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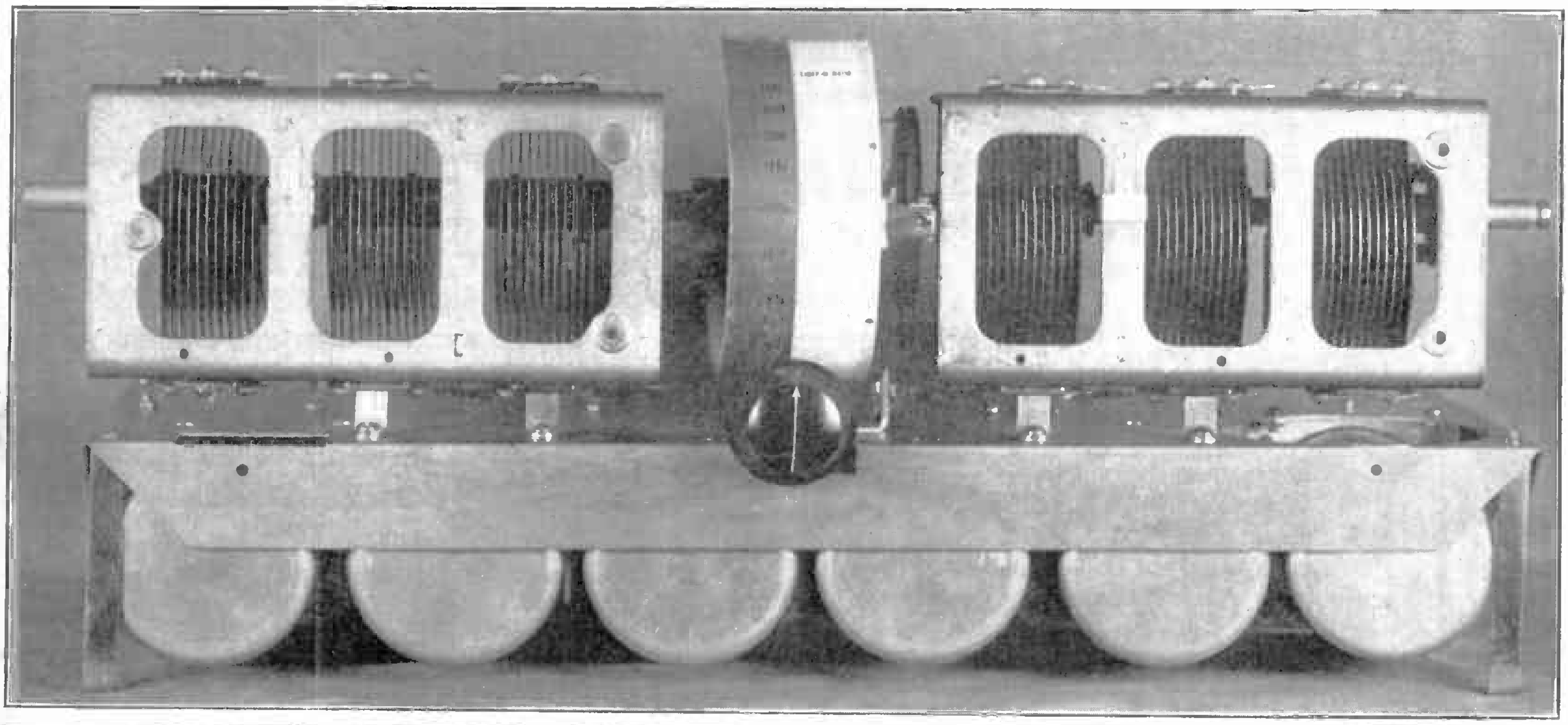

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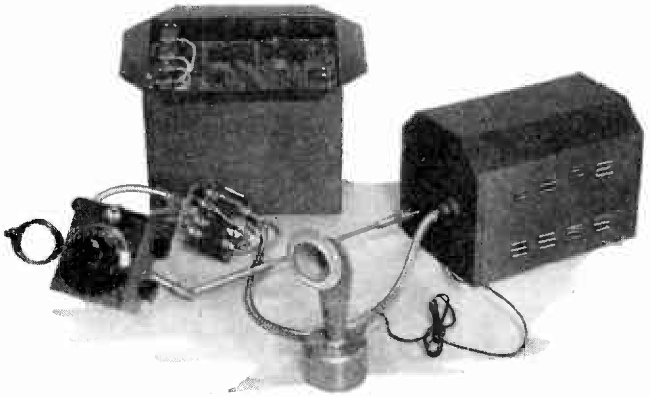

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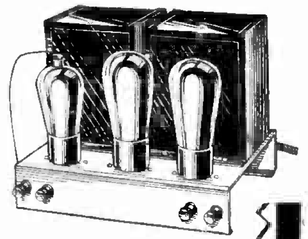

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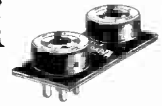

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Use of 6 Tuned Circuits

A Theoretical Discussion of an AC Design on That Basis

By Herman Bernard
Managing Editor

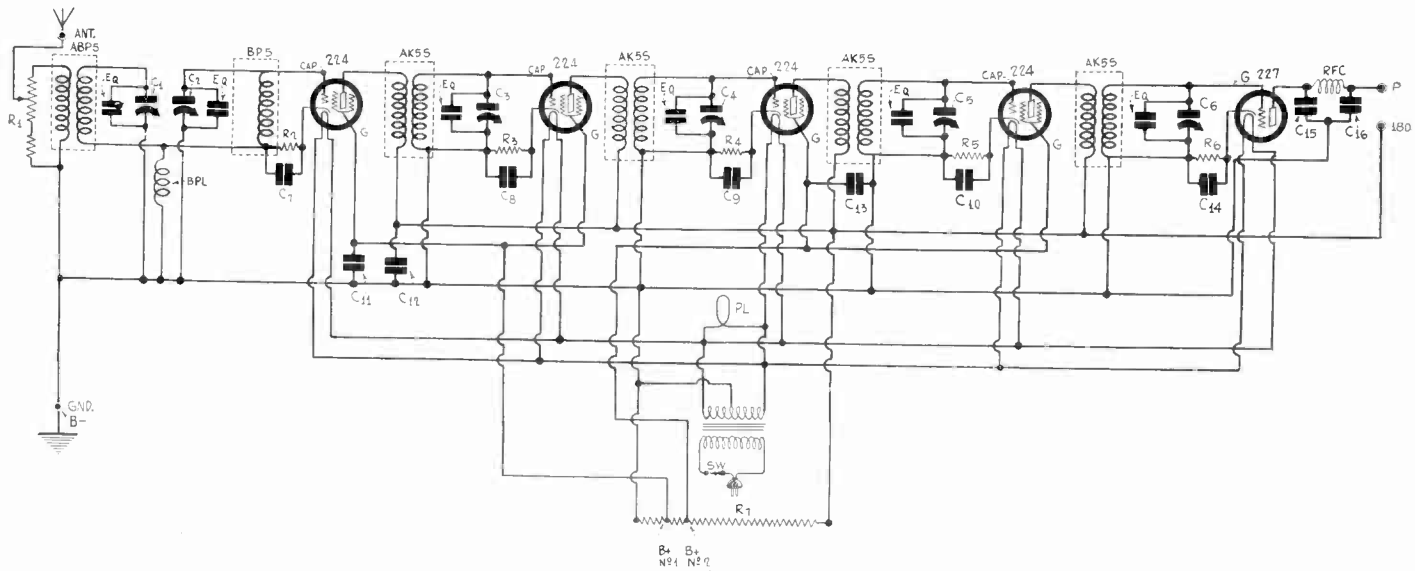


FIG. 1
A THEORETICAL CIRCUIT, USING A BAND PASS FILTER INPUT, WITH A TOTAL OF SIX TUNED CIRCUITS. THE PROBLEMS CONNECTED WITH THE DESIGN OF SUCH A RECEIVER ARE DISCUSSED IN THE TEXT. C11, C12 AND C13 ARE 1 MFD. EACH.

ASSUMING that you are to use six tuned circuits, how would you accommodate them in an AC tuner design?

There is a multitude of variations. The first theoretical consideration might be to include five stages of tuned radio frequency amplification. The input to the detector would be the sixth tuned stage. The fourth and fifth stages might be worked at high gain, the preceding ones at low gain, for the selectivity that they afford. In that way a measure of stability might be established.

But five stages of tuned radio frequency amplification would constitute rather too unstable a tuner or, if stability is provided, the amount of theoretically possible amplification cast away would be very great. Perhaps it would be better therefore to limit the number of tuned RF steps to four, leaving one tuned circuit for the detector input and one for a band pass filter. Stability attainment is thereby rendered much more practical, but the device of limiting the circuit to low gain in the first and second RF stages is still necessary, even with careful shielding.

Where Theory is Serviceable

Let us consider such a circuit theoretically, for the design, as shown in Fig. 1, has not yet been built, and we seek at this time only to predict the results. Then we shall proceed to the constructing, testing, revision and final authentication, for we have the materials with which to work, and also experience with other circuits involving the very principles to be invoked in this instance.

While the discussion is purely theoretical at this stage, it must not be supposed that theory means wild guesses. Theory, as meant here, is a code of operation, based on experience, and applied to a present problem. Therefore a theoretical circuit is not a dangerous instrument but simply a circuit that has not been built, but in the design of which experience with similar circuits has been incorporated.

With these facts in mind we can proceed to a better understanding of the underlying factors of the diagrammed circuit. We have the tuning condensers, the shielded coils, the subpanel (although one resuscitated from a previously operating circuit), the dial and the choice of resistors, condensers, and other parts.

Band Pass Filter Introduced

Take the input circuit, deemed to consist of two tuned circuits united so as to produce a band pass filter. The first coil, ABP_5, is like any other radio frequency transformer, in that it has one winding for the antenna-ground connections and a larger winding for the tuned secondary. R_1 is the volume control, appearing to be two resistors, but really one, since it is a potentiometer with a definite minimum resistance that makes it impossible totally to short the input.

Instead of the secondary of ABP_5 going directly to ground it is returned to ground through a band pass coupling coil, BPL,

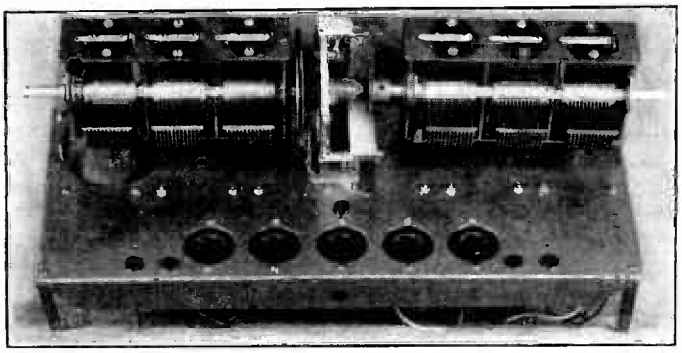


FIG. 2

REAR VIEW OF A RANDOM METAL SUBPANEL ON TOP OF WHICH THE CONDENSERS, DIAL AND SOCKETS WERE MOUNTED. THIS PHOTOGRAPH WAS TAKEN BEFORE ANY WIRING WAS DONE.

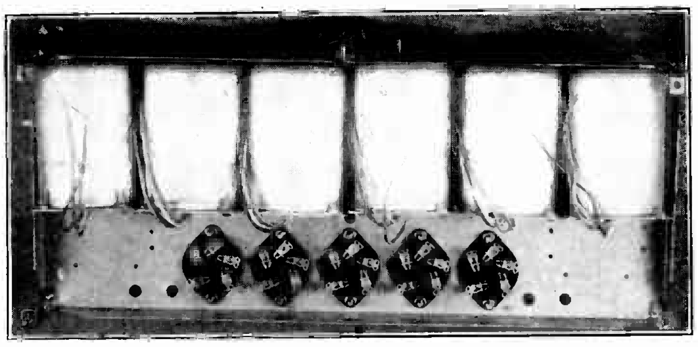


FIG. 3

UNDERNEATH VIEW OF THE SUBPANEL, WITH TENTATIVE LOCATION OF THE SIX SHIELDED COILS AND THE SOCKETS. YOU WILL NOTE THIS METHOD LEAVES NO ROOM FOR THE VOLUME CONTROL.

which is common to the other tuned winding, BP_5, so that the two tuned circuits are coupled by BPL, which may consist of 10 turns of No. 28 wire on 1 inch diameter, to provide a 10 kc band at 1,500 kc.

