" is too hot it is difficult keep it tinned.

(6)—Right. Oxide of tin forms on the surface of the iron in e form of a film and this prevents solder from flowing readily.

(7)—Right. Equality of the inductances is essential in order at matching may be done throughout the tuning range and uality of rate of change of capacities is essential in order at matching may be done at all.

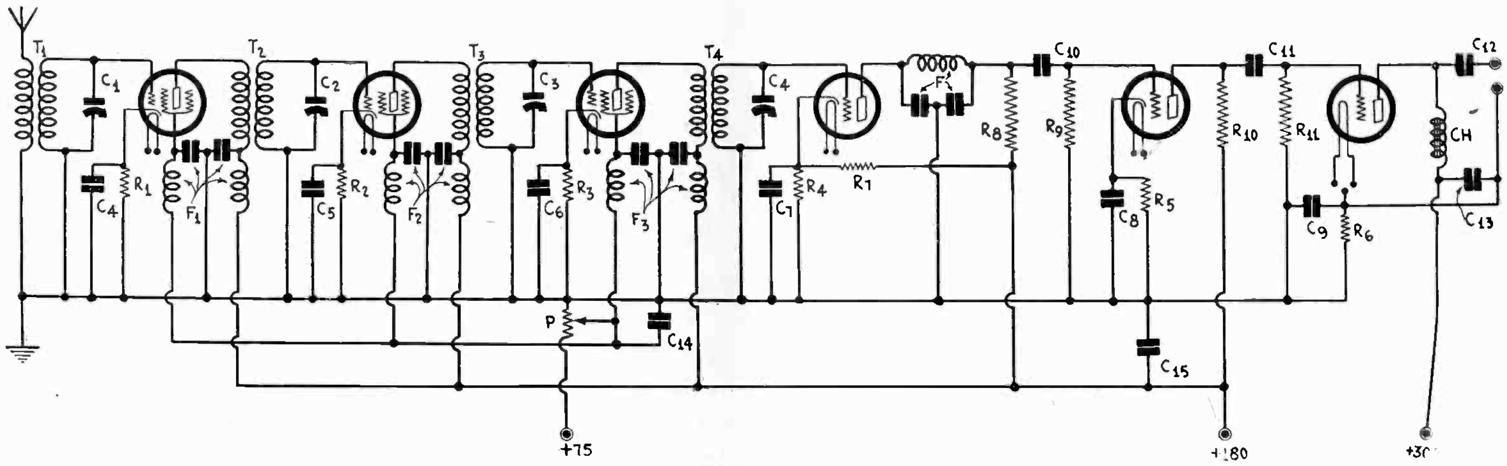
(8)—Right. The capacity trimmers are used to bring about uality of capacity at the low setting of the tuning control and ductive trimmers are useful in equlizing the inductances.

(9)—Wrong. It is possible to use one frequency standard and harmonics for checking many different broadcast frequencies. ven if an exact harmonic is not available it is possible to inrpolate and thus get a very close measure on the broadcast equency.

A Question and Answer Department conducted by Radio World's Technical Staff. Only Questions sent in by University Club Members are answered. Those not answered in these columns are answered by mail.

# RADIO UNIVERSITY

Annual subscriptions are accepted at $6 for 52 numbers, with the privilege of obtaining answers to radio questions for the period of the subscription, but not if any other premium is obtained with the subscription.

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### SPEAKER HUM REMOVED

RECENTLY I bought a receiver in which there was provision for the field of a 90-volt dynamic speaker. I connected a Jensen dynamic to the binding posts provided and the result is a terrific hum which can be heard even above loud signals. I had used the same speaker before, taking the field current from a special B supply unit, and there was hardly any hum. What little there was could only be heard close to the speaker. What is the trouble and how can it be remedied?—H. A. D.

The field current supplied by the new receiver is not filtered well enough. It may be that the filter in the B supply becomes overloaded when the extra current is taken. The remedy is to provide additional filtering. A large by-pass condenser across the field winding may be sufficient, but it may be that you also have to use a choke coil in series with the field winding. Why not continue to use the B supply unit that did provide adequately filtered field current?

### COMBINING AC AND DC

IS IT POSSIBLE to build a receiver so that DC is used on the filaments of the radio frequency amplifier and the detector and AC on the filaments of the audio frequency tubes? Would there be any advantage in arranging a circuit in this way?—W. H. C.

It is perfectly feasible to arrange a circuit that way, and many receivers are so built. Using DC up to and including the detector may make it easier to eliminate hum, but otherwise there is no advantage. It would be much simpler to use AC throughout.

### POLARITY TESTS

CAN YOU SUGGEST any methods of testing the polarity of voltage sources, such as that of the DC power supply?—W. J. S.

One of the simplest polarity testers is a glass of water in which a small quantity of salt has been dissolved. Put the two terminals in the water, as far apart as practicable. Bubbles will appear around both terminals but there will be twice as many around the negative. Another simple test is one involving the use of a raw potato. Cut a potato in two and insert the terminals into one of the cut surfaces. Around the positive terminal a green spot will form. There is also a tester available which works on the principle of the neon cell. The device has two neon cells, and it is arranged so that when the device is connected across a DC voltage source one cell lights up, indicating the polarity. If the device is connected across an AC voltage both cells light up. This is one of the handiest devices gotten out.

### RESISTANCE-COUPLED RF

WOULD IT BE practical to use resistance coupling and screen grid tubes in the radio frequency amplifier? I am desirous of building an amplifier of this type provided that it would be satisfactory.—E. A. B.

It would not be satisfactory. In the first place even screen grid tubes do not work efficiently in resistance coupled circuits at high frequencies and in the second there would be no selectivity. There would be a good deal of detection in the RF amplifier which would give rise to repeat tuning.

### IMPEDANCE-COUPLED AMPLIFIER

IS IT POSSIBLE to get as good quality with impedance-coupled audio amplifiers as with resistance coupled circuits? Are there any advantages of impedance aside from quality over resistance couplers?—W. C. C.

There is very little difference between the quality of output of the two types of couplers provided that the impedances of the impedances are high. The quality from a resistance coupler is slightly better at the low frequencies. Impedance couplers have no advantages. Both types of amplifiers are subject to the same disadvantages and impedance coils cost much more than resistances. They also occupy more space in the set and an impedance coupled circuit takes more plate current.

### THE MORGAN AMPLIFIER

SOME TIME AGO you published a type of circuit which you call the Morgan amplifier. Have you tested this amplifier thoroughly and is it as good as claimed? Have you had any reports on the circuit, favorable or otherwise?—J. J. R.

The circuit was developed by Prof. Morgan who knows his subject thoroughly. The circuit is correctly designed. We have had no unfavorable reports whatsoever, but we have had some very enthusiastic reports. One who built the circuit reported that before he could get satisfactory results he had to make minor changes in the voltages but after he had made these changes the circuit was by far the best he had ever listened to. That changes are necessary at times is clear from the fact that tubes are not equal. It is necessary to make small changes in the voltages to compensate for these differences. But they are easily made.

### GET A NEW B SUPPLY

I HAVE A B supply unit which I used with an old five-tube receiver. It gave good service on the old set and I am now wondering whether it will work the MB-29 tuner and an audio frequency amplifier using two 245s in the last stage. What do you say?—A. B. Q.

Since you said nothing as to what B supply unit you had we can only guess as to its adequacy in the new receiver. Our guess is that it will be sadly lacking in power and that the results with the new combination will not be as good as those with the old. By all means get a B supply which is able to handle the MB-29 and the power amplifier. Since you have the old B supply, you might try it on the new combination before you get the new B supply. Undoubtedly you will find that a substantial B supply is a good investment.

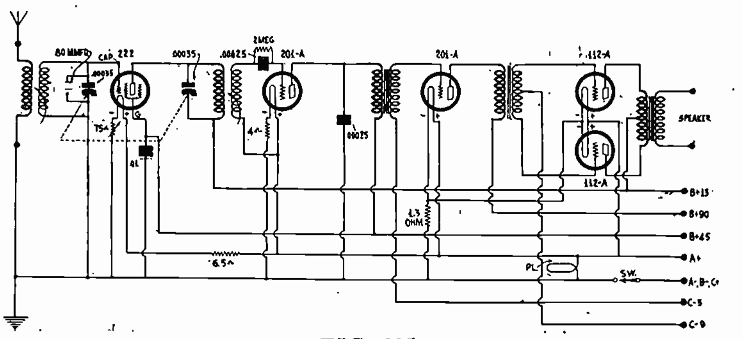


FIG. 825

A SIMPLE FIVE-TUBE RECEIVER EMPLOYING SCREEN GRID AMPLIFICATION IN THE FIRST STAGE AND PUSH-PULL IN THE OUTPUT. GANG CONTROL OF THE TWO TUNED CIRCUITS IS A FEATURE.

### GANG TUNING DESIRED

WILL YOU PLEASE publish a diagram of a circuit as follows: One screen grid tube of the 222 type, one 201A detector, one 201A amplifier, one stage of push-pull with 112A tubes, transformer coupling, and gang control of the two tuned circuits.—J. A. J.

See Fig. 825 above for the circuit you request.

### BEST INSULATORS

WILL YOU KINDLY name some of the best insulators for radio purposes? Also please name some of the best conductors.—A. G. M.

Fused quartz and ceresin wax are two of the best insulators known, each having a resistivity of 5 billion billion ohms per centimeter cube. Next comes hard rubber with a resistivity one-fifth as great. Colorless mica and sulphur come next. Rosin and paraffin also rank high as insulators.

The best conductors are silver, copper, aluminum and gold and are good conductors. The poorest conductors of the metals or alloys are bismuth, Nichrome, mercury, cast iron and German silver, in the order named.

# EQUALITY LAW IS EVADED AS 'IMPOSSIBLE'

Washington.

Strict adherence to the Davis amendment to the radio law for the equal distribution of radio facilities among the zones and states is a "physical impossibility" if satisfactory reception for all listeners is to be provided, Federal Radio Commissioner Harold A. Lafount told the Senate Committee on Interstate Commerce.

After Senator Dill (Dem.), of Washington, and co-author of the amendment, again had criticized the Commission for its failure to observe the requirements of the law, Commissioner Lafount said reception would be "ruined" if the Commission attempted to follow it to the letter.

Despite the inherent difficulties of the amendment, he said, the Commission has accomplished a virtual equality in the distribution of stations and wavelengths among the five zones into which the Nation is divided, based on population, but has been unable to do so in the case of power distribution.

### Calls Board a Violator

Although Senator Dill admitted that the Davis amendment is not satisfactory in every detail, and that some other yardstick for the distribution of facilities should be provided, he declared this does not alter the fact that the Commission has violated the intent of the law.

"The Commission has evaded the law and has not adhered to it to the letter," declared the Senator. "The Commission has taken it upon itself to readjust the law when it should have followed it.

"I am not satisfied with the Davis amendment, and I never have been, but the public demand that something be done about the then chaotic radio conditions forced its enactment," Senator Dill continued. "I do not believe that both houses of Congress would agree to its repeal, but want a substitute for it first. They do not trust the Commission."

### Commission Replies

Commissioner Lafount called attention to the fallacies of the Davis amendment. The zones are so disproportionate in size, he declared, that the smallest of them, the first or eastern zone, does not cover a geographical area as large as the state of Montana, which is only about one-fiftenth of the entire fifth or western zone. Yet, he declared, under the law, the geographically great fifth zone may have no more radio facilities than the compact first zone.

Moreover, he said, when the Davis amendment was passed, the eastern and middlewestern zones. in which the greatest centers of population—New York and Chicago—were located naturally had the largest number of stations. It was natural, he said, that they should have had more broadcasting power, and although there has been a sweeping reallocation, this same power situation obtains today.

Commissioner Lafount said that atmospheric and other physical conditions which have the tendency either of absorbing or accentuating radio signals, which prevail in different localities, also prevent a mathematical allocation of facilities.

### Granite Plays Its Part

For example, he declared, along the Mississippi Valley reception is excellent, while a station broadcasting with the same power and on the same wavelength in New England will not be heard over a range even approaching that of the transmitter in the Mississippi Valley. This, he said, is because of the granite absorption in New England.

Asked by Senator Dill what a proper system of regulating broadcasting should be, Commissioner Lafount said such a proposition should be left to the judgment of the Commission. It is a continuous problem, he said, needing almost day to day attention and revision, and should be kept fluid, without restrictive laws which do not recognize the engineering problems.

A discussion of the chain program problem, and of reports of duplication of such programs on the listeners' dial was precipitated by Senator Brookhart (Rep.), of Iowa, according to "The United States Daily." The Senator said that in his state a listener reported that he received the same program 20 places on his dial.