The principal object in the present instance is to gain selectivity, which is accomplished by tuning twice before reaching the input to the first tube. This is in sharp distinction to the practice of introducing a radio frequency choke coil in the antenna-ground circuit, which admits all frequencies to the grid band at 1,500 kc.

Avoids Cross Modulation

Here we obtain a fair order of selectivity before any amplification takes place. This not only improves the selectivity throughout but it also tends to rid the circuit of any tendency to cross modulation due to stray detection in the first tube. This detection may arise from too strong an input, resulting in detection by shock excitation, or from a negative bias which is too low. But we can arrange the bias as desired, so it will be high, probably selecting 2 or 3 volts, and then we have a relatively high input impedance in addition to the other incorporation, that of a twice-tuned input, to raise the impedance greatly. The higher the selectivity, the higher the input impedance.

Likely we will run into a snag right away, unless we make suitable precautionary provision. If the coils are to be identical throughout the circuit, that is, all radio frequency transformers are to be wound exactly the same, we will find a preponderance of inductance in the first pair of tuned circuits, due to the coupling coil BPL adding its inductance to the inductance of the two tuned windings of which it is made a common part.

Inductances Equalized

The inductance of the coupling coil is 20 microhenries, therefore we will wind the secondary of the antenna coil so that its inductance alone is 20 microhenries less than the inductance of the other secondaries. Then there is the winding BP_5, which may be regarded for the moment as a straight impedance. It has no other coil in mutual inductive relationship to it, therefore its own inductance will be the resultant inductance. The effect of a primary, as in the other instance, would be to decrease slightly the inductance otherwise present in the secondary. We solve both problems as follows: the standard radio frequency transformers AK_5S are to be wound with No. 28 enamel wire, with 76 turns secondaries on 1¾" diameter tubing about 3" high, with primaries of 40 turns of the same kind of wire, separated from the secondary by a layer of Empire or similar insulating and moisture-proof cloth 21/10,000 inch thickness. Thus we make coils AK_5S, of which there are four. The antenna coil will have 74 turns on the secondary, same kind of wire, same separation and 40 turns on the primary. The impedance coil BP_5, used as input to the first tube, will have 72 turns, with no primary. All coils, except the coupling inductance, BPL, are shielded. The shields reduce the effective inductance. The number of turns stated seems to be too much for the intended capacity of .0005 mfd. used for tuning, but the data are given for effective inductance when the shielding is taken into consideration.

Capacity of Equalizers

Equalizing condensers will balance the two circuits, so that single control operation will be effective. In fact, this same system of balancing prevails throughout all the tuned circuits, the equalizers having a minimum capacity of 20 mfd. and a maximum capacity of 100 mmfd. All stray capacities resulting from wiring, placement of parts, relative similarity of potentials, and the like, can be balanced out by this trimming range, but can not be assuredly balanced out by trimmers of smaller maximum capacity, where close shielding is used.

As stated, we shall not use the first tuned stage at high gain, therefore we select a relatively low screen grid voltage (applied to the G post of the socket). The same low voltage will prevail on the screen of the second 224 tube. Independent biasing resistors, R_2 and R_3, are shown, and since the screen voltage is lower than ordinarily, the current through these resistors is lower, and the resistors have to be considerably higher than the usual 300 ohms recommended, if we are to exceed 1.5 volts negative bias. We will make provision for at least 2 volts negative bias, possibly 3 volts, although at this moment we are not certain whether independent biasing resistors will be used finally, or the drop in a section of a voltage divider (R_7), by returning the tuned circuits eventually to ground in two instances and directly to ground in the three other instances, and establishing a connection point for the RF cathodes to a potential 2 or 3 volts higher than ground. The detector may take its own individual biasing potential, whereby R_6 would be 20,000 ohms.

Value of Condensers

If a common biasing resistor, a part of the voltage divider, is used, the same bias may prevail for all RF tubes, so that for the preliminary stages the bias will be higher than the signal level would require, but not higher than selectivity would render advisable. Therefore the controlling factor is the bias desired on the RF tube ahead of the detector, and 3 volts will be ample for this. If independent stage biasing is to be used, as shown, R_2 and R_3 may be 800 ohms each, and R_4 and R_5 may be 400 ohms each. The condensers C_7, C_8, C_9 and C_{10}, since serving RF purposes only, may be .00025 mfd. or higher.

The detector biasing resistor, R_6, of 20,000 ohms, should have a 1 mfd. condenser across it, if the detector is to be independently biased finally. A point on the voltage divider could be selected that would provide detecting bias, as well. The detector bias will be about 6 volts negative.

It is advisabe to use negative bias detection, or so-called power detection, both being the same thing, except that the power detector bias is somewhat higher and the plate voltage likewise. The detector, when operated in either of these two ways, will stand a heavy signal input without distortion. The sensitivity may not be as great as by the leak-condenser method of detection, but we have abundant amplitude, and require only the requisite voltage-handling capability in the detector.

Detector Output Filtered

A filter circuit is used at the detector output to keep the radio frequencies out of the audio amplifier. This filter consists of a radio frequency choke coil of from 50 to 60 microhenries, and two condensers, C_{15} and C_{16}, of .0005 mfd. each, or less.

A filament transformer is included, first, because there are five tubes, each drawing 1.75 amperes, a total of 8.75 amperes, and most power amplifiers, even if they afford a 2.5 volt winding for RF and detector tubes, use this winding for one or two audio tubes as well, and a possible 12.25 amperes is a lot of current to draw from a supply of perhaps undetermined capacity. There will be no danger of overloading the power amplifier's transformer by the present method, and all necessary precautions should be taken against all types of overload.

Also a voltage divider is to be used in the tuner. The value may be a total of 7,000 ohms or so, suitably tapped. The main object is to be assured of application of the proper voltages to the tubes of the tuner—biasing, screen grid and plate voltages. Hence the P post of the tuner is connected to the primary of the audio transformer, or to one side of the plate resistor or impedance coil, in the power amplifier. The post beside it, marked 180, goes to the 180-volt tap of the power amplifier. This voltage is available from almost all power packs, and if not exactly 180 volts are obtainable, then the nearest voltage thereto may be used, although it is not well to go above 200 volts nor under 100 volts.

Voltage for Detector Tube

The detector plate voltage is not definitized in the tuner circuit, since this voltage depends on a potential applied in the power amplifier. Around 100 volts will be excellent, although as little as 50 volts may be used, or as much as 180 volts. Whatever voltage is applied within this range, the tube will detect, as the current through R_6 depends on the plate voltage. Should a resistor be in the detector plate circuit, however, no less than

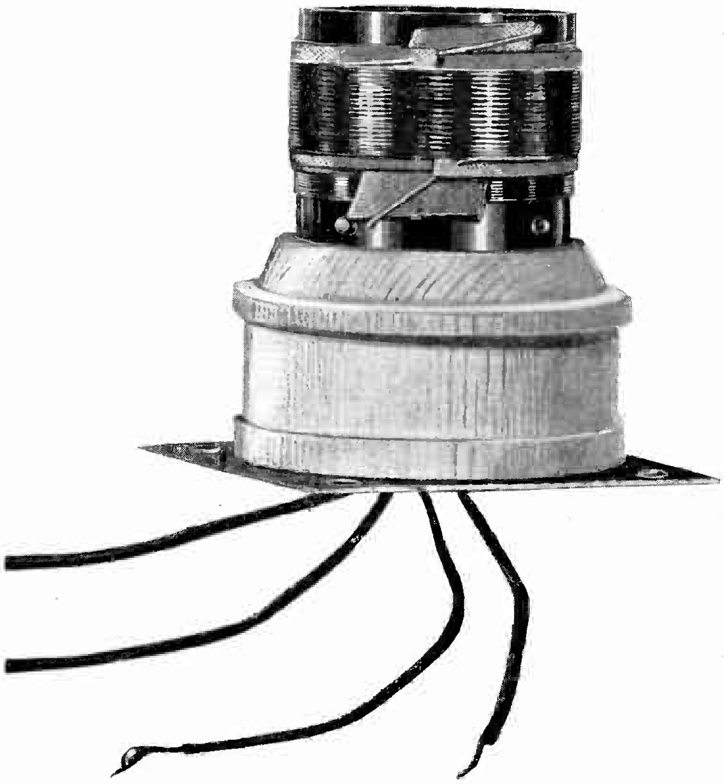


FIG. 4
THE MECHANICAL METHOD OF ERECTING THE COIL IS SHOWN AT LEFT, SO IT WILL FIT INTO THE SHIELD AT RIGHT. A CIRCULAR BLOCK OF WOOD AN INCH OR SO HIGH AFFORDS GOOD PROTECTION AGAINST THE COIL "LEANING OVER." MOUNT COIL ON THE BLOCK AFTER DRILLING HOLE FOR OUTLEADS.

100 volts should be used. This may require a change in your power amplifier wiring, in any event, since if it was gaited for a leak-condenser detector, the voltage may not be quite as high as desired.

With the bias depending on plate and screen currents, in all the RF tubes, no critical aspect prevails as to bias voltage, as that voltage is higher when higher bias is needed, and lower when lower plate voltage permits of lower bias. The situation takes care of itself automatically.

The voltage divider may be used finally for obtaining all biasing voltages, for it may be designed to lend itself to that use. Ordinarily the biasing voltage taken from a voltage divider results in some instability, due to the effect of the modulation. But here all the plates go to the highest potential, except the detector plate, which may as well go there, too. Hence no plate current flows through the voltage divider whatever, under any conditions. The 180-volt lead is connected through the plate load impedances to the plates, and the plate currents flow through the tubes and biasing resistors to ground.

Different With Screen Currents

But the screen grid currents do flow through that part of the voltage divider that would include the section to be used for joint biasing. This current is modulated. But it is of a low order of magnitude, as compared with the plate current. In the case of the two tubes directly ahead of the detector, the proportion is about 3-to-1, plate current to screen current. In the first pair of RF stages, it will be remembered, a much lower voltage than standard value is used on the screen grids, so the proportion is less than 5-to-1.

The instability referred to has nothing to do with squealing but concerns the rise and fall of the amplitude of the carrier due to modulation. It will be observed that if the bias depends strictly on the modulation, and works in the right direction, the higher the amplitude of the carrier, the greater the current and the greater the bias, then a condition of automatic volume control will prevail. But the condition will not be strong enough, at best, to make the volume control really effective. It will be a relative change, not high enough for practicability. This situation obtains only when high bias is used on radio frequency tubes. In the detector circuit the modulation is upward also, that is, increased amplitude results in increased plate current.

In any event, the plate current is steady originally, being direct current. The effect of the signal is to unsteady it, and the rate of this unsteadiness is the rate of change in the undulation.

With six tuned circuits a problem to consider is how to make them work together, in view of the two three-gang condensers actuated from a single control.

Any circuit with three accurately tuned stages immediately feeding a detector is certainly a good amplifier and selector. Now, suppose the sections C_4, C_5 and C_6 were thus accurately tuned and attention were concentrated on making them balance. Then we would tackle the remaining three, and under conditions whereby we would be permitted some off-resonance effects. When it is recalled that many three-tuned-circuit receivers have as their input and antenna winding that picks up all frequencies, we feel safe in assuming excellent results when in addition to the three accurately tuned circuits we have three more circuits, tuned as accurately as possible, and maybe just as accurately as the first-mentioned three!

Now let us build the tuner, wiring it carefully, testing it thoroughly and see if it is all that we think it ought to be and if not, ascertain what need be done to make it do all that it should do.

*[Next week a full report will be given as to results obtained from the receiver as diagrammed this week.—*EDITOR.*]*

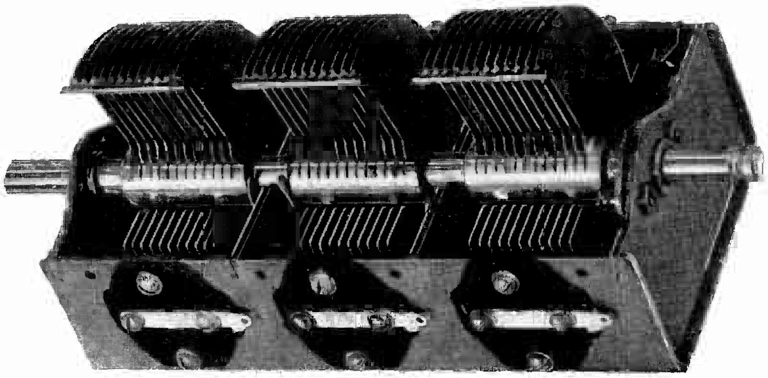


FIG. 5
TWO THREE-GANG CONDENSERS ARE USED IN THE CIRCUIT. EACH SECTION IS .0005 MFD. TRIMMING OR EQUALIZING CONDENSERS ARE REQUIRED ADDITIONALLY. PHOTO SHOWS ONE OF THE THREE-GANG.