### Finds Distance Appetite Wanes

Commissioner Lafount said few complaints of duplication are received by the Commission. People today, he said, are content to listen to stations in close proximity to the point of reception which offer chain or other programs, and do not attempt to pick up distant stations as they formerly did when it was a novelty.

Senator Dill asked why the Commission did not limit the broadcasting of chain programs on cleared channels, used by high-powered stations, so there would be a minimum of duplication. He suggested that the Commission might restrict the use of chain programs on certain of the eight cleared channels assigned to each of the five radio zones.

Questioned as to the proposal to impose license fees upon broadcasting stations with a view to defraying the cost of administering radio in the United States, Commissioner Lafount said he was not definitely opposed to such a system, but that it would be extremely difficult to handle.

### Rates Under Secretary

At the outset of the hearing, the chairman of the Commission, Ira E. Robinson, resumed his testimony, begun the preceding day. Senator Kean (Rep.), New Jersey, interrogated the witness as to the existing conditions in the New York metropolitan area, wherein certain high-powered broadcasting stations, accredited to the New York quota, have their transmitters located in New Jersey. He said these transmitters "blanket out" reception of New Jersey stations, and should not be permitted under the law which recognizes such conditions.

Mr. Robinson said the Commission, in administering radio, looks upon it from the broad national viewpoint, and how the American public generally may be served to the maximum extent. He said the Commission has had the New Jersey controversy aired before it.

Advertising rates of broadcasting stations were the basis of further examination of Commissioner Lafount by Senator Dill. He asked why WOR, in Newark, N. J., of only 5,000-watt power, received greater compensation for use of its station than some 50,000-watt stations. Commissioner Lafount said the New Jersey station is so situated and so equipped that "it can reach more people than some of the 50,000-watt stations."

# BOARD PROBES BAD RECEPTION IN ALLEGHENIES

Washington.

The Allegheny Valley delegation in the House, with Representative Estep (Rep.) of Pittsburgh, Pa., as spokesman, conferred with the Federal Radio Commission with a view to getting better radio reception facilities.

There is interference between WJAS and WCAE, it was stated by the delegation. The Radio Commission announced it would make an investigation of the situation through its engineers.

There were five members of the House at the conference. They were Mr. Estep, as spokesman; Representatives Kelly (Rep.), of Edgewood, Pa.; Porter (Rep.), of Pittsburgh, Pa.; Campbell (Rep.), of Grafton, Pa., and Sullivan (Rep.), of Pittsburgh.

### Speaks for Pittsburgh

After the conference, Representative Kelly said that Pittsburgh has four broadcasting stations, "perhaps fewer," he said, "than any other city of its size in the United States."

He added:

"Complaints are being heard from radio listeners-in that there is great interference and a generally unsatisfactory condition within the city proper. The delegation at its conference urged better radio reception facilities for the Pittsburgh section of the country. Under the Radio Commission act of 1928, the so-called Davis amendment called for equitable allotment of power channels. Five zones were established and certain channels allocated to each one of them. The Pennsylvania territory comes within Zone 2.

### Not Given Quota

"At the present time this zone has not yet been given its equitable portion of the national and regional channels. Three zones have been given more than the channels to which they are entitled.

"Our state is under the disadvantage of having less than the quota facilities it is entitled to. The same is true, particularly, of our Zone 2, while other sections of this country enjoy more than their just quota.

"The conditions have been growing worse in our zone than anywhere else since the reallocation of 1928. Our people have been hoping that the Federal Radio Commission would make the necessary readjustments in the interest of better radio reception in our zone. Ever since the 1928 reallocation, we have been deprived in the Pittsburgh section of one cleared channel, the 1,020 channel.

"The Federal Radio Commission now, I believe, will make the necessary readjustments as the result of the promised engineering investigation of our present unfortunate situation."

# RCA EXTORTER, SENATE HEARS; DEMANDS CITED

Washington.

Having obtained licenses for trans-ocean radioing of news, Press Wireless, Inc., sought apparatus from the Radio Corporation of America and was met with extrotionate demands, said Joseph Pierson, president, addressing the Senate Committee on Interstate Commerce.

### Tells of Demands

Here is what Mr. Pierson said RCA demanded:

"Communication must be between points 'within the continental United States' only.

"Will rent, but not sell, apparatus to Press Wireless, Inc., and (a) Press Wireless must pay RCA the General Electric Company's price for building the apparatus plus 45 per cent profit for the RCA; and (b) Press Wireless must pay as royalty or rental 5 per cent of the gross receipts to the RCA.

"Use can be for press messages only.

"Press Wireless must charge its clients 'with a view to earning a reasonable profit,' and not as a mutual company.

"Press Wireless must allow RCA to inspect its apparatus and its accounts at will.

"Press Wireless, Inc., must surrender to RCA without any charge whatsover all patents or patent rights it now has or will ever have."

### No Chance to Live

"RCA wants," said Mr. Pierson, "not only high tribute indefinitely prolonged, but they even would force us to give up to them use of these valuable frequencies which the Federal Radio Commission licensed only to us."

He explained that Press Wireless, Inc., is authorized by the Federal Radio Commission to create a trans-oceanic radio-telegraph network for the transmission of news dispatches for the American press. It has been granted 20 trans-oceanic frequencies for such a service, which later will be augmented by 20 domestic frequencies for continental transmission of press dispatches.

RCA has refused to sell it equipment for such a service, Mr. Pierson said, but offered to "lease" the necessary apparatus, under "extortionate" conditions.

### Eight Experimental Frequencies

Press Wireless, Inc., has been granted authority by the Federal Radio Commission to maintain experimental operation on eight frequencies in the trans-oceanic band, preparatory to its establishment of a press communications system. Stations in Chicago and Los Angeles were licensed to maintain the communications.

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### WANTS VOLTAGES STATED

JUST a word in regards to your magazine. I think it is one of the most complete magazines on the subject of radio that I can or any one else can purchase, and I hope you continue with the fine articles found within its covers.

There is one thing I think would be of help to me as a novice and that is when you diagram a circuit please mark the voltages which the tests you made show to work the best.

JAS. BROWN,
Flemington, W. Va.

# *74 Stations Now in Northern Europe*

Washington.

Broadcasting stations in northern Europe, comprising Norway, Sweden, Denmark, Iceland, Finland, Esthonia, Latvia, Lithuania, Danzig, and Czechoslovakia, have been increased to 74, according to an announcement of the Department of Commerce after a check-up of the stations in these countries.

Among these countries Sweden leads with 32 stations. Norway is second with 12 and Finland third with 9 stations. Denmark has 6 stations, Danzig 5, Czechoslovakia 4, Iceland and Esthonia 2 each and Latvia and Lithuania 1 each.

The highest powered station listed is in Lahtis, Finland, which operates with 40,000 watts on a wavelength of 1,552.8 meters. The second strongest station is SBG in Motala, Sweden, which operates with 30,000 watts on a wavelength of 1,348 meters. The remaining 72 stations range in power from 50 to 12,500 watts.

# WMAK STARTS NEW WAVE SUIT

Washington.

A new appeal in the Buffalo broadcasting case, involving the Buffalo "Evening News" and WMAK, of that city, was filed with the Court of Appeals of the District of Columbia by WFBL, at Syracuse.

The Syracuse statio nappeals from the action of the Commission removing it from half-time operation on the 900-kilocycle channel, and placing it full time on the 1490-kilocycle channel. It contends that the Commission did not act directly on its application for increased time and power on the 900-kilocycle channel.

The Commission, in its decision, issued a construction permit to the newspaper for a station to operate full time on the 900-kilocycle channel, which now is shared by WMAK and WFBL. Previously, WMAK filed an appeal from the action.

Coincident with the filing of the new appeal, the Commission filed with the court its statement of facts and grounds for decision in the Buffalo case. Asking that the appeal of WMAK be dismissed, because the reasons cited are not specific, the Commission states it granted the Buffalo "Evening News" appeals because the Buffalo Broadcasting Corporation, controlling WMAK, has a virtual monopoly of broadcasting facilities in Buffalo.

This corporation, it states, controls the four leading broadcasting stations in Buffalo, namely, WKBW, WMAK, WKEN and WGR.



# NO DANGER NOW OF TUBE TRUST, RCA MAINTAINS

Washington.

"There is no danger whatever of a monopoly in the radio tube field," John W. Davis, as counsel for the Radio Corporation of America, told the Federal Trade Commission in asking the Commission to discuss its tube monopoly complaint against RCA.

The Trade Commission had charged that Clause 9 of patent licenses granted by RCA to set manufacturers violated Section 3 of the Clayton act and Section 5 of the Federal Trade Commission act, "on that the RCA" required the licensees to use, for initial installation in manufacturing the patented electrical circuits licensed thereby, radio tubes purchased from the corporation."

### Licensing Competitors

Mr. Davis declared in his motion that "Clause 9 has not been enforced by the Radio Corporation for over a year and a half past" and that the RCA "has also been permanently enjoined by a United States court."

"The Radio Corporation," his motion continued, "is, in fact, actually aiding its tube competitors by licensing them under its tube patents."

### Now Oppose Policy

"Clause 9 of the patent license to the set manufacturers was in effect for approximately one year," added Mr. Davis. "During that time the sales department of the Radio Corporation became thoroughly convinced that, wholly apart from its legality or illegality, the policy embodied in Clause 9 was very undesirable from a purely merchandising standpoint."

## Press Exploration Licenses Renewed

Washington.

The licenses held by the New York "Times" and the San Francisco "Examiner" for high frequency radio communication with scientfic expeditions in remote areas of the globe have been extended for a period of six months by the Federal Radio Commission.

The "Times" station maintains direct communication with the Byrd Antarctic expedition and uses a power of 1,000 watts on high frequencies in the international band. The "Examiner's" station has been used for communication with the expedition of Sir Hubert Wilkins and with various airplane flights in the Pacific territory.

When Louis M. Loeb, of New York, attorney for the "Times," applied for the extension he supported his claim by quoting Admiral Byrd as follows:

"No group of men ever appreciated the advantages of radio more than the members of the Antarctic expedition. It has been invaluable. I think it would be fair to say that it would have been impossible to have carried out the operations of an expedition of so many units without radio."

Commissioner Sykes advised Mr. Loeb that the Radio Commission had no intention of cutting off radio communication with the Byrd exploration party.

# BILL BARS ALL UTILITIES FROM STATION RIGHTS

Washington.

Legislation which would prohibit the ownership or operation of broadcasting stations by public utilities or their subsidiaries will be offered by Senator Brookhart (Rep.), of Iowa, he announced.

At a hearing of the Senate Committee on Interstate Commerce relative to the Couzens bill to create a commission on communications, which also would control radio, Senator Brookhart declared he believed public utilities should not be accorded channels. He also deplored the use of channels and ownership of broadcasting stations by newspapers, but said he would offer an amendment to the pending bill to exclude utilities.

The announcement was made by the Senator when the Chairman of the Federal Radio Commission, Ira E. Robinson, was on the witness stand. Robinson had called to the Committee's attention the recent decision of the Court of Appeals of the District of Columbia, overruling a decision of the Commission respecting WENR, at Chicago, a 50,000 watt station, owned by the Insull public utility interests.

### Thirteen Utilities Stations

The Commission had denied the station an increase in broadcasting time from ttwo days per week to at least one-half time. The court overruled this decision, granting to the Insull station one-half time on the channel in question, ordering that this time be taken away from WLS, also of Chicago, operated by "The Prairie-Farmer."

An analysis recently prepared by the stations on the air operated by public power utilities.

In his testimony, Robinson disclosed that the Commission shortly expects to take action on the case of KWKH at Shreveport, La., owned by W. K. Henderson, who, it is alleged, uses indecent and profane language over his station.

### Congress Distrusts Board

Senator Dill criticized the Commission sharply for its failure to carry out the terms of the Davis equalization amendment to the radio law, which requires the equal distribution of radio broadcasting facilities among the five radio zones into which the country is divided. He said that Congress cannot trust the Commission to distribute the facilities equally as the Davis amednment requires, and that he will endeavor to have a formula worked out by Congress, which will be "ironclad" and not give the Commission any leeway so that it will not misinterpret the intent of the law.

In the course of his testimony, Chairman Robinson was questioned as to license fees for broadcasting stations and other users of the ether; high power and cleared channels for broadcasting stations; whether broadcasting stations should be considered public utility common carriers, open to all, and other general broadcasting questions now in controversy.

The witness favored the imposition of license fees as a means of defraying the costs of administering radio. He opposed higher power and cleared channels generally, saying he did not go along with the Commission in its interpretation of the Davis amendment.

# *Dill Asks Arrest of Air Profaner*

Washington.

Senator Dill (Dem.), of the State of Washington, again addressed the Senate on the use of profanity over the radio, reclaring that if KWKH, at Shreveport, La., continues to disregard the law in this respect, its owner should be arrested and the station discontinued.

Mr. Dill, co-author of the radio act, took the floor to explain that, in objecting to the use of obscene language over the Shreveport station, which is owned by W. K. Henderson, he did not wish to be interpreted as objection to Mr. Henderson's policy of attacking chain stores. Some independent merchants have wrongly made this interpretation, he said, while he has been opposed only to the use of profane language.

"As I have said before, I took up this matter with the Commission, and the Commission said it had no affidavits as to the indecency and obscenity being used," declared Senator Dill. "I think it now has some and will have many more."

Senator Walsh (Dem., of Montana, inquired whether the matter had been referred to the Attorney General, and whether the existing law, in the opinion of Senator Dill, is adequate to meet the situation. Senator Dill said he thought existing law fully adequate to cover the case.

"I have written a letter to the Attorney General calling his attention to statements I have made and to sections of the law, and have suggested that he refer the matter to the United States attorney in that district. so that the use of profanity may be stopped or the owner prosecuted under the criminal provisions of the act," concluded Senator Dill.

# Two Cities Obtain Radio Police Permits

Washington.

The police departments of two cities have been granted authority by the Federal Radio Commission to use short waves for the creation of crime detection and criminal apprehension services. The cities are Minneapolis, Minn., and Tulare, Calif.

Construction permits were also granted to these police departments for stations to use channels in the continental high frequency spectrum. Many other cities have already established such service and many more now hold construction permits for the erection of stations of this character.



# DEFOREST SAYS AIR IS FULL OF "AD" AVARICE

**By DR. LEE DeFOREST**
**Newly Elected President of Institute of Radio Engineers**

The insidious influence of the avaricious advertiser and his stupid insistence on direct advertising have, I regret to observe, become increasingly effective and devastating.

As the so-called "Father of Radio Broadcasting" I wish again to raise my voice in most earnest protest against this revolting state of affairs.

The present all too marked tendency of the broadcast chains and of many individual stations to lower their bars to the greed of direct advertising will rapidly work to sap the life-blood and destroy the greatest usefulness of this magnificent new means of contact which we engineers have so laboriously toiled to upbuild and to perfect.

### Public Flareback

In all seriousness I attribute a part of the present undeniable slackening in radio sales to the public as actually due to this pernicious advertising. The radio public is, I believe, becoming nauseated by the quality of many of the present programs. Short-sighted greed of the broadcasters, station owners and advertising agencies, is slowly killing the broadcasting goose, layer of many golden eggs.

Too long has this perilous situation continued without earnest protest from our organization. We members of this institute must be jealous of its good name, regardful of a wise suyervision of this broadcast institution.

We should, I maintain, take active steps to get rid of the stupid avarice which is killing the most splendid and potent means of entertainment, culture and education which mankind has yet devised.

### Foreign Relish by Domestics

If we anticipate the day of the international broadcast, when American programs are interchanged with those from Europe, you may rest assured that any foreign programs of high-class music will be relished in this country in preference to much of the stuff which American audiences are now compelled to hear.

This factor, the international broadcast, is at hand. The sterling work of radio communication eigineers the world over in the fascinating field of shortwave transmission is rapidly bringing it to pass. And this development will eventually mean mutual acquaintanceship among people, international amity, an end of war, and finally the blessings of one common tongue.

# RECEIVER FOR KOLSTER ASKED ON $17,000,000

Paterson, N. J.

A receiver for the Kolster Radio Corporation, was asked by David Schiffman of Passaic, N. J., as owner of 200 shares of common stock. Vice Chancellor Lewis, signed an order, returnable, directing the Kolster officers to show cause why a receiver should now be appointed. Meanwhile the corporation was enjoined from collecting or contracting any further debts.

Executives of the $17,000,000 corporation were in conference following filing of the petition. Ellery W. Stone, president of the corporation, said that on advised counsel, executives of the corporation would make no statements.

### Cites $916,233 Loss

Mr. Schiffman said he found the corporation sustained a loss of $916,233 in 1929, its financial statement listing assets of $7,011,758 in certain patent rights, "which your complainant alleges are fictitious and of no value." The statement showing such assets, according to the petition, was made "as part of a scheme to sell stock to the stockholders of record as of April 30th, 1928," at $22 a share. The same stock, according to Mr. Schiffman's petition, was being quoted in the market at $5 a share at the time his petition was filed.

Kolster Radio shares were selling on the New York Stock Exchange at 4¼ just before the receivership application, then dropped to 2½ . In 1929 the high was 78¾.

### Sales Grow, Profits Drop

Mr. Schiffman alleged that while the company in 1928 showed gains in sales, its net profits declined 75 per cent, due to increased cost of manufacturing and to competition.

The Kolster Radio Corporation was incorporated in Delaware on July 1st, 1926, as Federal-Brandes, Inc., and changed its name on April 9, 1928. As of Nov. 1, 1926, it purchased the entire capital stock of the Brandes corporations in Newark, Toronto and London. Later it acquired the capital stock of the Federal Telegraph Company by exchanging share for share of its A common stock for the $10 par value shares of the Federal Company.

Rudolph Spreckels, head of the Spreckels Sugar Corporation, is chairman of the board

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## WABC Testing New Site for 50 kw. Plant

WABC, key station of the Columbia Broadcasting System, which has been seeking a site for its proposed 50 kw transmitter, is testing field strength near Jones Beach, L. I., twenty-five miles out of New York City.

The company telegraphed the Federal Radio Commission for permission to test for 10 days and obtained it.

The station will use the call letters W2XAN, the WABC short wave transmitter, but will operate on the WABC frequency of 860 kilocycles. Granting of the license is another step in the Columbia's effort to find a suitable location for its high-power transmitter, which it wants to locate where it will not interfere with other stations. The original intention to locate the station at Columbia Bridge, N. J., was abandoned because of opposition in New Jersey.

## 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 at bottom 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 ..............................................

W. V. Bozzelle, 529 Newton St., Gretna, La.
Bruce Adams, St. Onge, So. Dak.
Walter Magamol, 19 N. Fourth Ave., Highland Park, N. J.
Nicholas Lalli, 19 No. Iowa Ave., Atlantic City, N. J.
John J. Martin, 1711 Stanwood St., Phila., Pa.
H. B. Wyatt, 288 Main St., Room 308, Worcester, Mass.
F. E. Broadhurst, 6394 Trumbull Ave., Detroit Mich.
Benjamin Berger, 1443 Wilkins Ave., Bronx, N. Y. City, N. Y.
W. G. Schoettler, Box 501, Atlantic City, N. J.
Wm. Kaiser, 1610 Blue Is. Ave., Chicago, Ill.
Raymond P. Mahoney, 1303 Divinity Place, Phila., Pa.
Elmo L. Barrett, Jr., P. O. Box 23, Morgantown, W. Va.
C. L. Sowder, 1502 Melrose Ave., N. W., Roanoke, Va.
Wm. R. Sewell, 6192 Hecla Ave., Detroit, Mich.
B. C. Brewton, Claxton, Ga.
Emil De Legien, 1104 Carroll Pl., Apt. E. 4, Bronx, N. Y. City.
Fred Buettner, 1333 Wilmerding Ave., E. McKeesport, Pa.
A. G. Chiginski, 716 7th St., S. W., Washington, D. C.
Lee Deane, R. No. 3, Kingsville, Mo.
Wm. C. Ogle, 1759 2nd St., San Diego, Calif.
L. D. Orr, Box 306, New Bethlehem, Pa.
Bob Lamb, c/o Leesburg Radio Amateurs Assoc., Leesburg, Fla.

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# STATION RATES UNRESTRICTED

Washington, D. C.

The Interstate Commerce Commission has no authority over rates charged to advertisers by broadcasting stations and chains, Commissioner Joseph B. Eastman told a Senate committee, as he recorded himself in favor of a communications commission.

Broadcasting stations, the Interstate Commerce Commissioner explained, are not regarded as being engaged in the transmission of intelligence as common carriers. No complaints have been made as to broadcasting rates, he added, and only one request for an investigation, which was received two years ago from the C. K. MacAlpine Company, 50 Church Street, New York City, had ever been received by the commission.

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### A THOUGHT FOR THE WEEK

*HERE'S an idea that may appeal to a lot of listeners-in: organize a "National Shiver Week" and, at one fell stroke, get rid of those strong-meat dramalets of mystery, racketeering and gang life that are now sending the young ones scurrying off to bed, there to cover up their head and dream of murderous goings-on all night? If we can get these garish things off our chests in a seven-day period perhaps the country can spend fifty-one weeks in normal living and thinking again. Noise, the other name is radio melodrama!*

# WILBUR ASKS RADIOS TO HELP THE ILLITERATE

**By RAY LYMAN WILBUR**
**Secretary of the Interior**

Independent private institutions with sufficient funds for educational and cultural experiments could render the same great service in the field of radio education that they have in all American education. We do not yet know what the best methods are in education by the radio. We do not know how to discover them except by experimentation, nor how to choose the proper teachers for this special work except by trial.

We do not know how best to handle drama, literature, etc. We have already discovered that there is much interesting broadcasting possible in the field of political science, history and music.

### Literacy Experiment

My hope is that we can continue the work that is now going forward and inaugurate under conditions of great freedom with adequate funds further experimentation under the guidance of those who cannot be considered as having a commercial viewpoint.

Personally, I should like to see just what could be done for several thousand illiterate families by providing them with a radio and a special service for a period of months. It would be a novel experience to become literate without being able to write or read, using literate in the sense of becoming informed and able to follow what is going on in the world about one. Here is an opportunity for some one to unite his interest, enthusiasm, and financial resources with some university which has a well developed department of sociology.

### What People Want

I have indicated the significance of the radio and the necessity of some means of checking results as well as devising experiments in educational procedure. Control can not come through any individual or institution or any governmental agency alone. It must evolve from the experience of the industry and the creation of controlling ideals and principles.

There is a gratifying tendency to cleanse the air of unsavory broadcasts of all sorts. The Commonwealth Club of San Francisco recently reported a study in which over 7,000 people returned answers to 20 leading questions. Seventy-six per cent asked for educational programs, 84 per cent asked for more semi-classical music; 57 per cent reported that they listened to book reviews, and, says the report, "We found a tidal wave of indignation against jazz." It is important that the truth be presented over the radio. You have often heard individuals say: "I saw it in print," as if that were a finality.

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### NEW CROSLEY SALES MANAGER

Cincinnati, O.

R. H. Woodford, for the past five years general sales manager of the radio division of the Stewart-Warner corporation, has been appointed general sales manager of the Crosley Radio corporation. He succeeded Neal Newman, resigned.

# REVISED LIST OF STATIONS BY CALL LETTERS

## With Location, Power, Frequency and Wavelength

### 74 ADDITIONS, DELETIONS, NEW WAVE ASSIGNMENTS, COMPARED WITH LIST PREVIOUSLY PUBLISHED

[The transmitter location of each station is given, but where the studio is located in some other city or town, the studio location is given also, designated by the letter "S." Where two different powers are given, the larger is usually for daylight use only. "Kc" stands for frequency in kilocycles, "kw" for power in kilowatts, "M" for wavelength in meters.]