A Pocket Size Set

It Gives Good Results Despite Its Tinyness

By Neal Fitzalan

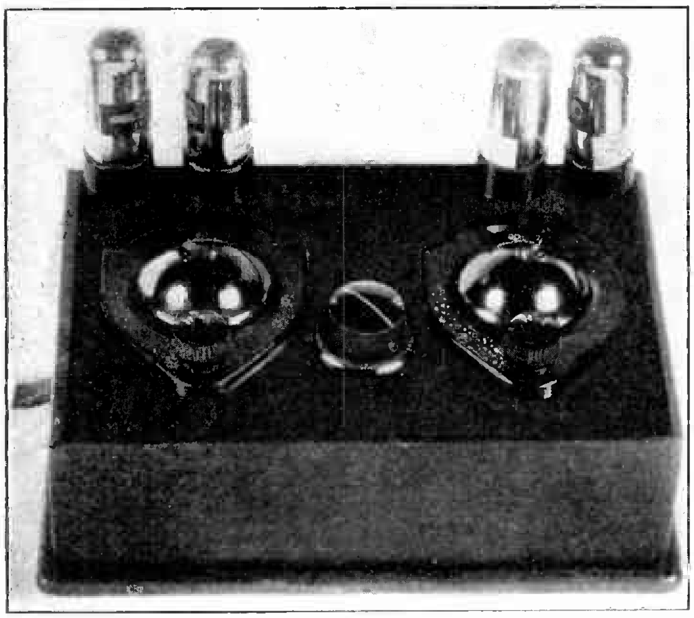


FIG. 1
TOP VIEW OF THE RECEIVER THAT YOU CAN ALMOST PUT IN YOUR POCKET. YET IT WORKS A SPEAKER.

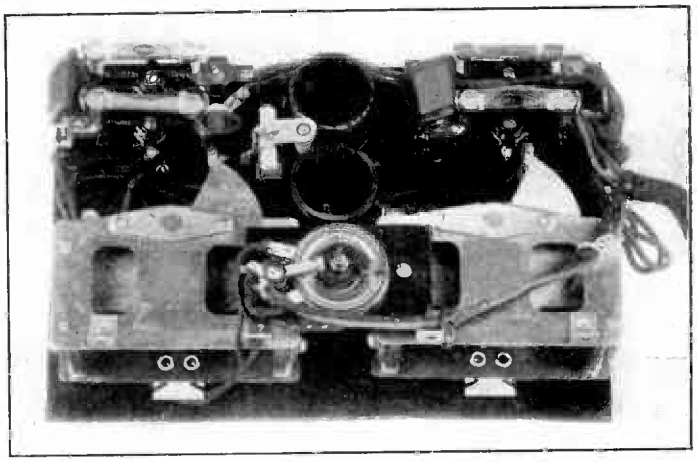


FIG. 2
WHAT'S UNDER THE PANEL OF THE RECEIVER.

A HIGHLY compact and neat little receiving set may be assembled from inexpensive parts. Fig. 1 shows a top view of the receiver with the four UX199 tubes in place. There is ample room for all parts on a 5½x8⅜" panel.

Fig. 2 shows the underneath view of the set. Referring to the wiring diagram, Fig. 3, we find that it is a conventional tuned detector, preceded by a tuned RF stage, the detector followed by two resistance-coupled stages.

You will notice from Fig. 1 the tuning inductances have been mounted very close together and also well within the electrostatic fields of the condensers. This combination of opposing effects results in a circuit that is stable. Eddy current effects help offset the otherwise troublesome feedback.

The ends of the tuning coils nearest to you are the grid ends, and the opposite ends go to plus and minus of the filament circuit respectively.

The values for the grid leaks and plate coupling resistors are (reading wiring diagram from left to right), 50,000 ohms, 2 megohms, 50,000 ohms, 2 megohms.

The set will not operate well on an indoor antenna as at present wired, but is effective on a good outdoor antenna of at least 100 feet in length, and using a good water-pipe ground.

The writer has had exceptional results in DX reception with simple circuits using 199s.

Since this is a diminutive receiver it is necessary to use small-size coils. The forms used have a diameter of 1.25 inches and the wire is No. 30 enameled copper. The primary winding contains 22 turns and the secondary 106 turns. This secondary gives the proper inductance to be used with a .00035 mfd. tuning condenser. The two coils are identical. The primary winding is ¼ inch long and the secondary 1 3/16 inches long.

This little receiver is suitable for use in a camp not too far from a broadcast station since it can be operated with light filament and plate batteries. If an antenna is erected between two tall trees as good results can be obtained in camp as at home, and in many instances much better results. One of the conditions for good results in camp, however, is a good ground. It is more difficult to get a good ground where there is not cold water system available. But a long steel rod driven into moist earth is very good. In lieu of this type of ground it is possible to use a counterpoise. This may be a long wire strung directly under the antenna, if this is horizontal for a considerable distance, and raised above the ground by about six feet. The counterpoise should be insulated from ground.

If the major portion of the antenna is vertical the counterpoise may consist of a number of long wires radiating from the lead-in in the form of a star. There is no definite shape of length of antenna or counter poise which will give the best results. The higher the antenna wire, as a rule, the more stations will be picked up. Also, the longer the counterpoise, or the larger the number of radiating wires, the better that portion of the pick-up will be.

It is really surprising how good a "ground" a counterpoise is. The reason why such a system is effective is that the resistance is low.

If the camping trip is made in a car the filament supply may be taken from the storage battery in the car. The total current drawn from the battery is so small that the set may be operated for hours without noticeable drain from the car battery.

The receiver is not recommended for use in the car while this is in motion. An adequate antenna and counterpoise cannot be obtained. Moreover, there is no provision in the set for eliminating the ignition noise, and chances are there will be no provision in the car either to do this.

If it is contemplated to use the set at the seashore, or near any body of water, a good ground can be obtained by running a wire from the set into the water. On a beach there may be considerable difficulty in erecting an antenna that will be high enough to pick up sufficient signals. The main idea, anywhere, is to get the antenna wire as high up in the air as possible.

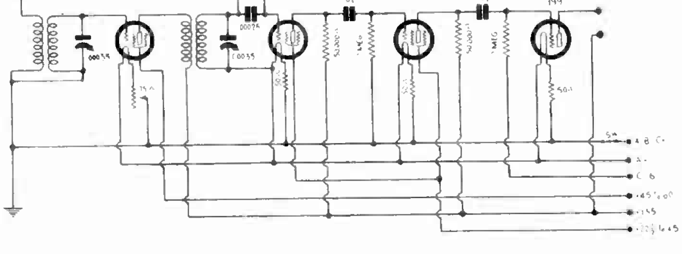


FIG. 3
WIRING DIAGRAM OF 4 TUBE MIDGET RECEIVING SET USING 199S—EFFECTIVE ON A GOOD ANTENNA, AND A GOOD WATER-PIPE GROUND.

List of Parts

Two .00035 Variable Condensers.
Two coils as described.
One .00025 grid condenser.
One 1 megohm grid leak.
One A75 switch rheostat.
Three 50 ohm wire wound resistor strips
Two dials.
Four 4-prong sub panel sockets.
Four resistor mounts.
Two 2 megohm resistors.
Two .05 megohm (50,000 ohm) resistors.
One battery cable.
One roll of wire.
Two .01 mfd. coupling condensers.
One bakelite panel 5½x8⅜".
One cabinet to fit.

Sideband Suppression

Mythical Quantities Are Real Enough in Effect on Quality

By Herbert E. Hayden

THERE is now somewhat of a controversy concerning whether sidebands really exist or are nothing but mathematical abstractions. One school says that a modulated wave is a high frequency wave, the amplitude of which varies according to the tone frequency amplitude impressed on it. The other school says that the modulated wave consists of three distinct waves, the carrier and two side bands. Mathematically these conceptions are equivalent, which is admitted by both sides of the controversy. Hence the question deals with whether or not the two conceptions lead to different results when a modulated wave is selected by means of resonant circuits.

It can be shown both mathematically and experimentally that the consequences of both conceptions are the same so that the principal unreality in the controversy is the bone of contention.

As everybody knows, a tuned circuit responds to one frequency more than to any other frequency or frequencies. If a modulated wave consists of three frequencies, the carrier and two side frequencies, all being different, it is clear that if the resonant circuit is adjusted to one of them it cannot at the same time be adjusted to the other two. Hence one will come through the tuned circuit more strongly, relatively, than the other. If the frequency of resonance is made to coincide with the carrier frequency the side frequencies will be suppressed to a certain degree, depending on the selectivity of the tuned circuit and on the amount by which the side frequencies differ from the carrier frequency. The greater the selectivity and the greater the frequency difference the greater the suppression.

Easy to Understand

When the modulated wave is looked at in this manner it is easy to understand how the side frequencies, or sidebands, if there are many side frequencies, are suppressed. They are simply tuned out just as other frequencies differing from the carrier desired are tuned out. The side frequency conception also makes it easy to treat a modulated wave mathematically, and that is the reason why this conception was formulated.

If we take the other view of a modulated wave there is no basis for even talking about the side frequencies. They do not exist and they are not components of the wave, because the wave is the product of the carrier and the audio frequency impressed on it. But still when this wave encounters a tuned circuit resonant to the carrier frequency it undergoes exactly the same changes as if it were composed of the carrier and the two side frequencies. This can be demonstrated mathematically, though the mathematics is a little more complex than that of the side-frequency theory, and it can also be demonstrated experimentally. The experimental demonstration is exactly the same as that of the side frequency theory.

Those who argue that the side frequencies do not exist are correct so long as they draw the conclusion that a modulated wave can pass through a highly resonant circuit, or series of such circuits, without undergoing any changes. They cannot argue away the fact that the degree of modulation is decreased by such a circuit.

Misunderstanding of Sidebands

Judging by the comments made by many radio fans there seems to be a widespread misconception of the meaning of sideband cutting. But just what the conception is, is difficult to fathom. No doubt, every fan has his own peculiar conception, just as engineers have different conceptions.

One idea, apparently, is that sideband cutting is in some manner related to amplitude distortion similar to that type of distortion that occurs when the grid bias is so high as to cut off the plate current during a part of every cycle. Nearly everybody is familiar with the characteristic choking effect when this occurs. One fan expressed it thus: "It seems like the signals have a hard time to squeeze through."

If this is the idea of sideband cutting there can be no circuit so selective that it would have the slightest effect on the quality. Sideband cutting is not at all a matter of amplitude, or signal intensity. It is a matter of frequency distortion, or relative suppression of the higher audio frequencies as compared with the very low frequencies.

Neither is it a case of sharp cut-off. That is to say, a tuner does not cut off sharply, say at 5,000 cycles, so that everything above that frequency is completely eliminated and everything below it is let through with undiminished intensity. The suppression begins at zero modulating frequency and increases as the frequency increases, but it increases more rapidly at the higher frequencies than at the lower. The change is gradual, not abrupt. In a certain frequency range, depending on the selectivity, the rate of increase in the suppression is maximum.

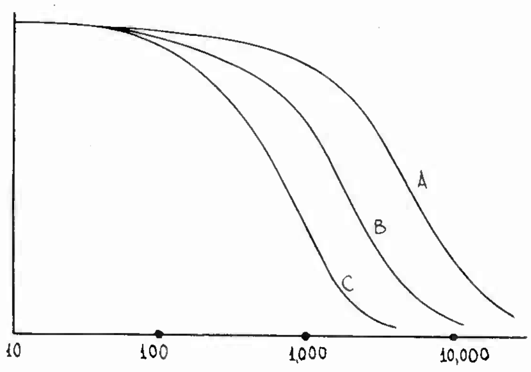


FIG. 1
THREE CURVES SHOWING THE MANNER IN WHICH SIDEBANDS ARE SUPPRESSED BY THREE TUNERS OF DIFFERENT DEGREES OF SELECTIVITY. CURVE C IS FOR THE MOST SELECTIVE CIRCUIT.