*Station Transmitter Power kc. M.*

WAAF—Chicago. Ill. ........ 500 920 325.9
WAAM—Newark, N. J. ........ 1&2kw. 1250 239.9
WAAT—Jersey City, N. J. ........ 300 1070 280.2
WAAW—Omaha, Nebr. ........ 500 660 454.3
WABC-WBOQ—Queens Co. N. Y.
S.—New York City ........ 5,000 860 348.6
WABI—Bangor, Me. ........ 100 1200 249.9
WABO-WHEC—See WHEC-WABO
WABZ—New Orleans. La. ........ 100 1200 249.9
WADC—Tallmadge, Ohio ........ 1kw. 1320 227.1
WAGM—Royal Oak, Mich. ........ 50 1310 228.3
WAIU—Columbus, Ohio ........ 500 640 468.5
WAPI—Birmingham, Ala. ........ 5kw. 1140 263
WASH—Grand Rapids Twp., Mich. 500 1270 236.1
WBAA—W. Lafayette, Ind. ........ 500 1400 214.2
WBAK—Harrisburg, Pa. ........ 500 1430 209.7
WBAL—Glen Morris, Md.
S—Baltimore, Md. ........ 10kw. 1060 258.5
WBAP—Fort Worth, Texas ........ 50kw. 800 374.8
WBAX—Wilkes-Barre, Pa. ........ 100 1210 247.8
WBBC—Brooklyn, N. Y. ........ 500 1400 214.2
WBBL—Richmond, Va. ........ 100 1370 218.8
WBBM-WJBT—Glenview, Ill.
S—Chicago, Ill. ........ 25kw. 770 389.4
WBBR—Rossville, N. Y. ........ 1kw. 1300 230.6
WBBY—Charleston, S. C. ........ 75 1200 249.9
WBBZ—Ponca City, Okla. ........ 100 1200 249.9
WBCM—Hampton Twp., Mich.
S—Bay City, Mich. ........ 500 1410 212.6
WBIS-WNAC—See WNAC-WBIS
WBMS—Hackensack, N. J. ........ 250 1450 206.8
WBNY—New York, N. Y. ........ 250 1350 221.1
WBOQ-WABC—See WABC-WBOQ
WBOW—Terre Haute, Ind. ........ 100 1310 228.3
WBRC—Birmingham, Ala. ... 1kw.&500w. 930 322.4
WBRE—Wilkes-Barre, Pa. ........ 100 1310 228.3
WBRL—Tilton, N. H. ........ 500 1430 209.7
WBSO—Wellesley Hills, Mass. ........ 250 920 325.9
WBT—Charlotte, N. C. ........ 5kw. 1080 277.6
WBZ—E. Springfield, Mass.
S—Springfield, Mass. ........ 15kw. 990 302.8
WBZA—Boston, Mass. ........ 500 990 302.8
WCAC—Storrs, Conn. ........ 500 600 499.7
WCAD—Canton, N. Y. ........ 500 1220 245.8
WCAE—Pittsburgh, Pa. ........ 500 1220 245.8
WCAH—Columbus, Ohio ........ 500 1430 209.7
WCAJ—Lincoln, Nebr. ........ 500 590 508.2
WCAL—Northfield, Minn. ........ 1kw. 1250 239.9
WCAM—Camden, N. J. ........ 500 1280 234.2
WCAO—Baltimore, Md. ........ 250 600 499.7
WCAP—Asbury Park, N. J. ........ 500 1280 234.2
WCAT—Rapid City, S. D. ........ 100 1200 249.9
WCAU—Byberry, Pa.
S—Philadelphia, Pa. ........ 10kw. 1170 256.3
WCAX—Burlington, Vt. ........ 100 1200 249.9
WCAZ—Carthage, Ill. ........ 50 1070 280.2
WCBA—Allentown, Pa. ........ 250 1440 208.2
WCBD—Zion, Ill. ........ 5kw. 1080 277.6
WCBM—Baltimore, Md. ........ 250 1370 218.8
WCBS—Springfield, Ill. ........ 250&100 1210 247.8
WCCO—Anoka, Minn.
S—Minneapolis, Minn. ........ 7½kw. 810 370.2
WCDA—Cliffside Park, N. J.
S—New York City, N. Y. ........ 250 1350 221.1
WCFL—Chicago, Ill. ........ 1kw. 1280 234.2
WCGU—Coney Island, N. Y. ........ 500 1400 214.2
WCKY—Crescent Springs, Ky.
S—Covington, Ky. ........ 5kw. 1480 202.6
WCLO—Kenosha, Wis. ........ 100 1200 249.9
WCLS—Joliet, Ill. ........ 100 1310 228.3
WCMA—Culver, Ind. ........ 500 1400 214.2
WCOA—Pensacola, Fla. ........ 500 1340 223.7
WCOC—Meridian, Miss. ........ 1kw&500 880 340.7
WCOD—Harrisburg, Pa.
(formerly WPRC) ........ 100 1200 249.9
WCOH—Greenville, N. Y.
S—Yonkers, N. Y. ........ 100 1210 247.8
WCRW—Chicago, Ill. ........ 100 1210 247.8
WCSH—Portland, Maine ........ 500 940 319.0
WCSO—Springfield, Ohio. ........ 500 1450 206.8
WDAE—Tampa, Fla. ........ 1kw. 1220 245.8
WDAF—Kansas City, Mo. ........ 1kw. 610 491.5
WDAG—Amarillo, Texas ........ 250 1410 212.6
WDAH—El Paso, Texas ........ 100 1310 228.3
WDAY—W. Fargo, N. D. ........ 1kw. 940 319
WDBJ—Roanoke, Va. ........ 250&500 930 322.4
WDBO—Orlando, Fla. ........ 1kw. 1120 267.7
WDEL—Wilmington, Del. ........ 250&350 1120 267.7
WDGY—Minneapolis, Minn. ........ 1kw. 1180 254.1
WDOD—Chattanooga, Tenn. ..2½&1kw. 1280 234.2
WDRC—New Haven, Conn. ........ 500 1330 225.4
WDSU—New Orleans, La. ........ 1kw. 1250 239.9
WDWF-WLSI—Cranston, R. I. ........ 100 1210 247.8
WDZ—Tuscola, Ill. ........ 100 1070 280.2
WEAF—Bellmore, N. Y.
S—New York, N. Y. ........ 50kw. 660 454.3
WEAI—Ithaca, N. Y. ........ 500 1270 236.1
WEAN—Providence, R. I. ........ 250&500 780 384.4
WEAO—Columbus, Ohio ........ 750 570 526
WEAR—Cleveland, Ohio ........ 1kw. 1070 280.2
WEBC—Superior, Wis.
S—Duluth, Minn. ........ 2½kw. 1290 232.4
WEBE—Cambridge, Ohio. ........ 100 1210 247.8
WEBQ—Harrisburg, Il. ........ 100 1210 247.8
WEBR—Buffalo, N. Y. ........ 200&100 1310 228.3
WEBW—Beloit, Wis. ........ 500 560 535.4
WEDC—Chicago, Ill. ........ 100 1210 247.8
WEDH—Erie, Pa. ........ 30 1420 211.1
WEEI—Weymouth, Mass.
S—Boston, Mass. ........ 10kw. 590 508.2
WEHC—Emory, Va. ........ 100 1370 218.8
WEHS—Evanston, Ill. ........ 100 1420 211.8

*Station Transmitter Power kc. M.*

WELK—Phila., Pa. ........ 100 1370 218.8
WEMC—Berrien Springs, Mich.. 1kw. 590 508.2
WENR-WBCN—Chicago, Ill. ..... 50kw. 870 344.6
WEVD—Forest Hills, N. Y.
S—New York City ........ 500 1300 230.6
WEW—St. Louis, Mo. ........ 1kw. 760 394.5
WFAA—Grapevine, Tex. ........ 50kw. 800 374.5
WFAN—Philadelphia, Pa. ........ 500 610 491.5
WFBC—Knoxville, Tenn. ........ 50 1200 249.9
WFBE—Cincinnati, O. ........ 100 1200 249.9
WFBG—Atoona, Pa. ........ 100 1310 228.3
WFBJ—Collegeville, Minn. ........ 100 1370 218.8
WFBL—Syracuse, N. Y. ........ 1kw. 1490 201.2
WFBM—Indianapolis, Ind. ........ 1kw. 1230 243.8
WFBR—Baltimore, Md. ........ 250 1270 236.7
WFDF—Flint, Mich. ........ 100 1310 228.3
WFDV—Rome, Ga. ........ 100 1370 218.8
WFDW—Talledaga, Ala. ........ 100 1420 211.8
WFI—Philadelphia, Pa. ........ 500 560 535.4
WFIW—Hopkinsville, Ky. ........ 1kw. 940 319
WFJC—Akron, Ohio ........ 500 1450 206.8
WFKD—Wissinoming, Pa.
S—Philadelphia, Pa. ........ 50 1310 228.3
WFLA-WSUN—Clearwater, Fla. 1-2½kw. 900 331.1
WGAL—Lancaster, Pa. ........ 15 1310 228.3
WGBB—Freeport, N. Y. ........ 100 1210 247.8
WGBC—Memphis, Tenn. ........ 500 1430 209.7
WGBF—Evansville, Ind. ........ 500 630 475.9
WGBI—Scranton, Pa. ........ 250 880 340.7
WGBS—Astoria, L. I., N. Y.
S—New York City ........ 500 600 499.7
WGCM—Gulfport, Miss. ........ 100 1210 247.8
WGCP—Newark, N. J. ........ 250 1250 239.9
WGES—Chicago, Ill. ........ 500 1360 220.4
WGH—Newport News, Va. ........ 100 1310 228.3
WGHP—Fraser, Mich.
S—Detroit, Mich. ........ 1kw. 1340 223.7
WGL—Fort Wayne, Ind. ........ 100 1370 218.8
WGMS-WLB—See WLB-WGMS
WGN-WLIB—Elgin, Ill.
S—Chicago, Ill. ........ 25kw. 720 413
WGR—Amherst, N. Y.
S—Buffalo, N. Y. ........ 1kw. 550 545.1
WGST—Atlanta, Ga. ........ 250 890 336.9
WGTB—Columbia, S. C. ........ 500 1010 296.9
WGY—S. Schenectady, N. Y. ..... 50kw. 790 379.5
WHA—Madison, Wis. ........ 750 940 319
WHAD—Milwaukee, Wis. ........ 250 1120 267.7
WHAM—Victor Twp. N. Y.
S—Rochester, N. Y. ........ 5kw. 1150 260.7
WHAP—Carlstadt, N. J.
S—New York City ........ 1kw. 1300 230.6
WHAS—Jeffersontown, Ky.
S—Louisville, Ky. ........ 10kw. 820 365.6
WHAT—Phila., Pa. ........ 100 1310 228.3
WHAZ—Troy, N. Y. ........ 500 1300 230.6
WHB—Kansas City, Mo. ........ 500 860 348.6
WHBC—Canton, Ohio ........ 10 1200 249.9
WHBD—Mt. Orab, Ohio ........ 100 1370 218.8
WHBJ—Hattiesburg, Miss. ........ 100 1370 218.8
WHBF—Rock Island, Ill. ........ 100 1210 247.8
WHBL—Sheboygan, Wis. ........ 500 1410 212.6
WHBQ—Memphis, Tenn ........ 100 1370 218.8
WHBU—Anderson, Ind. ........ 100 1210 247.8
WHBY—West De Pere, Wis.
S—Green Bay Wis. ........ 100 1200 249.9
WHDF—Calumet, Mich. ........ 100 1370 218.8
WHDH—Gloucester, Mass. ........ 1kw. 830 361.2
WHDI—Minneapolis, Minn. ........ 500 1180 254.1
WHDL—Tupper Lake, N. Y. ........ 10 1420 211.8
WHEC-WABO—Rochester, N. Y. 500 1440 208.2
WHFC—Cicero, Ill. ........ 100 1420 211.8
WHIS—Bluefield, W. Va. ........ 100 1420 211.1
WHK—Cleveland, Ohio ........ 1kw. 1390 215.7
WHN—New York, N. Y. ........ 250 1010 296.9
WHO—Des Moines, Iowa ........ 5kw. 1000 299.8
WHP—Lemoyne, Pa.
S—Harrisburg, Pa. ........ 500 1430 209.7
WIAS—Ottumwa, Iowa ........ 100 1420 211.1
WIBA—Madison, Wis. ........ 100 1210 247.8
WIBG—Elkins Park, Pa. ........ 50 930 322.4
WIBM—Jackson, Mich. ........ 100 1370 218.8
WIBO—Desplaines, Ill.
S—Chicago, Ill. ........ 1&1½kw. 560 535.4
WIBR—Steubenville, Ohio ........ 50 1420 211.1
WIBS—Jersey City, N. J. ........ 250 1450 206.8
WIBU—Poynette, Wis. ........ 100 1310 228.3
WIBW—(near) Topeka, Kan. ........ 1kw. 580 516.9
WIBX—Utica, N. Y. ........ 100-300 1200 249.9
WICC—Easton, Conn.
S—Bridgeport, Conn. ........ 500 1190 252
WIL—St. Louis, Mo. ........ 100-250 1200 249.9
WILL—Urbana, Ill. ........ 250-500 890 336.9
WILM—Wilmington, Del. ........ 100 1420 211.1
WIOD-WMBF—Miami Beach, Fla.. 1kw. 560 535.4
WIP—Philadelphia, Pa. ........ 500 610 491.5
WISN—Milwaukee, Wis. ........ 250 1120 267.7
WJAC—Johnstown, Pa. ........ 100 1310 228.3
(Formerly WHBP.)
WJAD—Waco, Texas ........ 1kw. 1240 241.8
WJAG—Norfolk, Nebr. ........ 1kw. 1060 282.8
WJAK—Marion, Ind. ........ 50 1310 228.3
WJAR—Providence, R. I. ........ 250-400 890 336.9
WJAS—North Fayette Twp.
S—Pittsburgh, Pa. ........ 1kw. 1290 232.4
WJAX—Jacksonville, Fla. ........ 1kw. 900 331.1
WJAY—Cleveland, Ohio ........ 500 610 491.5
WJAZ—Mt. Prospect, Ill. ........ 5kw. 1480 202.6
WJBC—La Salle, Ill. ........ 100 1200 249.9
WJBI—Red Bank, N. J. ........ 100 1210 247.8
WJBK—Ypsilanti, Mich. ........ 50 1370 218.8
WJBL—Decatur, Ill. ........ 100 1200 249.9
WJBO—New Orleans, La. ........ 100 1420 211.1
WJBT-WBBM—See WBBM-WJBT
WJBU—Lewisburg, Pa. ........ 100 1210 247.8
WJBW—New Orleans, La. ........ 30 1200 249.9
WJBY—Gadsden, Ala. ........ 50 1210 247.8
WJDX—Jackson, Miss. ........ 500-1kw. 1270 236.1
WJJD—Mooseheart, Ill. ........ 20kw. 1130 265.3
WJKS—Gary, Ind. ........ 500-1½kw. 1360 220.4

*Station Transmitter Power kc. M.*

WJR—Sylvan Lake Village, Mich.
S—Detroit, Mich. ........ 5kw. 750 399.8
WJSV—Mt. Vernon Hills, Va. ..... 10kw. 1460 205.4
WJW—Mansfield, Ohio
(Formerly WLBV.) ........ 100 1210 247.8
WJZ—Bound Brook, N. J.
S—New York City, N. Y. 30kw. 760 394.5
WKAQ—San Juan, P. R. ........ 500 890 336.9
WKAR—E. Lansing, Mich. ........ 1kw. 1040 288.3
WKAV—Laconia, N. H. ........ 100 1310 228.3
WKBB—Joliet, Ill. ........ 100 1310 228.3
WKBC—Birmingham, Ala. ........ 100 1310 228.3
WKBF—Indianapolis, Ind. ........ 500 1400 214.2
WKBH—La Crosse, Wis. ........ 1kw. 1380 217.3
WKBI—Chicago, Ill. ........ 50 1420 211.8
WKBN—Youngstown, Ohio ........ 500 570 526
WKBO—Jersey City, N. J. ........ 250 1450 206.8
WKBP—Battle Creek, Mich. ........ 50 1420 211.1
WKBQ—New York, N. Y. ........ 250 1350 221.1
WKBS—Galesburg, Ill. ........ 100 1310 228.3
WKBV—Connersville, Ind. ..... 100-150 1500 199.9
WKBW—Amherst, N. Y.
S—Buffalo, N. Y. ........ 5kw. 1470 204
WKBZ—Ludington, Mich. ........ 50 1500 199.9
WKEN—Grand Island, N. Y.
S—Buffalo, N. Y. ........ 1kw. 1040 288.3
WKRC—Cincinnati, Ohio ........ 1kw. 550 545.1
WKRC—Cincinnati, Ohio ........ 500 550 545.1
WKY—Oklahoma City, Okla. ........ 1kw. 900 331.1
WLAC—Nashville, Tenn. ........ 5kw. 1490 201.2
WLAP—Louisville, Ky. ........ 30 1200 249.9
WLB-WGMS—Minneapolis, Minn. 500 1250 239.9
WLBC—Muncie, Ind. ........ 50 1310 228.3
WLBF—Kansas City, Kans. ........ 100 1420 211.1
WLBG—Ettrick, Va.
S—Petersburg, Va. ........ 250
WLBL—Stevens Pt., Wis. ........ 2kw. 900 331.1
WLBW—Oil City, Pa. ........ 1kw. 1260 238
WLBX—L. I. City, N. Y. ........ 100 1500 199.9
WLBZ—Bangor, Maine ........ 500 620 483.6
WCI—Ithaca, N. Y. ........ 50 1210 247.8
WLEX—Lexington, Mass. ........ 500 1360 220.4
WLEY—Lexington, Mass. ..... 100-250 1420 211.1
WLIB-WGN—See WGN-WLIB.
WLIT—Philadelphia, Pa. ........ 500 560 535.4
WLOE—Chelsea, Mass.
S—Boston, Mass. ..... 100-250 1500 199.9
WLS—Crete, Ill.
S—Chicago, Ill. ........ 5kw. 870 344.6
WLSI-WDWF—See WDWF—WLSI.
WLTH—Brooklyn, N. Y. ........ 500 1400 214.2
WLW—Mason, Ohio
S—Cincinati ........ 50kw. 700 428.3
WLWL—Kearny, N. J.
S—New York City ........ 5kw. 1100 272.6
WMAC—Cazenovia, N. Y. ........ 250 570 526
WMAF—S. Dartmouth, Mass. ........ 500 1360 220.4
WMAK—Martinsville, N. Y.
S—Buffalo, N. Y. ........ 750 900 331.1
WMAL—Washington, D. C. ..... 250-500 630 475.9
WMAN—Columbus, Ohio ........ 50 1210 247.8
WMAQ—Addison, Ill.
S—Chicago ........ 5kw. 670 447.5
WMAY—St. Louis, Mo. ........ 100-250 1200 249.9
WMAZ—Macon, Ga. ........ 250-500 890 336.9
WMBA—Newport, R. I. ........ 100 1500 199.9
WMBC—Detroit, Mich. ........ 250 1420 211.1
WMBD—Peoria Hts., Ill. ..500w.-1kw. 1440 208.2
WMBF-WIOD—See WIOD-WMBF.
WMBG—Richmond, Va. ........ 100 1210 247.8
WMBH—Joplin, Mo. ........ 100-200 1420 211.1
WMBI—Addison, Ill.
S—Chicago ........ 5kw. 1080 277.6
WMBJ—Pittsburgh, Pa. ........ 100 1500 199.9
WMBO—Auburn, N. Y. ........ 100 1370 218.8
WMBQ—Brooklyn, N. Y. ........ 100 1500 199.9
WMBR—Tampa, Fla. ........ 100 1370 218.8
WMC—Memphis, Tenn. ........ 500-1kw. 780 384.4
WMCA—Hoboken, N. J.
S—New York City, N. Y. 500 570 526
WMES—Boston, Mass ........ 50 1500 199.9
WMMN—Fairmont, W. Va. ... 250-500 890 336.9
WMPC—Lapeer, Mich. ........ 100 1500 199.9
WMRJ—Jamaica, N. Y. ........ 10 1420 211.1
WMSG—New York, N. Y. ........ 250 1350 221.1
WMT—Waterloo, Iowa ........ 500 600 499.7
WNAC-WBIS—Quincy, Mass.
S—Boston, Mass. ........ 1kw. 1230 243.8
WNAD—Norman, Okla. ........ 500 1010 296.9
WNAX—Yankton, S. Dak. ........ 1kw. 570 526
WNBF—Binghamton, N. Y. ........ 100 1500 199.9
WNBH—New Bedford, Mass. ........ 100 1310 228.3
WNBJ—Knoxville, Tenn. ........ 50 1310 228.3
WNBO—Washington, Pa. ........ 100 1200 249.9
WNBR—Memphis, Tenn. ........ 500 1430 209.7
WNBW—Carbondale, Pa. ........ 10 1200 249.9
WNBX—Springfield, Vt. ........ 10 1200 249.9
WNBZ—Saranac Lake, N. Y. ........ 50 1290 232.4
WNJ—Newark, N. J. ........ 250 1450 206.8
WNOX—Knoxville, Tenn. ........ 2kw. 560 535.4
WNRC—Grensboro, N. C. ........ 500 1440 208.2
WOAI—San Antonio, Texas ........ 50 1190 252
WOAN—Lawrenceburg, Tenn. ........ 500 600 499.7
WOAX—Trenton, N. J. ........ 500 1280 234.2
WOBT—Union City, Tenn. ..... 100-250 1310 228.3
WOBU—(near) Charleston ........ 250 580 516.9
WOC—Davenport, Iowa ........ 5kw. 1000 299.8
WOCL—Jamestown, N. Y. ........ 25 1210 247.8
WODA—Paterson, N. J. ........ 1kw. 1250 239.9
WODX—Springhill, Ala.
S—Mobile, Ala. ........ 500 1410 212.6
WOI—Ames, Iowa ........ 5kw. 640 468.5
WOKO—Mt. Beacon, N. Y.
S—Poughkeepsie, N. Y. ... 500 1440 208.2
WOL—Washington, D. C. ........ 100 1310 228.3
WOMT—Manitowoc, Wis. ........ 100 1210 247.8
WOOD—Furnwood, Mich.
S—Grand Rapids, Mich. .. 500 1270 236.1
WOPI—Bristol, Tenn. ........ 100 1500 199.9
WOQ—Kansas City, Mo. ........ 1kw. 1300 230.6