For ordinary tuned circuits the suppression below 5,000 cycles is negligible but increases rapidly above that point. By the time the 10,000 cycle frequency is reached the suppression may be so great that the amplitude of this signal of this frequency may be entirely inaudible. If the circuit is excessively selective serious suppression may begin as low as 1,000 cycles.

Another Comment

One comment that suggests misconception of sideband cutting is often made in connection with long distance reception. The owner of a certain superheterodyne in which the RF stage is strongly regenerative and the intermediate frequency tuner sharply selective and tuned to a comparatively low frequency said, referring to the quality: "That is not so bad is it, and no sideband cutting." The truth was that there was very much sideband cutting. There was very little reproduction of any frequency above 1,000 cycles and entirely too much below 100 cycles. The characteristic barrel-effect was excessively strong.

Sideband cutting does not always mean unpleasant quality. In many instances it means quite the reverse. People say that the quality is sweet and mellow. Nevertheless, it always means unnatural quality, a strong preponderance of bass.

Such quality is tolerable, if not actually pleasant, as long as the signal is primarily music, because few musical tones are suppressed. Not many fundamental musical tones are higher than 5,000 cycles so that if the suppression is negligible up to that frequency there is little change in the fundamentals of any musical notes, nor in the more important harmonics of the lower pitch tones. However, the higher harmonics of the lower pitch tones, and all the harmonics of the highest musical tones, are suppressed. This, of course affects the timbre of the reproduced music but few people, if any, are aware of it. At least not unless the suppression becomes extremely great. It should be remembered that the higher frequencies are never entirely missing.

Speech Affected

The same thing does not hold true of speech, because much of the intelligence in speech is carried by the frequencies above 5,000 cycles. While it is true that speech in which all frequencies above 5,000 cycles is understandable, it is not so easy to understand when the high frequencies are missing as when they are present in full strength. Many of the spoken words have to be completed by rapid-fire guessing. A certain word may be nothing but a grunt, but the context may require that a certain meaning be attached to that grunt, so the brain translates it into a real word. Just how closely the grunt resembles the word, or how much it deviates from it, depends on the degree of selectivity of the tuned circuit, or on the higher frequency suppression elsewhere in the receiver.

The best way to judge by ear whether or not there is sideband cutting is to listen to the hissing consonants in speech. If they can be heard distinctly there cannot be much suppression of the higher frequencies in the sidebands. The hissing consonants are *s*, *z*, *sh*, *zh*, *j*, soft *c*, soft *g*, and *x*. There are in addition many other consonants which depend on the high frequencies for their distinctness such as *v*, *f*, *th*, and *d*. In fact, nearly all consonants are dependent in varying degrees on the high frequencies.

Audio Coupling Ex

Principal Types Are Transformer, Single

By H. B.

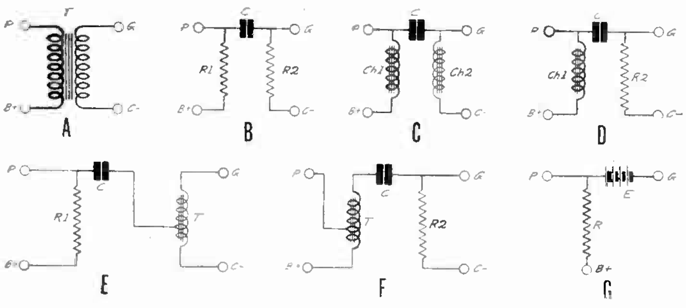


FIG. 1
SEVEN DIFFERENT FORMS OF AUDIO COUPLING.

AUDIO amplification is the magnification of audio frequency voltages. For purposes of general discussion these frequencies are considered to lie in the range from 50 to 5,000 cycles, although some systems amplify well in the region a little below 50 cycles, and quite a few amplify well in the range above 5,000 cycles. The normal adult ear has no difficulty hearing sounds from 24 to 10,000 cycles.

With the improvements that have taken place in audio frequency amplification in the past few years, the amplifier itself has been made to magnify well frequencies above and below the limits of keen response by loudspeakers, the sole means employed for reproduction of the audio frequencies, that is, their radiation as actual sound waves.

The function of the loudspeaker is to accept the variations in voltage and current, that is, the electrical pulses, and change these to corresponding pulsations of an ultimate mechanical nature, and these impacts produce audible sounds radiated as wave motion in air.

Input to the Amplifier

Audio amplification may be applied to any electrical input that varies or remains steady at audio frequency. The output of the detector tube of a radio receiver is one example. The output of a microphone is another. A phonograph pickup receives mechanical variations and converts them into electrical pulsations, so the pickup's output may be magnified by the audio amplifier.

The most used type of coupling for audio amplification is the transformer. This consists of two coils wound on an iron, steel or other core, the smaller winding being the primary and the larger the secondary. The primary is connected in the plate circuits of a tube, or to some other device than a tube, and the secondary in the grid circuit of another tube. The pulsations in the primary are induced in the secondary.

The transformer is represented by Fig. 1A, where P goes to the plate of the detector tube, let us say, and B goes to the positive B voltage to be applied to the detector plate through the primary, which is known as the plate load impedance. The secondary has to be connected to the grid of the next tube, which is the first audio amplifier, while return of the secondary is made to a voltage negative in respect to the filament of the first audio tube.

Resistance Coupling

Another form of audio coupling is resistance coupling, represented in one type by Fig. 1B, where the connections to R1 correspond to those to the primary in the instance of the transformer, while the resistor R2, of 1 meg. or more, corresponds in connections to the secondary in the instance of the transformer. Between plate and grid is a condenser, C, of .01 mfd. of greater capacity. This is an isolating condenser. It keeps the positive plate voltage off the grid of the succeeding tube. It is not a coupling condenser. The coupling consists of the voltage drop in R1 being duplicated in the grid leak R2. CR2 are in parallel with R1, CR2 being in itself a series circuit.

Whereas the transformer has a step-up ratio, the resistance coupler contributes no step-up, but relies on the amplification factor of the tube in the plate circuit of which the coupling resistor, R1, is connected.

Good quality is obtainable from resistance coupling, which is one form of direct coupling.

Two audio choke coils may be substituted for the resistors, in which instance impedance coupling results, as in Fig. 1C. Or, a choke coil may be in the plate circuit, while a resistor leak is in the grid circuit of the succeeding tube, as in Fig. 1D, or the resistor may be in the plate circuit and the coil in the grid circuit.

Special Types

A special form of coupling, known as the Clough system, has a resistor in the plate circuit, and a coil in the grid circuit of the next tube, the voltage drop in R1, Fig. 1E, being applied to a part of the coil, by utilizing a tap, so that in effect the grid coil is an auto-transformer, where the part from T to C minus is the primary and the entire winding is the secondary. A standard auto-transformer circuit is shown in Fig. 1F, while Fig. 1G shows a non-reactive circuit.

A circuit is non-reactive when it has resistance only, no inductance, no capacity.

A form of non-reactive coupling of more recent popularity is known as the Loftin-White system, because Edward Loftin and S. Young White were successful in reducing it to easy practice in AC designs, using heater type tubes. A typical Loftin-White amplifier is shown in Fig. 2. The condenser from cathode to a potentiometer arm is hum-bucking.

The theory of the non-reactive circuit is that the voltage drop

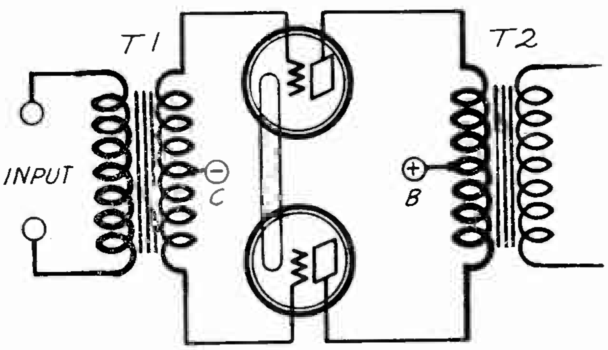


FIG. 3
PUSH-PULL, A SPECIAL FORM OF TRANSFORMER COUPLING, SUCCEEDING A SINGLE-SIDED STAGE.

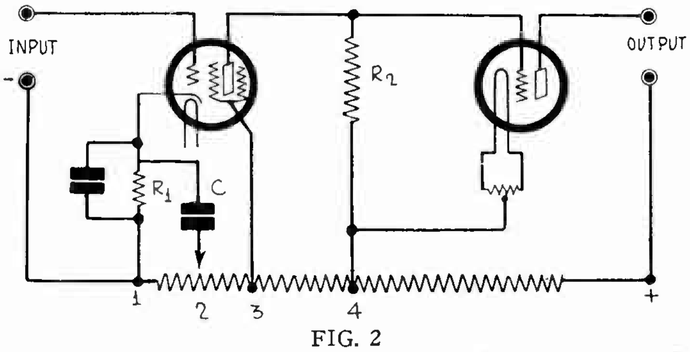


FIG. 2
A NON-REACTIVE AUDIO AMPLIFIER FOR AC OPERATION.

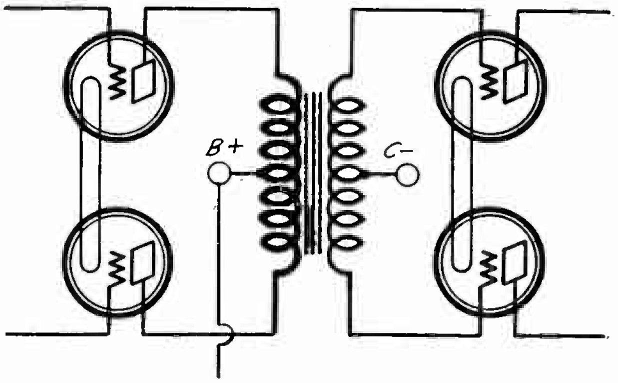


FIG. 4
PUSH-PULL OUTPUT TO A PUSH-PULL INPUT OF THE SUCCEEDING STAGE.

plained for Novices

or Push-Pull, Resistance and Impedance

Herman

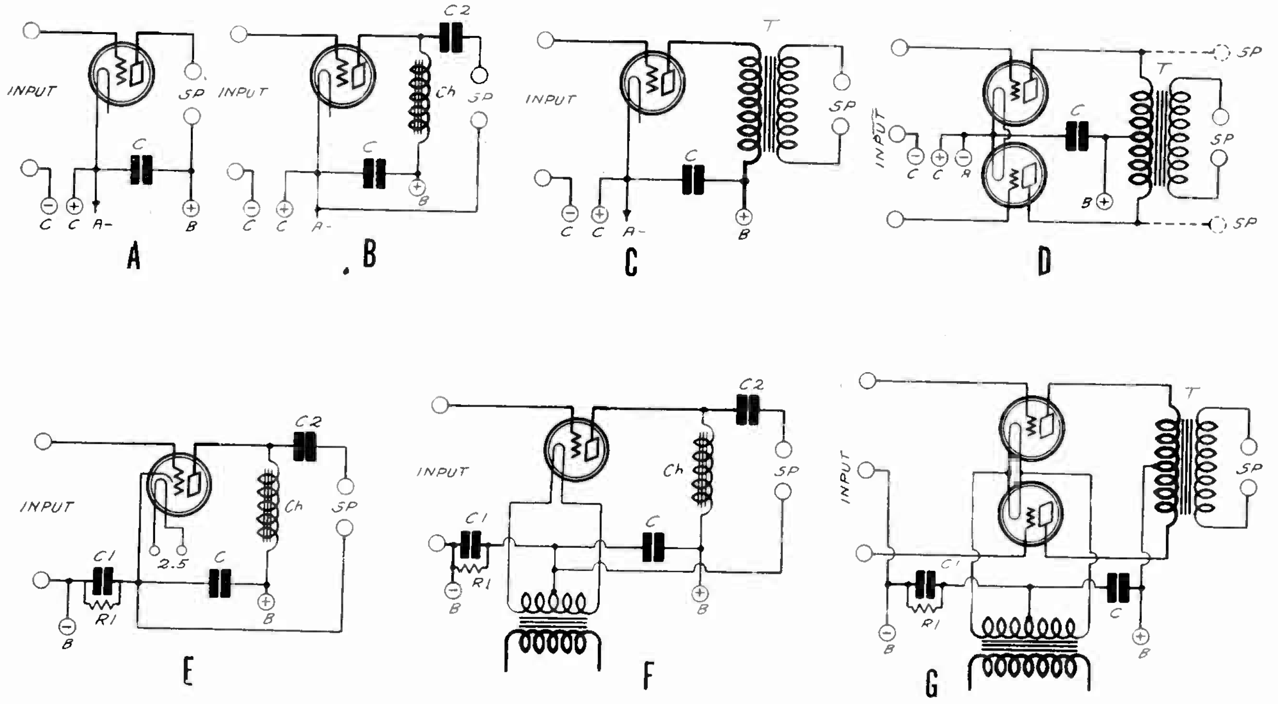


FIG. 5

METHODS OF LAST AUDIO STAGE OUTPUT FOR COUPLING TO A LOUDSPEAKER.

in a plate resistor is directly applied to the grid of the next tube, so that indeed the same resistor is also a grid leak, while the available B voltage is used in series. So, in Fig. 2, the first tube is the first audio amplifier, biased negatively by the resistor R1. If it is desired to have the first tube a detector, this may be done by increasing the value of R1, so that the tube is worked at a higher negative bias for detection.