| Station Transmitter | Power | kc. | M. |
|---|---|---|---|
| WOR—Kearny, N. J. | | | |
| S—Newark, N. J. | 5kw. | 710 | 422.3 |
| WORC—Auburn, Mass. | | | |
| S—Worcester, Mass. | 100 | 1200 | 249.9 |
| (formerly WKBE) | | | |
| WORD—Batavia, Ill. | | | |
| S—Chicago, Ill | 5kw. | 1480 | 202.6 |
| WOS—Jefferson City, Mo. | 500-1kw. | 630 | 475.9 |
| WOV—Secaucus, N. J. | | | |
| S—New York City | 1kw. | 1130 | 265.3 |
| WOW—Omaha, Neb. | 1kw. | 590 | 508.2 |
| WOWO—Ft. Wayne, Ind. | 10kw. | 1160 | 258.5 |
| WPAP-WQAO—See WQAO-WPAP | | | |
| WPAW—Pawtucket, R. I. | 100 | 1210 | 247.8 |
| WPCC—Chicago, Ill. | 500 | 560 | 535.4 |
| WPCH—Hoboken, N. J. | | | |
| S—New York City | 500 | 810 | 370.2 |
| WPEN—Philadelphia, Pa. | 100-250 | 1500 | 199.9 |
| (formerly WPSW) | | | |
| WPG—Atlantic City, N. J. | 5kw. | 1100 | 272.6 |
| WPOE—Patchogue, N. Y. | 100 | 1370 | 218.8 |
| WPOR-WTAR—See WTAR-WPOR | | | |
| WPSC—State College, Pa. | 500 | 1230 | 243.8 |
| WPTF—Raleigh, N. C. | 1kw. | 680 | 440.9 |
| WQAM—Miami, Fla. | 1kw. | 560 | 535.4 |
| WQAN—Scranton, Pa. | 250 | 880 | 340.7 |
| WQAQ-WPAP—Cliffside, N. J. | | | |
| S—New York City, N. Y. | 250 | 1010 | 296.9 |
| WQBC—Utica, Miss. | 300 | 1360 | 220.4 |
| WQBZ—Weirton, W. Va. | 60 | 1420 | 211.1 |
| WQDM—St. Albans, Vt. | 5 | 1370 | 218.8 |
| WRAF—LaPorte, Ind. | 100 | 1200 | 249.9 |
| WRAK—Erie, Pa. | 50 | 1370 | 218.8 |
| WRAW—Reading, Pa. | 100 | 1310 | 228.3 |
| WRAX—Philadelphia, Pa. | 250 | 1020 | 293.9 |
| WRBI—Tifton, Ga. | 20 | 1310 | 228.3 |
| WRBJ—Hatiesburg, Miss. | 10 | 1500 | 199.9 |
| WRBL—Columbus, Ga. | 50 | 1200 | 249.9 |
| WRBQ—Greenville, Miss. | 100 | 1210 | 247.8 |
| WRBT—Wilmington, N. C. | 100 | 1370 | 218.8 |
| WRBU—Gastonia, N. C. | 100 | 1210 | 247.8 |
| WRC—Washington, D. C. | 500 | 950 | 315.6 |
| WREC—Whitehaven, Tenn. | | | |
| S—Memphis, Tenn. | 500&1kw. | 600 | 499.7 |
| WREN—Lawrence, Kans. | 1kw. | 1220 | 245.8 |
| WRHM—Fridley, Minn. | | | |
| S—Minneapolis, Minn. | 1kw. | 1250 | 239.9 |
| WRJN—Racine, Wis. | 100 | 1370 | 218.8 |
| WRK—Hamilton, Ohio | 100 | 1310 | 228.3 |
| WRNY—Coytesville, N. J. | | | |
| S—New York City, N. Y. | 250 | 1010 | 296.9 |
| WRR—Dallas, Texas | 500 | 1280 | 234.2 |
| WRUF—Gainesville, Fla. | 5kw. | 830 | 361.2 |
| WRVA—Mechanicsville, Va. | | | |
| S—Richmond, Va. | 5kw. | 1110 | 270.1 |
| WSAI—Mason, Ohio | | | |
| S—Cincinnati, Ohio | 500 | 1330 | 225.4 |
| WSAJ—Grove City, Pa. | 100 | 1310 | 228.3 |
| WSAN—Allentown, Pa. | 250 | 1440 | 208.2 |
| WSAR—Fall River, Mass. | 250 | 1450 | 206.8 |
| WSAZ—Huntington, W. Va. | 250 | 580 | 516.9 |
| WSB—Atlanta, Ga. | 1kw. | 740 | 405.2 |
| WSBC—Chicago, Ill. | 100 | 1210 | 247.8 |
| WSBT—South Bend, Ind. | 500 | 1230 | 243.8 |
| WSDA-WSGH—See WSGH-WSDA | | | |
| WSFA—Montgomery, Ala | 500 | 1410 | 212.6 |
| WSGH-WSDA—Brooklyn, N. Y. | 500 | 1400 | 214.2 |
| WSIX—Springfield, Tenn. | 100 | 1210 | 247.8 |
| WSJS—Winston-Salem, N. C. | 100 | 1310 | 228.3 |
| (formerly WJDZ) | | | |
| WSM—Nashville, Tenn. | 5kw. | 650 | 461.3 |
| WSMB—New Orleans, La. | 500 | 1320 | 227.1 |
| WSMK—Dayton, Ohio | 200 | 1380 | 217.3 |
| WSOA—Deerfield, Ill. | | | |
| S—Chicago, Ill. | 5kw. | 1480 | 202.6 |
| WSPD—Toledo, Ohio | 500&1kw. | 1240 | 241.8 |
| WSSH—Boston, Mass. | 500 | 1360 | 220.4 |
| WSUI—Iowa City, Iowa | 500 | 880 | 340.7 |
| WSUN-WFLA—See WFLA-WSUN | | | |
| WSVS—Buffalo, N. Y. | 50 | 1370 | 218.8 |
| WSYR—Syracuse, N. Y. | 250 | 570 | 526 |
| WTAD—Quincy, Ill. | 500 | 1440 | 208.2 |
| WTAG—Worcester, Mass. | 250 | 580 | 516.9 |
| WTAM—Brecksville Village, Ohio | | | |
| S—Cleveland, Ohio | 50kw. | 1070 | 280.2 |
| WTAQ—Township of Washington, Wis. | | | |
| S—Eau Claire, Wis. | 1kw. | 1330 | 225.4 |
| WTAR-WPOR—Norfolk, Va. | 500 | 780 | 384.4 |
| WTAW—College Station, Texas | 500 | 1120 | 267.7 |
| WTAX—Streator, Ill. | 50 | 1210 | 247.8 |
| WTBO—Cumberland, Md. | 50 | 1420 | 211.1 |
| WTFI—Toccoa, Ga. | 250 | 1450 | 206.8 |
| WTIC—Avon, Conn. | | | |
| S—Hartford, Conn. | 50kw. | 1060 | 282.8 |
| WTMJ—Brookfield, Wis. | | | |
| S—Milwaukee, Wis. | 1kw.&2½kw. | 620 | 483.6 |
| WTNT—Nashville, Tenn. | 5kw. | 1490 | 201.2 |
| (formerly WBAW) | | | |
| WTOC—Savannah, Ga. | 500 | 1260 | 238 |
| WWAE—Hammond, Ind. | 100 | 1200 | 249.9 |
| WWJ—Detroit, Mich. | 1kw. | 920 | 325.9 |
| WWL—New Orleans, La. | 5kw. | 850 | 352.7 |
| WWNC—Asheville, N. C. | 1kw. | 570 | 526 |
| WWRL—Woodside, N. Y. | 100 | 1500 | 199.9 |
| WWVA—Wheeling, W. Va. | 5kw. | 1160 | 258.5 |
| KBTM—Paragould, Ark. | 100 | 1200 | 249.9 |
| KCRC—Enid, Okla. | 100&250 | 1370 | 218.8 |
| KDB—Santa Barbara, Calif. | 100 | 1500 | 199.9 |
| KDFN—Casper, Wyo. | 100 | 1210 | 247.8 |
| KDKA—Wilkins Township, Pa. | | | |
| S—Pittsburgh, Pa. | 50kw. | 980 | 305.9 |
| KDLR—Devils Lake, N. D. | 100 | 1210 | 247.8 |
| KDYL—Salt Lake City, Utah | 1kw. | 1290 | 232.4 |
| KECA—Los Angeles, Calif. | 1kw. | 1430 | 209.7 |
| KEJK—Beverly Hills, Calif. | 500 | 1170 | 256.3 |
| KELW—Burbank, Calif. | 500 | 780 | 384.4 |
| KEX—Portland, Ore. | 5kw. | 1180 | 254.1 |
| KFAB—Lincoln, Neb. | 5kw. | 770 | 389.4 |
| KFBB—Great Falls, Mont. | 1kw. | 1360 | 220.4 |
| KFBK—Sacramento, Calif. | 100 | 1310 | 228.3 |
| KFBL—Everett, Wash. | 50 | 1370 | 218.8 |
| KFDM—Beaumont, Texas | 500 | 560 | 535.4 |
| KFDY—Brookings, S. D. | 500&1kw. | 550 | 545.1 |
| KFEL—Denver, Colo. | 500 | 920 | 325.9 |
| KFEQ—St. Joseph, Mo. | 2½kw. | 560 | 535.4 |
| KFGQ—Boone, Iowa | 100 | 1310 | 228.3 |
| KFH—Wichita, Kans. | 1kw. | 1300 | 230.6 |
| KFHA—Gunnison, Colo. | 50 | 1200 | 249.9 |
| KFI—Los Angeles, Calif. | 5kw. | 640 | 468.5 |
| KFIF—Portland, Ore. | 100 | 1420 | 211.1 |
| KFIO—Spokane, Wash. | 100 | 1230 | 243.8 |
| KFIU—Juneau, Alaska | 10 | 1310 | 228.3 |
| KFIZ—Fond du Lac, Wis. | 100 | 1420 | 211.1 |
| KFJB—Marshalltown, Iowa | 100 | 1200 | 249.9 |
| KFJF—Oklahoma City, Okla. | 5kw. | 1470 | 204 |
| KFJI—Astoria, Ore. | 100 | 1370 | 218.8 |
| KFJM—Grand Forks, N. D. | 100 | 1370 | 218.8 |
| KFJR—Portland, Ore. | 500 | 1300 | 230.6 |
| KFJY—Fort Dodge, Iowa | 100 | 1310 | 228.3 |
| KFJZ—Fort Worth, Texas | 100 | 1370 | 218.8 |
| KFKA—Greeley, Colo. | 500&1kw. | 880 | 340.7 |
| KFKB—Milford, Kans. | 5kw. | 1050 | 285.5 |
| KFKU—Lawrence, Kans. | 1kw. | 1220 | 245.8 |
| KFKX-KYW—See KYW-KFKX | | | |
| KFLV—Rockford, Ill. | 500 | 1410 | 212.6 |
| KFLX—Galveston, Texas | 100 | 1370 | 218.8 |
| KFMX—Northfield, Minn. | 1kw. | 1250 | 239.9 |
| KFNF—Shenandoah, Iowa | 500&1kw. | 890 | 336.9 |
| KFOR—Lincoln, Nebr. | 100&250 | 1210 | 247.8 |
| KFOX—Long Beach, Calif. | 1kw. | 1250 | 239.9 |
| KFPL—Dublin, Texas | 15 | 1310 | 228.3 |
| KFPM—Greenville, Texas | 15 | 1310 | 228.3 |
| KFPW—Siloam Springs, Ark. | 50 | 1340 | 223.7 |
| KFPY—Spokane, Wash. | 1kw. | 1340 | 223.7 |
| KFQA-KMOX—See KMOX-KFQA | | | |
| KFQD—Anchorage, Alaska | 100 | 1230 | 243.8 |
| KFQU—Holy City, Calif. | 100 | 1420 | 211.1 |
| KFQW—Seattle, Wash. | 100 | 1420 | 211.1 |
| KFQZ—Hollywood, Calif. | | | |
| S—Los Angeles, Calif. | 250 | 860 | 348.6 |
| KFRC—San Francisco, Calif. | 1kw. | 610 | 491.5 |
| KFRU—Columbia, Mo. | 500 | 630 | 475.9 |
| KFSD—San Diego, Calif. | 500&1kw. | 600 | 499.7 |
| KFSG—Los Angeles, Calif. | 500 | 1120 | 267.7 |
| KFUI—Juneau, Alaska | 10 | 1310 | 228.3 |
| KFUL—Galveston, Texas | 500 | 1290 | 232.4 |
| KFUM—Colorado Springs, Colo. | 1kw. | 1270 | 236.1 |
| KFUO—Clayton, Mo. | 500&1kw. | 550 | 545.1 |
| KFUP—Denver, Colo. | 100 | 1310 | 228.3 |
| KFVD—Culver City, Calif. | 250 | 1000 | 299.9 |
| KFVS—Cape Girardeau, Mo. | 100 | 1210 | 247.8 |
| KFWB—Hollywood, Calif. | 1kw. | 950 | 315.6 |
| KFWF—St. Louis, Mo. | 100 | 1200 | 249.9 |
| KFWI—San Francisco, Calif. | 500 | 930 | 322.4 |
| KFWM—Richmond, Calif. | 500&1kw. | 930 | 322.4 |
| KFXD—Jerome, Idaho | 50 | 1420 | 211.1 |
| KFXF—Denver, Col. | 500 | 920 | 325.9 |
| KFXK—Denver, Colo. | 250 | 630 | 475.9 |
| KFXJ—Edgewater, Colo. | 50 | 1310 | 228.3 |
| KFXM—San Bernadino, Calif. | 100 | 1200 | 249.9 |
| (formerly KFWC) | | | |
| KFXR—Oklahoma City, Okla. | 100 | 1310 | 228.3 |
| KFFXY—Flagstaff, Ariz. | 100 | 1420 | 211.1 |
| KFYO—Abilene, Texas | 100&250 | 1420 | 211.1 |
| KFYR—Bismarck, N. D. | 500 | 550 | 545.1 |
| KGA—Spokane, Wash. | 5kw. | 1470 | 204 |
| KGAR—Tuscon, Ariz. | 100 | 1370 | 218.8 |
| KGB—San Diego, Calif. | 250 | 1330 | 225.4 |
| KGBU—Ketchikan, Alaska | 500 | 900 | 331.1 |
| KGBX—St. Joseph, Mo. | 100 | 1310 | 228.3 |
| KGBZ—York, Nebr. | 500&1kw. | 930 | 322.4 |
| KGCA—Decorah, Iowa | 50 | 1270 | 236.1 |
| KGCI—San Antonio, Texas | 100 | 1370 | 218.8 |
| KGCR—Watertown, S. D. | 100 | 1210 | 247.8 |
| KGCU—Mandan, N. D. | 100 | 1200 | 249.9 |
| KGCX—Wolf Point, Mont. | 100&250 | 1310 | 228.3 |
| KGDA—Dell Rapids, S. D. | 50 | 1370 | 218.8 |
| KGDE—Fergus Falls, Minn. | 50 | 1200 | 249.9 |
| KGDM—Stockton, Calif. | 250 | 1100 | 272.6 |
| KGDY—Oldham, S. D. | 15 | 1200 | 249.9 |
| KGEF—Los Angeles, Calif. | 1kw. | 1300 | 230.6 |
| KGEK—Yuma, Colo. | 50 | 1200 | 249.9 |
| KGER—Long Beach, Calif. | 1kw. | 1360 | 220.4 |
| KGEW—Fort Morgan, Colo. | 100 | 1200 | 249.9 |
| KGEZ—Kalispell, Mont. | 100 | 1310 | 228.3 |
| KGFF—Alva, Okla. | 100 | 1420 | 211.1 |
| KGFG—Oklahoma City, Okla. | 100 | 1370 | 218.8 |
| KGFI—Corpus Christi, Texas | 100 | 1500 | 199.9 |
| KGFJ—Los Angeles, Calif. | 100 | 1200 | 249.9 |
| KGFK—Hallock, Minn. | 50 | 1200 | 249.9 |
| KGFL—Raton, N. Mex. | 50 | 1370 | 218.8 |
| KGFW—Ravenna, Nebr. | 50 | 1310 | 228.3 |
| KGFX—Pierre, S. D. | 200 | 580 | 516.9 |
| KGGC—San Francisco, Calif. | 50 | 1420 | 211.1 |
| KGGF—Picher, Okla. | 500 | 1010 | 296.9 |
| KGGM—Albuquerque, N. Mex. | 250&500 | 1230 | 243.8 |
| KGHF—Pueblo, Colo. | 500 | 1320 | 227.1 |
| KGHG—McGehee, Ark. | 50 | 1310 | 228.3 |
| KGHI—Little Rock, Ark. | 100 | 1200 | 249.9 |
| KGHL—Billings, Mont. | 500 | 950 | 315.6 |
| KGIQ—Twin Falls, Idaho | 250 | 1320 | 227.1 |
| KGIR—Butte, Mont. | 250 | 1360 | 220.4 |
| KGIW—Trinidad, Colo. | 100 | 1420 | 211.1 |
| KGIX—Las Vegas, Nev. | 100 | 1420 | 211.1 |
| KGJF—Little Rock, Ark. | 250 | 890 | 336.9 |
| KGKB—Brownwood, Texas | 100 | 1500 | 199.9 |
| KGKL—San Angelo, Texas | 100 | 1370 | 218.8 |
| KGKO—Wichita Falls, Texas | 250&500 | 570 | 526 |
| KGKX—Sandpoint, Idaho | 100 | 1420 | 211.1 |
| KGKY—Scottsbluff, Ark. | 100 | 1500 | 199.9 |
| KGMB—Honolulu, Hawaii | 500 | 1320 | 227.1 |
| KGMC—Jerome, Ark. | 100 | 1310 | 228.3 |
| KGMD—Roswell, N. Mex. | 100 | 1500 | 199.9 |
| KGO—Oakland, Calif. | 7½kw. | 70 | 379.5 |
| KGRC—San Antonio, Texas | 100 | 1370 | 218.8 |
| KGRS—Amarillo, Texas | 1kw. | 1410 | 212.6 |
| KGU—Honolulu, Hawaii | 500 | 940 | 319 |
| KGW—Portland, Ore. | 1kw. | 620 | 483.6 |
| KGY—Lacey, Wash | 10&50 | 1200 | 249.9 |
| KHJ—Los Angeles, Calif. | 1kw. | 900 | 331.1 |
| KHQ—Spokane, Wash. | 1kw. | 590 | 508.2 |
| KICK—Red Oak, Iowa | 100 | 1420 | 211.1 |
| KID—Idaho Falls, Idaho | 500 | 1320 | 227.1 |
| KIDO—Boise, Idaho | 1kw. | 1250 | 239.9 |
| KIT—Yakima, Wash. | 50 | 1310 | 228.3 |
| KJBS—San Francisco, Calif. | 100 | 1070 | 280.2 |
| KJR—Seattle, Wash. | 5kw. | 970 | 309.1 |
| KLCN—Blytheville, Ark. | 50 | 1290 | 232.4 |
| KLO—Ogden, Utah | 100&200 | 1370 | 218.8 |
| KLPM—Minot, N. D. | 100 | 1420 | 211.1 |
| KLRA—Little Rock, Ark. | 1kw. | 1390 | 215.7 |
| KLS—Oakland, Calif. | 250 | 1440 | 208.2 |
| KLX—Oakland, Calif. | 500 | 880 | 340.7 |
| KLZ—Denver, Colo. | 1kw. | 560 | 535.4 |
| KMA—Shenandoah, Iowa | 500&1kw. | 930 | 322.4 |
| KMBC—Independence, Mo. | | | |
| S—Kansas City, Mo. | 1&2½kw. | 950 | 315.6 |
| KMED—Medford, Ore. | 50 | 1310 | 228.3 |
| KMIC—Inglewood, Calif. | 500 | 1120 | 267.7 |
| KMJ—Fresno, Calif. | 100 | 1210 | 247.8 |
| KMMJ—Clay Center, Nebr. | 1kw. | 740 | 405.2 |
| KMO—Tacoma, Wash. | 1kw&500 | 860 | 348.6 |
| KMOX-KFQA—Kirkwood, Mo. | | | |
| S—St. Louis, Mo. | 5kw. | 1090 | 257.1 |
| KMTR—Hollywood, Calif. | 500 | 570 | 526 |
| KNX—Los Angles, Calif. | | | |
| S—Hollywood, Calif. | 5kw. | 1050 | 285.5 |
| KOA—Denver, Colo. | 12½kw. | 830 | 361.2 |
| KOAC—Corvallis, Ore. | 1kw. | 550 | 545.1 |
| KOB—State College | | | |
| New Mexico | 10kw. | 1180 | 254.1 |
| KOCW—Chickasha, Okla. | 250&500 | 1400 | 214.2 |
| KOH—Reno, Nev. | 100 | 1370 | 218.8 |
| KOIL—Council Bluffs, Iowa | 1kw. | 1260 | 238 |
| KOIN—Sylvan, Ore. | | | |
| S—Portland, Ore. | 1kw. | 940 | 319 |
| KOL—Seattle, Wash. | 1kw. | 1270 | 236.1 |
| KOMO—Seattle, Wash. | 1kw. | 920 | 325.9 |
| KOOS—Marshfield, Ore. | 50 | 1370 | 218.8 |
| KORE—Eugene, Ore. | 100 | 1420 | 211.1 |
| KOY—Phoenix, Ariz. | 500 | 1390 | 215.7 |
| KPCB—Seattle, Wash. | 100 | 1210 | 247.8 |
| KPJM—Prescott, Ariz. | 100 | 1500 | 199.9 |
| KPO—San Francisco, Calif. | 5kw. | 680 | 440.9 |
| KPOF—Denver, Colo. | 500 | 880 | 340.7 |
| KPPC—Pasaena, Calif. | 50 | 1210 | 247.8 |
| KPQ—Wenatchee, Wash. | 50 | 1210 | 247.8 |
| KPRC—Sugarland, Texas | | | |
| S—Houston, Texas | 1kw&2½kw | 920 | 325.9 |
| KPSN—Pasadena, Calif. | 1kw. | 1360 | 220.4 |
| KPWF—Westminster, Calif. | 5 to 10 kw. | 1490 | 201.2 |
| KSCJ—Sioux City, Iowa | 2½kw. | 1330 | 225.4 |
| KTAR—Phoenix, Ariz. | 1kw. | 620 | 483.6 |
| KTIP—Richmond, Tex. | 50 | 1500 | 199.9 |
| KTRH—Houston, Tex. | 500 | 1120 | 267.7 |
| KTUE—Houston, Tex. | 100 | 1420 | 211.1 |
| KUT—San Antonio, Tex. | 100 | 1500 | 199.9 |
| KWSC—Pullman, Wash. | 2kw. | 1220 | 245.8 |
| KQV—Pittsburgh, Pa. | 500 | 1380 | 217.3 |
| KQW—San Jose, Calif. | 500 | 1010 | 296.9 |
| KRE—Berkeley, Calif. | 100 | 1370 | 218.8 |
| KREG—Pasadena, Calif. | 100 | 1500 | 199.9 |
| KRGV—Harlingen, Texas | 500 | 1260 | 238 |
| KRLD—Dallas, Texas | 10kw. | 1040 | 288.3 |
| KRMD—Shreveport, La. | 50 | 1310 | 228.3 |
| KRSC—Seattle, Wash | 50 | 1120 | 267.7 |
| KSAC—Manhattan, Kans. | 500&1kw | 580 | 516.9 |
| KSAT—Birdsville, Texas | | | |
| S—Fort Worth, Texas | 1kw. | 1240 | 241.8 |
| (formerly KTAT) | | | |
| KSCJ—Sioux City, Iowa | 2½kw. | 1330 | 225.4 |
| KSD—St. Louis, Mo. | 500 | 550 | 545.1 |
| KSEI—Pocatello, Idaho | 250 | 900 | 331.1 |
| KSL—Salt Lake City, Utah | 5kw. | 1130 | 265.3 |
| KSMR—Santa Maria, Calif. | 100 | 1200 | 249.9 |
| KSO—Clarinda, Iowa | 500 | 1380 | 217.3 |
| KSOO—Sioux Falls, S. D. | 2kw. | 1110 | 270.1 |
| KSTP—Westcott, Minn. | | | |
| S—St. Paul, Minn. | 10kw. | 1460 | 205.4 |
| KTAB—Oakland, Calif. | 1kw. | 560 | 535.4 |
| KTAP—San Antonio, Texas | 100 | 1420 | 211.1 |
| KTAR—Phoenix, Ariz. | 1kw. | 620 | 483.6 |
| KTBI—Los Angeles, Calif. | 750 | 1300 | 230.6 |
| KTBR—Portland, Ore. | 500 | 1300 | 230.6 |
| KTBS—Shreveport, La. | 1kw. | 1450 | 206.8 |
| KTHS—Hot Springs Nat'l | | | |
| Park, Ark. | 10kw. | 1040 | 288.3 |
| KTIP—Richmond, Tex. | 50 | 1500 | 199.9 |
| KTM—Santa Monica, Calif. | | | |
| S—Los Angeles, Calif. | 500 | 780 | 384.4 |
| KTNT—Muscatine, Iowa | 5kw. | 1170 | 256.3 |
| KTSA—San Antonio, Texas | 1&2kw. | 1290 | 232.4 |
| KTSL—Cedar Grove, La. | | | |
| S—Shreveport, La. | 100 | 1310 | 228.3 |
| KTSM—El Paso, Texas | 100 | 1310 | 228.3 |
| KTUE—Houston, Texas | 100 | 1420 | 211.1 |
| KTW—Seattle, Wash | 1kw. | 1270 | 236.1 |
| KUJ—Longview, Wash. | 10 | 1500 | 199.9 |
| KUOA—Fayetteville, Ark. | 1kw. | 1390 | 215.7 |
| KUSD—Vermillion, S. D. | 500&750 | 890 | 336.9 |
| KUT—San Antonio, Tex. | 100 | 1500 | 267.7 |
| KVEP—Portland, Ore. | 15 | 1500 | 199.9 |
| (formerly KWBS) | | | |
| KVI—Des Moines, Wash. | | | |
| S—Tacoma, Wash. | 1kw. | 760 | 394.5 |
| KVL—Seattle, Wash | 100 | 1370 | 218.8 |
| KVOA—Tucson, Ariz. | 500 | 1260 | 238 |
| KVOO—Tulsa, Okla. | 5kw. | 1140 | 263 |
| KVOS—Bellingham, Wash. | 100 | 1200 | 249.9 |
| KWCR—Cedar Rapids, Iowa | 100 | 1310 | 228.3 |
| KWEA—Shreveport, La. | 100 | 1210 | 247.8 |
| KWG—Stockton, Calif. | 100 | 1200 | 249.9 |
| KWJJ—Portland, Ore. | 500 | 1060 | 282.8 |
| KWK—St. Louis, Mo. | 1kw. | 1350 | 221.1 |
| KWKC—Kansas City, Mo. | 100 | 1370 | 218.8 |
| KWKH—Kennonwood, La. | 10kw. | 850 | 352.7 |
| KWLC—Decorah, Iowa | 100 | 1270 | 236.1 |
| KWSC—Pullman, Wash. | 500 | 1220 | 245.8 |
| KWWG—Brownsville, Texas | 500 | 1260 | 238 |
| KXA—Seattle, Wash. | 500 | 570 | 526 |
| KXL—Portland, Ore. | 100 | 1420 | 211.8 |
| KXO—El Centro, Calif. | 100 | 1200 | 249.9 |
| KXRO—Aberdeen, Wash. | 75 | 1310 | 228.3 |
| KYA—San Francisco | 1kw. | 1230 | 243.8 |
| KYW-KFKX—Chicago, Ill. | 5kw. | 1020 | 293.9 |
| KYWA—Chicago, Ill. | 500 | 1020 | 293.9 |