Voltage Apportionment

The total B voltage is represented by the drop across the voltage divider from plus to minus. Assume there are 350 volts. If the bias on the first tube is 2 volts negative, there would be 348 volts left. But there is still another tube to accommodate.

A screen voltage of, say, 20 volts is applied, and a plate voltage of 98 volts. Thus to point (4) we have used 100 volts total, as the screen voltage is simply taken off a part of the drop used for plate voltage.

Now, there is a drop in the coupling resistor, R2, and as the plate side is negative in respect to the B plus side of this resistor, so the grid of the next tube (the same circuit) is negative in respect to the filament center of the last tube by the amount of this drop. The value of R2 is chosen, in respect to that of R1 and the voltage distribution, so that the drop in R2 is equal to the bias required for the last tube, on the basis of the plate voltage applied to the last tube. This voltage in the given instance can be 250 volts, so if the last tube were a 245, at 250 plate volts, the drop in R2 would have to be 50 volts.

Push-Pull

Push-pull is a special form of transformer coupling. It has not been made practical yet for other forms of coupling. The practice of push-pull is that the secondary of the input transformer, Fig. 3, divides its input between two tubes, by connection of the two extremes of the winding to the respective grids of these tubes, with center tap to the negative bias. Thus the voltage in one tube is always the same voltage as that in the other tube, but the phases are 180 degrees apart. The voltages are said to be equal but opposite at any given instant. The difference between the voltages obviously is zero. This fact is utilized to get rid of distortion, principally that due to harmonics. The push-pull circuit suppresses the even order of harmonics, or gets rid of them entirely, hence push-pull is used in circuits for obtaining quality of a higher order than transformers otherwise would be likely to render possible.

T1 is the push-pull input transformer. The output is taken through the transformer, T2. The difference lies in the fact that the input transformer has its secondary center-tapped, while the output transformer has its primary center-tapped.

However, both input and output may be in push-pull, as shown in Fig. 4, where both windings are center-tapped.

Final Audio Output

There are several ways of taking the output from the final audio tube or tubes for delivery to the loudspeaker. Let us take up the battery operated tubes first. In Fig. 5A the direct coupled output is shown, where the speaker's magnet coil would be connected between the posts designated speaker input. In Fig. 5B a filtered output is shown, where the direct current flows only through the audio choke coil, Ch, while the audio frequencies are coupled to the speaker through the condenser C2. An output transformer may be used, as in Fig. 5C.

For push-pull an output transformer with a center-tapped primary may be used. It so happens that the secondary is not absolutely essential, although in some instances for purposes of matching impedances it is preferable to include it. The dotted lines show the speaker connections when there is no secondary.

AC Tubes

As for AC, where a heater type tube is used as output with a choke-condenser filter circuit, the diagram is as shown in Fig. 5E.

Fig. 5F shows the filtered single-sided output, using choke and condenser, for a directly AC heated filament, while Fig. 6G gives the connection for a push-pull circuit of the AC type.

Speaker to Use

In connection with audio amplification, it is always important to consider the speaker. The dynamic is the most popular today. It may have its extra energizing coil, called the field coil or magnetizing coil or "pot," supplied by rectified AC, or DC from a storage battery or DC house line. Another popular speaker is the inductor, an improvement on the old-style magnetic, but still a magnetic. Either of these or an exponential horn may be used to advantage.

Hum Reduction in

Reverse-Wound Coil Systems and Co

By John C.

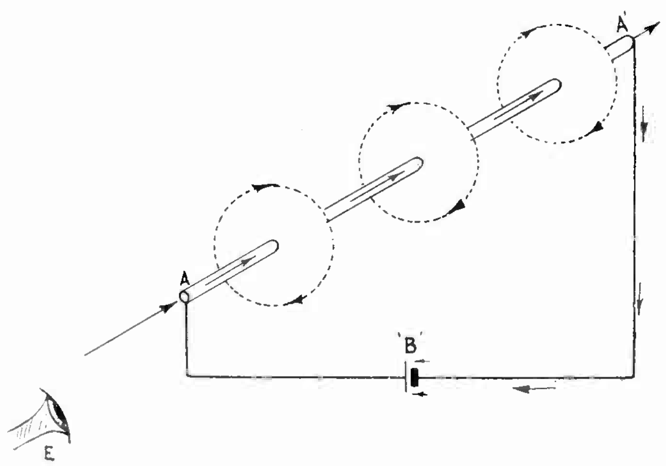


FIG. 1

A STEADY UNI-DIRECTIONAL CURRENT FLOWING THROUGH CONDUCTOR AA[1] (AWAY FROM OBSERVER) SETS UP A MAGNETIC FIELD AS SHOWN. BATTERY B IS THE SOURCE OF THE CURRENT.

THOSE who live in AC supply districts use the induction motor in many forms and for various purposes, such as the electric fan, vibrator and vacuum cleaner. Your radio set, if it is an "all-electric" one, contains a power transformer the operation of which is based on well-known laws of electromagnetic induction.

When a current of electricity flows along a conductor, at a steady rate, there is set up around the conductor a circular magnetic field the center of which is the axis of the conductor. In Fig. 1 the battery B, in sending a current through the conductor AA[1] sets up a circular field as shown. Now, if we imagine an alternating generator connected at the points where battery B is connected in Fig. 1, we would find that as an alternating current flows in the conductor AA[1] the circular field itself would be alternating, periodically reversing its flow, according to the frequency.

Neutralized emf

Now that we know that the magnetic field surrounding a conductor is dependent upon the character of the current flowing through the conductor, we move to the next consideration. Fig. 2 shows an arrangement of coils where by any emf (electro motive force), whether it be direct, pulsating direct for alternating, can be neutralized. The action here is an extension of that shown in Fig. 1. Suppose we complete the circuit of coil E with a battery and an ordinary telegraph key, and have previously connected the galvanometer to coil P only. Where we close the key we get a deflection of the galvanometer needle to, say, 4. Then with the key still held closed the needle returns to zero. If we now open the key we observe another deflection in the opposite direction (and if we had used a central zero galvanometer we could have shown that the reverse deflection was very much more rapid though no greater than the first one).

But the needle returns to zero again. Now let us shift the galvanometer connections over to coil P_1 and repeat. First close the key and notice that the galvanometer deflection is now *reversed,* showing that the induced current in coil P_1 is opposite to that in coil P. Now, if we reverse the galvanometer connection to coil P_1 we will find upon closing the key again that the deflection is the *same* as the one originally obtained from coil P. Therefore if we connect coils P and P_1 together as shown, we will find that we will obtain zero deflection of the galvanometer. Similiarly, if we connect a zero-center galvanometer in place of the instrument shown, and apply an emf of any form the resultant deflection will always be zero.

Origin of the Hum

Where does hum originate? In nearly all commercial dynamic speaker designs operated on pulsating direct emf. obtained from either a half-wave or full-wave rectifier (and as this pulsating DC energy is of the order of from 8 to 20 watts depending on the pot in question) the pulsations of the flux due to the nature of the exciting emf. will be quite considerable.

We say that the field of a dynamic speaker pot, when exited by the output of a rectifier, without the use of any device or circuit to smooth out the pulsating field flux and make it more uniform, is unfiltered or "raw."

When a dynamic speaker voice coil is placed in a raw pot field the continuously variable field flux cuts across the voice coil turns, inducing emf's which are in such relationship to the inducing flux (the pot flux) that the voice coil is being continuously repelled, first outward then inward, when the voice-coil circuit is complete. See Fig. 1. Now this outward and inward motion of the voice coil and cone occurs at a frequency equal to the original AC operating frequency if the rectifier is half-wave and at twice the AC line frequency if the rectifier is full-wave. In the case of a speaker pot operating from a 60 cycle AC source this cone frequency is 60 cycles for half-wave and 120 cycles for full wave. This steady 60 or 120 cycle note, there, is what we call "hum."

Series Opposing Connection

Referring to Fig. 4, page 12, the coil forms a secondary source of hum emf and is connected in opposing series with the voice coil so as to neutralize the hum developed by the cone. See Fig. 2. Though the hum coil R does oppose the emf developed in the voice coil, it can never develop the *same current and voltage at the same instant of time* that the voice call does, and therefore by this means though the hum can be reduced, it cannot be totally obliterated, specially with a flexible cone.

A simple system like this is fairly successful with low exiting power or a stiff cone. A reason for our not being able to make coil R exactly oppose the emf of the voice coil is the fact that the densities of the fluxes cutting across the two coils is not equal.

So we try to find some other way out of the difficulty. Fig. 5 shows an arrangement of coils that is effective in that it paves the way for reducing the hum by smoothing out the pulsating field first.

Referring to Fig. 3, we remember that when the copper ring was *held* down in the AC field strength of the core was weaker, hence in Fig. 4 if we wind a single or double layer the magnetizing turns, the result when the heavy turn coil leads are connected will be to set up an opposing pulsating field flux in the pot core, in other words, to smooth out the pulsating field, making it much easier to remove the hum emf than formerly.

Repulsive Effect Analyzed

This repulsive effect must give rise to the following. If we exite the core AB, Fig. 3A, and hold the metal ring above the exited coil we will find that its weight is relatively slight, and if we wish to place the ring down at its position of rest we will find that we have to use considerable force. A pick-up coil placed at the end of coil AB would indicate a decided weakening in the force of the magnetic field. Under these conditions, if

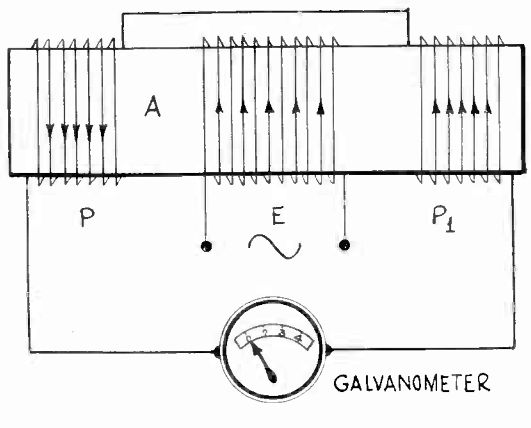


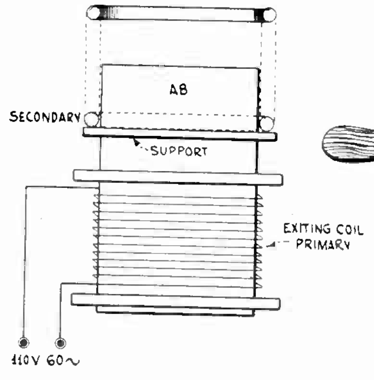
FIG. 2

COILS P, E, AND P_1 ARE WOUND AND CONNECTED AS SHOWN. ANY EMF IMPRESSED ACROSS E WILL GIVE ZERO DEFLECTION PROVIDED THE COUPLING CONDITIONS ARE EQUAL.

Dynamic Speakers

ndenser-Choke Combinations Analyzed

Williams



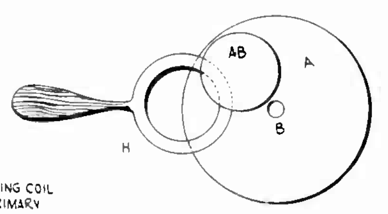


FIG. 3A
THIS SHOWS REPULSION OF COPPER RING BY AN AC FIELD.

FIG. 3B
THE REPULSION EFFECT APPLIED TO A ROTATION DISK.

the ring be now removed, the magnetic field strength will be restored.

Fig. 3B is an application of their repulsion to the case of a revolving disk (the repulsion or shaded pole motor. Looking down on the core AB we bring a rotatably-mounted metal disk B (copper or aluminum) to the position shown and interpose a copper ring H over the edge of core. The result is to produce rapid rotation of disk B.

The rotation is explained by the fact that the copper ring sets up a condition of similar fluxes. As similar fluxes repel, and these similar fluxes are developed and effective in the dotted or shaded area projecting over the core, the resultant magnetic reaction is a single flux which is *opposite* to the flux in the uncovered area of coil and therefore the dish rotates clockwise under conditions shown. This action is also utilized in the reduction of hum in dynamic speakers.

Now for the hum. In Fig. 4 is shown a dynamic speaker pot or field coil, with a hum coil R so wound placed and connected that it opposes the hum developed in the voice coil.

Cause of the Hum Reduction

The effects obtained above are due to the fact that every initial change in intensity or direction of current flow in a conductor creates an *opposing* change of exactly the same intensity as the one that induced it. This is a simple statement of the law of electro-magnetic induction.

The applications of this law of induction to the reduction of undesirable hum in dynamic speakers should follow, but I want to make one further illustration of the inductive repulsion effect which is also used to reduce hum, both in combination with other circuits and by itself.

Fig. 3A shows an iron core wound with an exciting coil which is to be connected to an AC source, and preferably in series with a key switch. Over the free end of this core AB is a loosely fitting single closed turn of very heavy wire. Now in the sketch the coil is depicted at rest in the position shown with no current in the exciting coil. Close the key and the ring will jump up vertically, showing that the magnetic flux developed due to the current flowing through the ring is opposite to the magnetic flux in the core AB, due to the existing coil current. This is ocular proof of the statement that given exciting fluxes produce equal and opposite fluxes, and is further proof of the statement that similar magnetic poles repel one another.

Loss of Power

In utilizing the inside of a solenoid for obtaining counter emfs some will say: "Placing a winding between the core and the magnetizing turn weakens the magnetizing flux anyway." The reply is, yes, but every scheme of compensating for undesirable electrical effects has its advantages and disadvantages. In this case disadvantage of a weaker magnetic coupling of the magnetizing coil is amply repaid by the room gained for placing a few turns of very heavy wire on reversely.

In work of this character any scheme that will produce ultimately the closest approximation to whatever is going on in the voice coil is an advantage.

Returning to Fig. 4, if we place the voice coil turns within the air gap and add this time a hum voltmeter, connecting the terminals of the voice coil to the hum voltmeter, and exciting the pot as usual with pulsating DC, the hum voltmeter will register a deflection of, say, 40. Now, connect together the terminals of the heavy coil and the deflection will fall to around 8. If this same experiment is tried with the coil set up of Fig. 4 but with the heavy coil open circuited, the results will not be as good. The deflection will be of the order of 12 to 15. This is because the coil R couples only a small portion of the magnetizing pulsating flux of the core (being nearest to it)—while the scheme of Fig. 5 actually smooths out the pulsating flux *before* the voice coil turns are cut by it, and the relatively large drop in hum voltage for this case proves out.

Also a flux meter test would confirm the readings of the hum voltmeter.

Applies to Wider Variety

Fig. 6 is essentially the same as Fig. 5, except that it is applicable to a wider variety of pots, especially long ones. Some dynamic pots are so designed that the coil length is less than the diameter. In a case like this a different method of applying reverse emfs is necessary.

In Figs. 5 and 6 the reverse emf of the heavy reversely-wound current coil is arranged to be the same as that of the voice coil under load, and the no-load voltage is within .8 of a volt of similarity. Then the output of this current coil is impressed across a variable resistance which can be made permanent. Next the voice coil is connected in series with the secondary of its operating transformer and the resulting two leads of the voice coil circuit are connected in opposing voltage relationship. With the pot excited, the resistance is adjusted until the hum is inaudible, which it will be if the resistance is correctly proportioned. The whole idea of this system of hum reduction is to provide two parallel paths for component currents acting in both pot and voice coil to flow in such a way that nearly complete neutralization is obtained. And when I say nearly I mean hum voltages less than 1 millivolt! If the hum voltmeter method be applied to what has just been written above, the deflection will be found to be almost unreadable.

Case of Small Dynamics

For small dynamics the single layer solenoid of Fig. 5 is all that is usually necessary for wattages up to 8 watts, but for larger and longer coils the multi-layer coil Fig. 6, is imperative.

Referring back the discussion of the weakening of the effective coil flux by removing turns, we must always bear in mind that the core flux is due to the ampere turns wound around it, i.e., if I remove 200 turns from a 1,000 ampere turn coil, and then increase the current to 1¼ amperes I have my 1,000 ampere turns pot back again. And it is a fact that if the pot exciting power and ampere turns are kept constant, you can pull out quite a little wire from the center of a coil without weakening the DC flux appreciably.

Now we will have a look at the arrangement of Fig. 7. It looks a little different from its predecessors in that there are two windings, a coarse one and a fine one. They are both wound reversely with respect to the magnetizing turns but you will notice that the greater part of the total winding space is occupied by the current coil, while the lesser part *nearer* to the voice coil end is occupied by the fine voltage coil. This arrangement of balancing coils often is necessary where one has *two* difficulties to overcome with respect to suppressing audible hum. A light weight pot winding, one of low inductance, and a cheap and inefficient rectifier as an operating source, one that does not rectify very well.

Purpose of Current Coil

Refer to Fig. 3 again. If we could place an ammeter in the circuit of the heavy copper ring and then turn on the exciting current the deflection would be comparatively large, perhaps over 200 amperes, and for this reason I refer to the heavy winding in Fig. 7 as a current coil, its principal purpose being to generate a large opposing effect. As the ratio of current to voltage is very great we are justified in calling it a current coil. Fig. 3 again can be used to develop the voltage coil idea also. Here again we substitute a winding of several turns for the heavy copper single turn and of the same dimension as the copper ring and then excite the coil.

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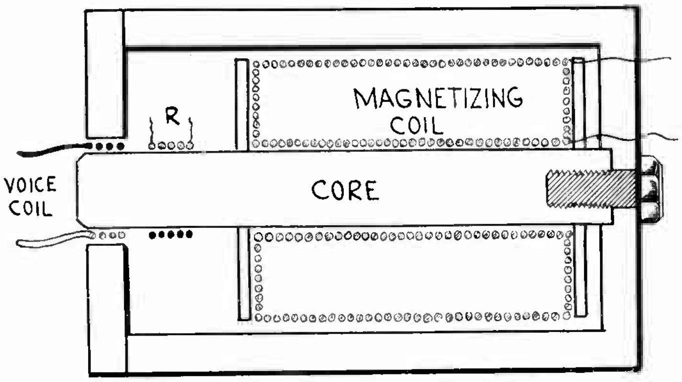

FIG. 4
AN ARRANGEMENT OF COILS TO EFFECT REDUCED HUM IN A SIMPLE COIL WITH EMF OPPOSING THAT OF THE VOICE COIL.

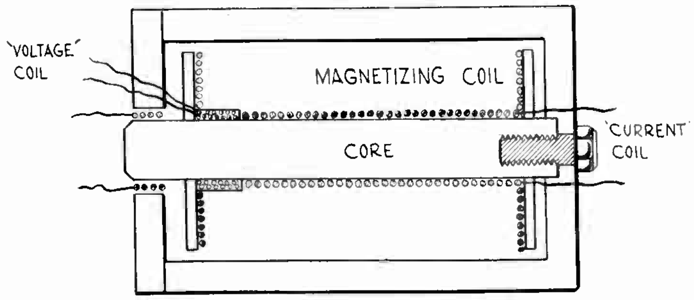

FIG. 7
SPECIAL APPLICATION OF TWO REVERSELY WOUND COILS TO SYSTEMS WHERE THE FIELD FLUX IS ROUGH. THE VOLTAGE COIL IS THE SOURCE OF OPPOSING HUM VOLTAGE. THE CURRENT COIL MERELY SMOOTHS OUT THE AMPLITUDE.

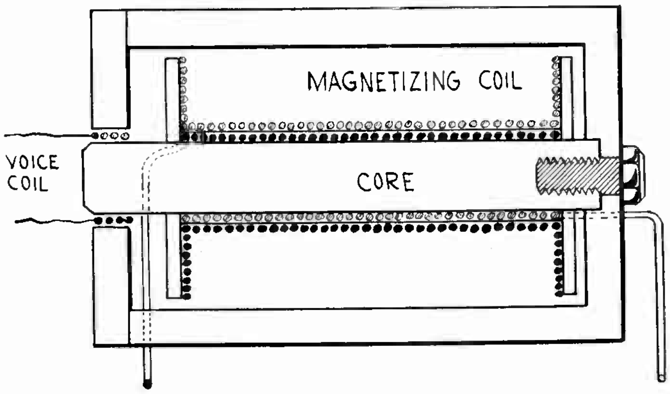

FIG. 5
A REVERSELY WOUND CURRENT COIL TO REDUCE THE AMPLITUDE OF THE PULSATING FLUX IN THE CORE.

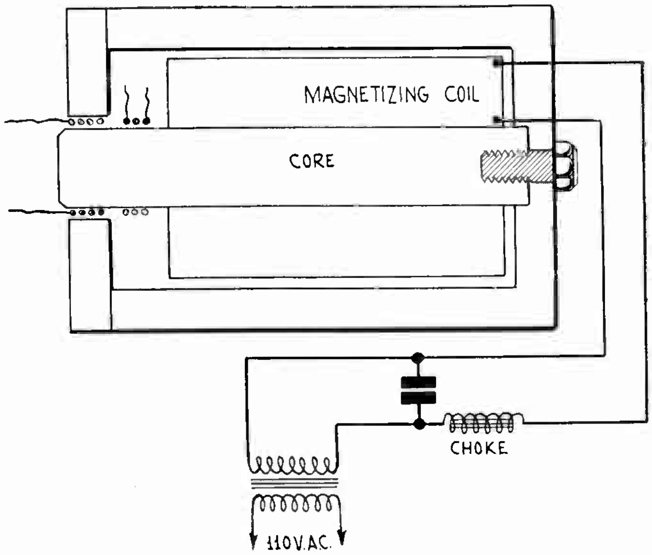

FIG. 8
HUM REDUCTION CIRCUIT USED IN SOME AC OPERATED THEATRE SPEAKERS. A CHOKE AND CONDENSER ARE USED BECAUSE THE MAGNETIZING COIL WEIGHS 12 POUNDS.

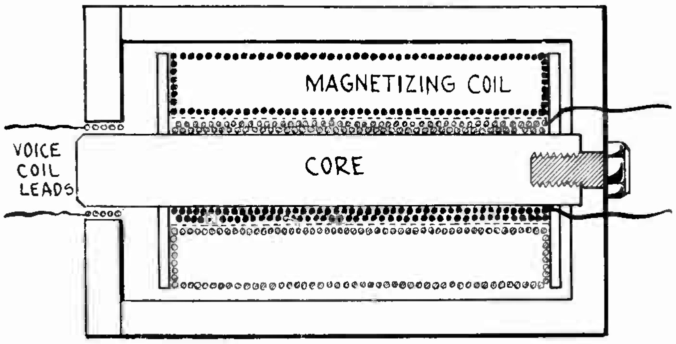

FIG. 6
SAME AS FIG. 5, EXCEPT THAT IT IS APPLIED TO LONG SOLINOIDS, WHERE A SINGLE LAYER CURRENT COIL WOULD BE UNSUITABLE.

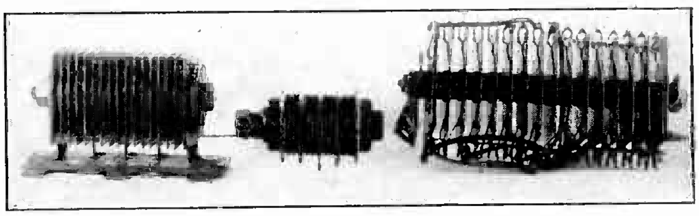

FIG. 9
THREE TYPES OF COMMERCIAL DRY RECTIFIERS.