# New Corporations

Radio Auction Stores—Atty. W. Weisman, 165 Broadway, New York, N. Y.

Loboves Radio Corp., Ridgefield Park—Attys. Morrison, Lloyd & Morrison, Ridgefield, N. J.

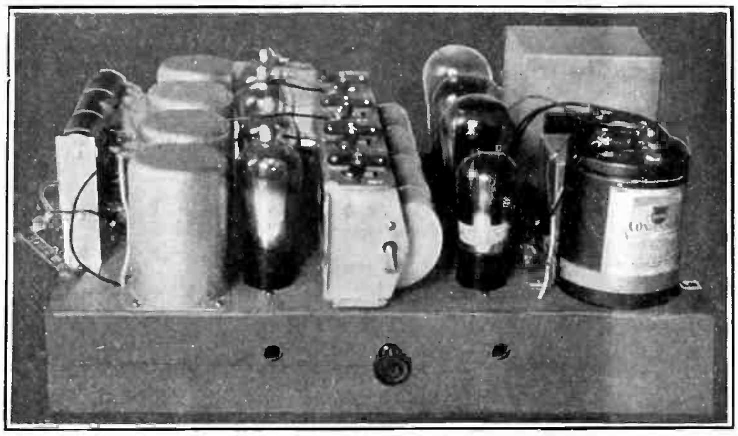
United Radio Corporation, Wilmington, Del.—Atty. Franklin L. Mettler, Wilmington, Del.