(Continued from preceding page)

The cases where the circuit of Fig. 7 is necessary include, as previously stated, the use of a cheap inefficient rectifier, the same rectifier operating on a 110 volt AC circuit with a series resistance (a non-reactive input) with resultant poor filtering of line harmonics, and other associated noises; a pot coil of less than 2 lbs. in weight, and consequent low inductance.

In all schemes for hum reduction the fact that one cannot obtain an *exact* balance is due partly to the fact that all such circuits take some energy and therefore to obtain an opposing emf in the case of Fig. 7 it is important to consume as little energy as possible in the hum reduction circuit. Hence we split it into two parts, as differentiated from all preceding cases, and use the current coil solely for the purpose of reducing the amplitude of the pulsation of the core flux, and use the voltage coil shunted by a high resistance, in this case, to balance out the residual hum developed by the voice coil.

Coil With More Turns

Fig. 8 is a combination which is somewhat similar to Fig. 4 in that a coil similar in location, though having more turns, performs practically the same function of coil R in Fig. 4.

The choke and condenser indicated in Fig. 8 are used in this instance solely for economic reasons. It is cheaper to use two separate devices like these to smooth out the amplitude of pulsating DC emf than to wind a magnetizing coil incorporating a reversely wound coil of any kind. This does not apply to magnetizing coils of between 2 to 5 lbs. but does apply to coils weighing 12 lbs. or over, especially where the winding facilities are arranged for one winding direction only. The choke and condenser form a filter and the coil that is similar to coil R in Fig. 4 is wound so that its opposing voltage is nearly equal to that of the voice coil.

A final word on the shading ring method which is not very effective, though it was used initially in combination with the scheme of Figs. 4 and 8. It consists of a non-magnetic metallic ring placed on the core between the magnetizing coil and the inside of the voice coil end of the pot. The effect of this is somewhat similar to that of Fig. 3A in which the copper ring shades the pole AB, causing the disk to rotate. This metallic ring, sometimes called a shading ring, is supposed to shade the voice coil end of the core and air-gap magnetic circuit and reduce the amplitude of the pulsating magnetic field. It does this, but rather weakly.

Dry Rectifier's Popularity

For reasons that have been pointed out the commercial popularity of the dry-rectifier operated speaker has been threatened from time to time due principally to inadequate rectifier design and the prevalence of bad acoustical hum, and it is on this account that many radio set manufacturers have turned to the high voltage, high impedance type of pot winding, which, being supplied with either partly or wholly filtered high voltage, is much less subject to hum troubles.

In Fig. 9 are shown some commercial forms of dry rectifiers.

(Concluded on next page)

Hi-Q Volume Control

How Small Screen Grid Change Produces Large Output Difference

By Lewis Winner

[*Last week, issue of March 22d, the author described the construction of the battery model Hi-Q 30, recently made available to set builders. He will be glad to answer questions on the Hi-Q, either AC or battery model. Address Lewis Winner, c/o* RADIO WORLD, 145 *West 45th Street, New York, N. Y.*—Editor.]

THE proper adjustment of the volume control in the HiQ-30 is most important in obtaining the utmost from this receiver. This may, at a glance, be mistaken for a petty matter.

As indicated last week, the overall amplification of the HiQ-30 is very great, and it is thus capable of amplifying extremely weak signals up to loudspeaker volume. Under these conditions a large portion of the total amplifying power of the set will be needed and the volume control will be advanced to a point, two-thirds the way around.

Suppose the receiver is tuned to a distant broadcast station, more powerful than another station on a channel close by. It will now be necessary to reduce the volume control to, say, the three-eights position, in order to avoid choking up of the detector, and the audio end of the set. Now let us tune to a very powerful local station. Naturally, the volume control will have to be reduced still further, probably near the zero point, to obtain the desired loudspeaker output without overloading.

Amplified 20,000,000 Times

Now let us see what actually has been taking place in the receiver. We can first assume that the volume from the loudspeaker was the same in all three instances, and corresponded to, say, fifty volts across the speaker terminals. Let us assume the modulation of the three stations equal, averaging twenty-five percent., and that their field strengths such as to induce the following voltages in the receiving antenna connected to the receiver:

10 microvolts from the weak distant station
100 microvolts from the strong distant station
100,000 microvolts from the powerful local station

Dividing these voltage inputs into the voltage obtained at the loudspeaker, allowing for twenty-five percent. modulation, indicates that the total amplification required of the receiver varies within wide limits as follows:

20,000,000 times in the case of the weak distant station
2,000,000 times in the case of the strong distant station
2,000 times in the case of the powerful local station

Volume Controlled at RF

Since the amount of audio frequency amplification is fixed, this this variation in amplification must occur in the radio frequency amplifier. In the HiQ-30 this variation is obtained by adjusting the voltage applied to the screens of the three screen grid radio-frequency amplifier tubes. This is accomplished by connecting the screen grids to the moving arm of 25,000-ohm potentiometer, the outside terminals of which are connected to the 45 volt terminal of the B battery and to ground. Thus the voltage applied to the screen grids of the radio frequency tubes varies from zero to 45, as the potentiometer is turned.

Under operating conditions the amplification required for different stations varies enormously. At the same time, once the station is tuned, comparatively slight variations in the amount of radio frequency amplification produce a relatively large change in the output from the loudspeaker. This is especially true in the case of the powerful local stations, where only a very small amount of radio frequency amplification is necessary.

When receiving such a local station, the volume control is set at a low point where the voltage impressed on the screens of the screen grid amplifier tubes is very small, say, 3 or 4 volts. Due to the characteristics of the screen grid tubes, their amplifying power changes very rapidly with slight changes in screen grid potential below ten or fifteen volts. Since the potentiometer volume control covers a range of 45 volts with one revolution, it is easy to see that only a slight movement is required to change the screen grid voltage a volt or so. If the proper setting for a given station is 4 volts, a slight movement of the volume control easily may increase the voltage to five or decrease it to three.

Additional Volume Control

Due to the critical characteristics of the screen grid tubes, this may quite easily increase the total radio frequency amplification to twice its original value or reduce it by one-half, depending on whether the control was increased or decreased. Naturally this results in a loudspeaker response which is either too loud or not loud enough, and the volume control setting for just the desired volume appears rather critical.

There are two simple methods of overcoming this condition. The first is the use of a variable resistor in series with the antenna. The value of this resistor is not critical, anything from 5,000 to 50,000 affording a sufficient reduction in the intensity of the signals from the powerful local station to enable the volume control in the receiver to be operated at a less sensitive portion of its range.

If best results are to be obtained, the antenna resistor should be set at a value just high enough to insure smooth operation of the volume control. In the Hi-Q this antenna resistor should not be used as a volume control in itself, although it may be all right in other receivers.

(*Concluded from preceding page*)

The one on the etreme right is the copper oxide type. This rectifier is highly efficient and provides almost pure DC, which is attested by the fact that it can be used in many cases similar to Fig 4 without any special filtering device. The rectifier on the left-hand side is the lead sulphide type. Its proponents claim long operating service under conditions of normal load, but in practice those rectifiers disintegrate rapidly, with increase of internal temperature, a defect not present or likely to occur with the copper oxide type. The center rectifier is somewhat similar to the lead sulphide type except that it is much smaller physically per watt of rectified output than either of the others. It too is subject to distintegration and must not be overloaded, as its recuperative ability is seriously impaired very easily.

The rectified output characteristics of the particular dry rectifier that you intend using must be known before the intended load is applied, so that the rectifier may be operated at the lowest temperature consistent with output requirements.

Drop per Disk

Now the rough average voltage-drop per section or per disk for small rectifiers as pictured is around 1 to 1¼ volts per disk, and for smaller disks the voltage drop is lower, so we have to be careful not to apportion a DC load beyond the capacity of the rectifier.

Dry rectifiers depend for their action on the fact that the combination of two dissimilar substances forms a cell that has the ability to conduct a current of electricity in one direction only, this property being termed unilateral conductivity.

Referring to the Fig. 10 you can see the two disks on each section of the copper exide type rectifier on the right. The others are not so easily discernible but the basic arrangement is similar.

A certain amount of mechanical pressure is necessary to maintain a uniform electrical contact between the rectifying surfaces. This pressure is obtained by means of the central clamp bolt as shown.

It will be seen by inspection that all three rectifiers are of the sixteen disk type, and the normal rating of each is supposed to be the same, namely, up to 8 watts DC at between 6 to 8 volts.

The operating temperature of the three models shown here is widely different. The right-hand rectifier will carry a load of 8 to 10 watts at a temperature of not more than 110° F. and the little one in the center will reach at least 130° F. and the left-hand one will be only a few degrees lower. Assembly will alter these temperatures a little.

Maximum versus Usable Power

Any new rectifier may be placed on an exciting circuit and its DC voltage will be the same as the exciting AC voltage. An ammeter in the AC side will of course show no current. Now if a variable load be connected to the DC side with an ammeter and voltmeter in the circuit, and the load slowly increased so that the ammeter deflection starts from zero, a point will be found for any rectifier so connected that it gives a certain maximum wattage indication. But this wattage indication is accompanied by a higher than normal operating temperature down to safe continuous values the contention wattage rating is lower than the maximum by as much as 1½ watts. Hence the need to adapt the load requirements correctly.

Answers to Questions

Many Put Interrogations That Supply

By Capt. Peter

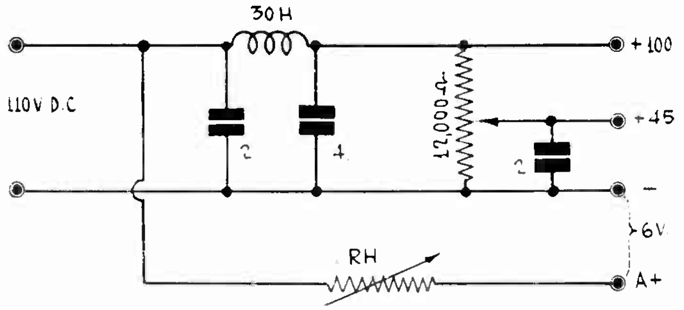

FIG. 1

THE CIRCUIT OF AN A AND B BATTERY ELIMINATOR DESIGNED FOR DC SUPPLY. THE RESISTANCE VALUE OF RH CANNOT BE DETERMINED WITHOUT KNOWING THE CURRENT WHICH WILL FLOW TO THE RECEIVER SERVED.

INCOMPLETE questions on technical subjects are asked of RADIO WORLD every day, questions which either cannot be answered at all or which cannot be answered without making a multitude of assumptions, conditions, counter questions, and long explanations. Some of the tentative conditions may not have any direct bearing on the trouble at hand, but any one may be as applicable as any other. If an attempt be made to answer one of these incomplete questions in this manner in the hope of preventing delay by fortuitously hitting on the right conditions, it takes a great deal of time to make the answer and the involved reply may cause more confusion than elucidation. The alternative is to write the questioner asking for the specific conditions necessary to give an explicit answer. This causes delay which is satisfactory neither to the questioner nor to the technical department of RADIO WORLD.

It is no cause for wonder that so many questions should be incomplete, for if the questioner could state all the conditions required to answer a question, he would probably be able to remedy the trouble without help. However, there are many types of questions for which the fan alone can give the data, and he can give them even if he is not well versed in radio. One thing that the fan should remember in asking questions is that nobody can read his mind by mail. If he does not put down in his letter the facts he knows, and has in his mind at the time of writing, there is no way that any one else can tell what those essential facts are.

Unfortunately, some who ask questions put down nearly everything that comes to mind, much of which is impertinent to the subject in question, and entirely forget to give the facts necessary. For example, just now a letter of four closely written pages came in from a professional set builder in which he devoted three and three-quarters pages to financial and legal experiences he had had with customers and the remaining quarter page to a technical question and the usual termination. He neglected to say what the technical question was about, unless he entwined it in legal phraseology.

A Typical Question

One question that is frequently asked deals with the tuning of circuits. Here is a sample. "I have a 19-plate condenser. How many turns are required on the coil?" To say that this question is asked frequently does not give an adequate indication of the frequency, for it "ticks in" with the regularity of a clock.