Electrical Transcription Broadcasting Systems — Attys. Falk & Orleans, 165 Broadway, New York, N. Y.

Homradio Sales Corp., Newark—Atty. David Bernheim, Newark, N. J.

# *High Gain at Low Cost*

# HB44 - - - $45.59



The HB44, assembled, presents in compact form, on a 17½ x 11½" steel chassis, a completely AC operated shielded receiver, using four 224 screen grid tubes, one 227, two 245s in push-pull, and a 280 rectifier, eight tubes all told. Here is the circuit that will bring 'em in from all over the country—and at a price you can afford—$45.59. This price includes EVERYTHING except speaker, cabinet and tubes.

## It's the Real Thing!

*(a)* Three stages of tuned R.F., using 224 screen grid tubes.
*(b)* Tuned input to 224 power detector.
*(c)* Audio, consisting of first stage resistance coupled, second stage 245s in push-pull.
*(d)* Four totally shielded R.F. coils.
*(e)* A chassis all drilled for necessary parts.
*(f)* A four gang condenser, guaranteed accurate, with equalizing condensers built in.
*(g)* 61 mfd. of filter and bypass capacity.
*(h)* Thirteen different fixed voltages available from the output.
*(i)* Single dial control.

### LIST OF PARTS FOR THE HB44

| | |
|---|---|
| ☐ SL1, SL2, SL3, SL4—Four stage individually shielded coil cascade for .00035 mfd. (Four Cat. SH-3 of Screen Grid Coil Co.) | $ 3.80 |
| ☐ C1, C2, C3, C4—One four gang .00035 mfd. condenser with equalizers E1, E2, E3, E4 built in | 3.95 |
| ☐ C5—One .01 mfd. mica condenser | .35 |
| ☐ C6, C7, C13, C14—Four 1 mfd. 200 volt DC bypass condensers | 2.00 |
| ☐ C8—One 1 mfd. 550 volt AC filter condenser | .85 |
| ☐ C9, C10, C11, C12—One Mershon, consisting of four condensers, two of 8 mfd. and two of 18 mfd. with bracket (Cat. Q-2-8, 2-18-B). | 5.15 |
| ☐ R1—One Electrad 25,000 ohm potentiometer with knob and two insulators | 1.60 |
| ☐ R2—One 50,000 ohm Lynch metallized resistor (.05 meg.), with mounting | .45 |
| ☐ R3—One Lynch 5.0 meg. metallized grid leak, with mounting | .40 |
| ☐ R4—One 5,000 ohm resistor with mounting | .50 |
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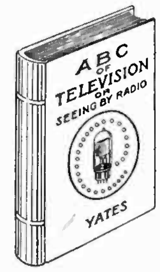


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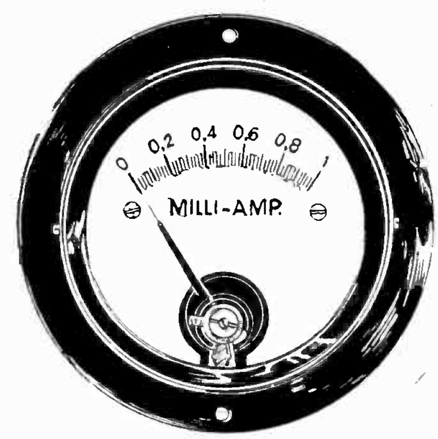


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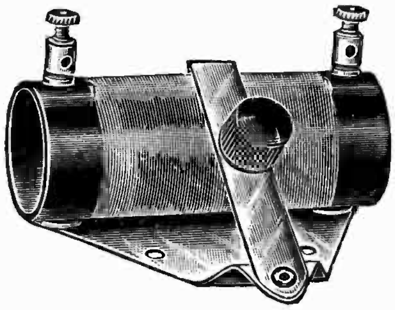

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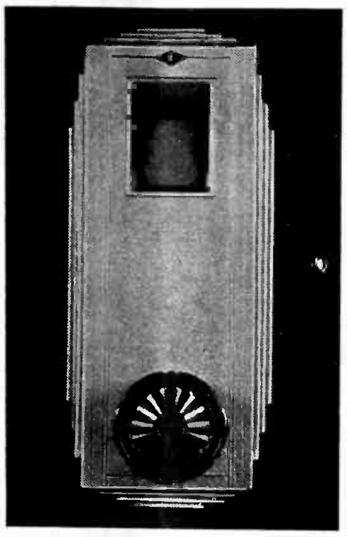

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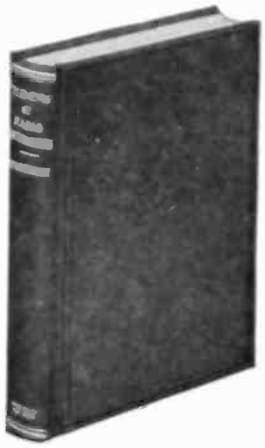

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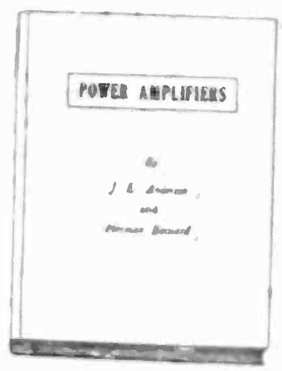


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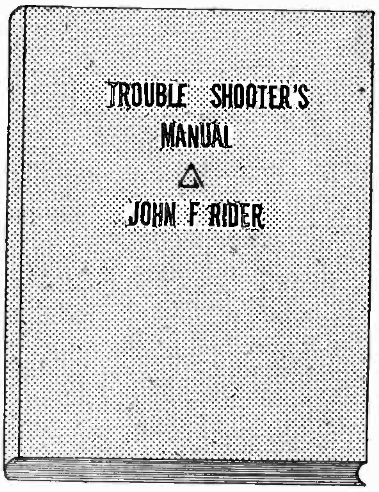


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6 tube electric, 8 tube 80, 83, 84, 85, 86, 88, 6 tube 60, 61, 62, 65, 66, u and 8 tube A.C. power pack.

**DAY FAN**
OEM7, 4 tube, 5-5 tube 1925 model, Day Fan 8 A.C., power supply for 6 tube A.C., B power supply 5524 and 5525, motor generator and filetr, 6 tube motor generator set, 6 tube 110 volt D.C. set, 6 tube 32 volt D.C. set.

**FADA**
50/80A receivers, 460A, Fada 10, 11, 30, 31, 10Z, 11Z, 30Z, 31Z, 16, 17, 32, 16Z, 32Z, 18, 18, special, 192A-192S and 192BS units, R80A, 480A, and SF 50/80A receivers, 460A receiver and R60 unit, 7 A.C. receiver, 475 UA or CA and SF45-75 UA or CA, 50, 70, 71, 72, C electric unit for special and 7 A.C. receivers, ABC 6 volt tube supply, 86V and 82W, E180Z power plant and E 420 power plant.

**FREED EISEMANN**
NR5, FE18, NR70, 470, NR57, 457, NR11, NR80 D.C.

**COLONIAL**
26, 31 A.C., 31 D.C.

**WORKRITE**
8 tube chassis, 6 tube chassis.

**AMRAD**
70, 7100, 7191 power unit.

**SPARTON**
A.C. 89.

**MISCELLANEOUS**
DeForest F5, D10, D17. Super Zenith Magnavox dial, Thermiodyne, Grimes 4DL inverse duplex, Garod neutrodyne, Garod EA, Ware 7 tube, Ware type T. Federal 102 special, Federal 59, Kennedy 220, Operadio portable, Sleeper RX1, Amrad inductrol.

## HERE ARE THE 22 CHAPTER HEADINGS

Service Procedure
Practical Application of Analysis
Vacuum Tubes
Operating Systems
Aerial Systems
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Radio Frequency Amplifiers
Trouble Shooting in RF Amplifiers
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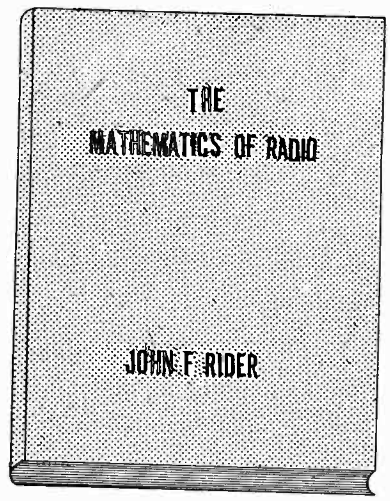
Testing, and Testing Devices
Troubles in DC Sets
Troubles in AC Sets




## *"Mathematics of Radio"*

**TABLE OF CONTENTS:**

**OHM'S LAW.**

**RESISTANCES:** Basis for resistance variation, atomic structure, temperature coefficient, calculation of resistance variation, expression of ampere, volt and Ohm fractions, application of voltage drop, plate circuits, filament circuits, filament resistances, grid bias resistances.

**DC FILAMENT CIRCUITS:** Calculation of resistances.

**AC FILAMENT CIRCUITS:** Transformers, wattage rating, distribution of output voltages, voltage reducing resistances, line voltage reduction.

**CAPACITIES:** Calculation of capacity, dielectric constant condensers in parallel, ondensers in series, voltage of ondensers in parallel, in series, utility of parallel condensers, series condensers.

**VOLTAGE DIVIDER SYSTEMS FOR B ELIMINATORS:** Calculation of voltage divider resistances, types of voltage dividers, selection of resistances, wattage rating of resistances.

**INDUCTANCES:** Air core and iron core, types of air core inductances, unit of inductances, calculation of inductance.

**INDUCTANCE REQUIRED IN RADIO CIRCUITS:** Relation of wavelength and product of inductance and capacity, short wave coils, coils for broadcast band, coupling and mutual inductance, calculation of mutual inductance and coupling.

**REACTANCE AND IMPEDANCE:** Capacity reactance, inductance reactance, impedance.

**RESONANT CIRCUITS:** Series resonance, parallel resonance, coupled circuits, bandpass filters for radio frequency circuits.

**IRON CORE CHOKERS AND TRANSFORMERS:** Design of chokes, core, airgap, inductance, reactance, impedance, transformers, half wave, full wave windings.

**VACUUM TUBES:** Two element filament type, electronic emission, limitations, classifications of filaments, structure, two element rectifying tubes, process of rectification, tungar bulb.

**THREE ELEMENT TUBES:** Structure of tube, detector, grid bias, grid leak and condenser, amplifiers, tube constants, voltage amplification, resistance coupling, reactance coupling, transformer coupling, variation of impedance of load with frequency, tuned plate circuit.

**POWER AMPLIFICATION:** Square law, effect of load, calculation of output power, undistorted output power, parallel tubes, push-pull systems, plate resistance.

**GRAPHS AND RESPONSE CURVES:** Types of paper, utility of curves, types of curves, significance of curves, voltage amplification, power amplification, power output, radio frequency amplification.

**MULTIPLE STAGE AMPLIFIERS:** Resistance coupling, reactance coupling, tuned double impedance amplification, underlying principles, transformer coupling, turns ratio, voltage ratio, tyes of cores, late current limitation, grid current limitation.

**ALTERNATING CURRENT TUBES:** Temperature variation hum, voltage variation hum, relation between grid and filament, filament circuit center tap, types of AC tubes.

**SCREEN GRID TUBE:** Structural design, application, amplification, associated tuned circuits, radio frequency amplification, audio frequency amplification.

**RADIO WORLD, 145 West 45th St., New York, N. Y.**
(Just East of Broadway)

Enclosed please find:

☐ $3.50 for which please send me postpaid "Trouble Shooter's Manual" (Cat. TSM), by John F. Rider, 240 pages, 8½x11", more than 200 illustrations, including wiring diagrams of commercial receivers as advertised; imitation leather cover, gold lettering.
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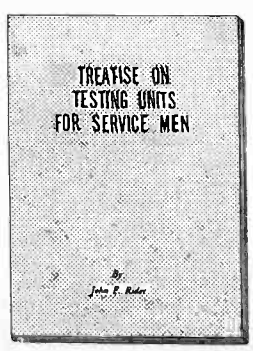


## *"Testing Units for Service Men."*

A 43-page, liberally illustrated book on testing units and circuits. Tells what equipment a service man should have and how to use it most effectively and quickly. Rapidity of operation is one of the points stressed throughout this valuable book, as a service man's time is his chief stock in trade.

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Multi-Range Meters
Service Station Test Bench