In what respect is that question incomplete? In nearly all respects. In the first place, a 19-plate condenser does not mean anything. The size of the plates may be as great as the plates in a battleship hull or they may be as small as the cover plates on a microscope. It is true that the variation in the plates in radio tuning condensers is not so great but they vary enough to make the 19-plate specification absolutely meaningless. Again, the distance between the plates in a radio condenser may vary from a few thousandths of an inch to a tenth of an inch or more. What is needed is the maximum capacity of the condenser, and this depends on the size of the plates and the distance between them, as well as on the number.

Other Missing Essentials

However, if the condenser is specified as a 19-plate condenser it is reasonable to suppose that the capacity is .00035 mfd. since that is the average capacity of a variable condenser of that number of plates. The answer to the above question in so far as it depends on the capacity must be based on the assumption that the condenser has a maximum capacity of .00035 mfd.

More important features are missing from the question. For example, the size of the coil form is not given. It is essential to know the diameter of the coil, or the number of turns cannot be given in any case. Not only is it necessary to know the size of the coil form but also the size of the wire, measured over the insulation. That is to say, it is required that the number of the wire and the kind of insulation be known. All the necessary values may be assumed but if that is done there is no assurance that the fan who desires the information can get the size of coil and the number and type of wire specified.

There is one other missing bit of information in the question that is essential to the solution of the problem. The question speaks of tuning, and the counter question is, "Tune what?" In other words, what is the frequency of resonance to be when all of the condenser is used?

Let us restate the question as it should have been asked. "I have a variable condenser of maximum capacity of .00035 mfd. which I want to use in tuning a broadcast receiver, to cover the entire band if possible. How many turns of No. 24 enameled wire will be required on a 2 inch coil form to give the required inductance?" This gives all the required information, for it gives the capacity, the diameter of the wire measured over the insulation, the frequency band, and the diameter of the coil form. At least it gives the necessary facts with sufficient accuracy for design purposes.

A Variation of Question

A variation of the above question is frequently asked. For example, "I have an XYZ condenser. How many turns of wire should I put on a 1.5-inch form?" Even if XYZ is a well-known brand it is impossible to answer the question, because not only is the capacity missing, as well as the coil dimensions, but there is no way of finding what the capacity of that particular condenser is.

Naturally, not all the questions of this type are as devoid of pertinent information as the two examples given above. But there are few that are entirely complete. In some instances, of course, the questioner is not in a position to give all the necessary facts, but then he should give all that he can. The needed facts are: the capacity of the tuning condenser, the wave band to be covered, the diameter of the coil form, and the number and type of insulation of the wire. The insulation is needed only because it determines the effective diameter of the wire, when the number of that wire is known.

What Changes Are Necessary?

One type of question often asked deals with alterations of old receivers. For example, "I have 1923 model PDQ receiver, battery operated. What changes will be necessary to convert it to an AC, screen grid, single-control receiver like the latest BVD receiver?" This is not at all unanswerable, but the answer is always unwelcome. Here it is: Throw out the old set, start from scratch, and build the new receiver.

Here is another: "I have a Model Y, Serial Number 385,764, DX-dyne. What changes are necessary to make it into a Model Z, Qualitydyne receiver?" Clearly, there is no change possible which will convert a receiver of given brand into one of another brand.

Sometimes a question demands to know what changes are necessary in a receiver to adapt it to tubes of a different make, but of the same type. Such a question might seem ridiculous, but it is not. Not everybody can be expected to know that the tubes in the set have identical characteristics with the tubes desired. So the answer to this question is: Change the tubes.

When the question refers to changes calling for tubes of different characteristics, the answer is not so simple, for it may call for rebuilding the receiver, or it may only call for a new filament transformer with a few appropriate wiring changes. When such questions are asked no answer can be given unless the circuit diagram of the receiver to be changed is supplied. Any question relating to changes of a receiver is incomplete unless the diagram is supplied.

Good, Better, Best

Questions involving comparisons of receivers and accessories defy intelligent reply in most instances. Once in a while a question demands to know whether or not a given receiver is good. The counter question must be: Good for what? How is the goodness of a receiver to be judged? No two individuals

That Can't Be Answered

Insufficient Basis for Any Definite Reply

V. O'Rourke

will judge the same receiver the same way. Goodness is really not a definite quality of a receiver.

But which of two receivers is the better? Certainly that is a definite question. "Better" can be no more definite than "good." It is necessary to compare the different characteristics of the two receivers. Which is the more sensitive, the more selective, the simpler to tune, the less expensive to operate, the easier to operate, the more reliable? Which is capable of better quality? But when we single out any one of these characteristics we are not much nearer an answer, for individual receivers of the same type and make differ widely, probably more widely than the averages of the two receivers of different types. And in many of the characteristics the individual's judgment enters.

In order to make any comparison it is necessary to have a common basis of judgment, a basis which is not subject to the personal equation. Such bases are not available for all receivers.

What has been said of "good" and "better" is also true of "best." Moreover, there is no best receiver, tuner, amplifier, speaker, power pack. There are so many variable factors which enter that one part may be best in conjunction with certain other parts and it may be the worst in conjunction with others. One complete receiver may be entirely satisfactory in one place and unsatisfactory in another. One man may like one receiver in a given locality and another man another set.

If there were no difference of opinion among engineers and fans there would be only one type of set and only one design.

Best Way of Judging

The best way of determining which receiver, or part, is best is to operate it and listen to it. Which gives best satisfaction? That is the best set. Nearly everybody can do this, either at home or in radio stores. If the prospective purchaser is located so that this is not practical, he can usually buy a set on approval. This is particularly the case when the set is bought by mail. Before buying in this manner, which inevitably will entail some expense, it is well to look into the reputation of the manufacturer of the set. A reputable manufacturer is more likely to turn out a satisfactory receiver than a fly-by-night manufacturer. One has good will to maintain.

There is a certain prejudice against discontinued models, either of going manufacturers or of makers which have been forced out of business. The fact is that some of these receivers are better than current models, and it is also true that discontinued models can be obtained for one-third or one-fourth the price of the current models. The principal objection to discontinued models is that it may be more difficult to get them serviced. This ceases to be an objection when it is remembered that once a current model has been sold for good, it is discontinued in so far as the manufacturer is concerned.

The problem of servicing devolves on the service man, and if he is any good he can service a discontinued model just as well, perhaps better than, a current model. In places where there are no service men there is no one to service either. Hence it devolves on the owner to keep his set in running order. It makes no difference to him whether he got a model that was current at the time of purchase or one that was of an earlier vintage, not as far as servicing is concerned, but it does make a difference in respect to cost.

Questions Involving Ohm's Law

One type of unanswerable questions is based on a misunderstanding of Ohm's law. This type of questions is asked so often that it should be kept constantly before the readers of radio magazines.

Here is one of the type: "What resistance should I put in series with the high voltage tap on the power pack to cut the voltage from 450 to 180 volts?" This is unanswerable, because the current flowing through the resistance is not given, and no information is supplied by which the current can be determined. Ohm's law states that the voltage drop is equal to the product of the resistance on ohms and the current in amperes. At least two of the factors should be given if the third is to be determined.

Many variations of this question are propounded. Here is one, for example: "What resistance should I put in series with the plate lead to reduce the plate voltage from 180 to 135 volts?" The only answer that can be given is: Divide 45 by the current that will flow through the resistance when it has been put into the circuit. The number 45 is used because it is desired to cut the voltage by this amount, that is, the voltage drop in the resistance to be added is to be 45 volts.

And here is another: "I want to build an A supply to be used on a 110 volts DC line for heating the filaments of 201A type tubes. What should the resistance in series with the filaments be?" The counter question must be: How much current

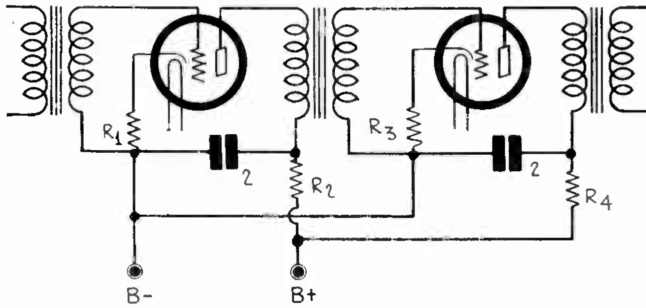

FIG. 2
THE RESISTORS DESIGNATED R1, R2, R3, AND R4 CANNOT BE DETERMINED DEFINITELY WITHOUT KNOWING THE CURRENTS FLOWING THROUGH THEM AS WELL AS THE VOLTAGE DROPS IN THEM. THESE MAY BE ESTIMATED WHEN THE TUBES ARE KNOWN.

will flow through the resistance? In other words, how many 201A tubes are used in the receiver? Without knowing the current an answer cannot be given. Sometimes this question takes the form of a request for a circuit diagram of the A supply, but the missing element is the same. To make this question complete supply a circuit diagram of the receiver to be served.

Grid Bias Resistors

A similar problem arises in connection with requests for grid bias resistance values. If the grid bias resistor is to be used for a single tube, or a specified number of similar tubes, there is no essential lacuna in the question, because the current and voltage drop are known for all the usual tubes. But the type of tubes and the number of tubes to be served by the resistor must be given or there can be no answer.

When the grid bias is obtained from a drop in the voltage divided more information is necessary. Usually it is best to send along the circuit diagram of the receiver and the voltage supply. In the absence of this information the best answer that can be given is: Don't. That is to say, don't use this method of obtaining grid bias. The individual resistance method is better. Since we have scoffed at the comparative "better" an explanation is in order. When the grid bias is obtained from voltage drops in the voltage divider there may be feed back complications which might set the circuit oscillating or blasting on certain notes. The individual bias resistor produces feed back, too, but it results in degeneration, which is much to be preferred over regeneration. In either case the grid bias resistor should be by-passed, the larger condenser being required when the bias is obtained from drops in the voltage divider.

SOS Questions

The most frequent unanswerable questions come in the SOS class. Here is one: "I have and RSV receiver which has been giving good service for over a year, but now it does not work. What shall I do?" And here is another. "I built the TRF set just exactly as you described it. I have made every test I can think of, but I cannot make it work. What is wrong with it?" Questions of this kind could be quoted indefinitely.

All these questions indicate that the questioner is in distress and he cannot be expected to think rationally, much less giving any information which might give an inkling as to what the trouble may be. What is needed in cases of this kind are symptoms. How, for example, does the set misbehave? What tests have been made and what was discovered as a result of these tests? If there is a service man available he should be called in. Possibly he can spot the trouble in a jiffy. While on the job he can put the circuit through simple tests which will disclose the kind and location of the trouble. Nobody can do that by mail. If a remedy is sought by mail the symptoms must be supplied to the one who is to diagnose the trouble.

Many of the SOS questions contain the statement that every possible test has been made without success. That is a great help provided that the tests made are described and the results included in the letter. Without this information "every test" means nothing at all in so far as the answer is affected. Sometimes the test made is described and still gives no information. For example: "My receiver does not work as it is supposed to do. I have made every test I can think of without luck. I have reversed the grid leak. What could be the matter with the set?" Who knows, if reversing the grid leak did not help!

Resolved, That Home-Built F

AFFIRMATIVE

By Francis Hunter Cabot

WHICH is better, a commercial set or a home-constructed set? There is a great deal to be said in favor of each type, and the answer to the question depends largely on the viewpoint or on personal preference rather than on the relative technical merits.

To answer the question intelligently it is necessary to compare the different points of value. Some persons regard one set of values as paramount while others will deem a different set of values of greater importance. For example, one group may regard appearance of prime importance while another group may place greater value on tone quality. Then there may be a group that ranks sensitivity first and still another group that must have selectivity above all things.

The receiver must be judged first by results desired and then by the means for obtaining these results. Most persons generally are agreed that tone quality come first, but they are willing to sacrifice some of the quality to reduce the cost of the receiver, the maintenance charges, to enhance the selectivity and the sensitivity, and to improve the appearance. One of the reasons they are willing to sacrifice quality is that very few people can tell the difference between really fine quality and just fair quality. This is no indictment against their judgment at all, for it takes long experience with first-class quality to appreciate it, and this experience must be obtained by comparison. It is not right to accuse people of having poor taste in this respect just because their tastes differ from those of somebody else.

Tone Quality Paramount

Just the same, tone quality is one of the prime attributes of a receiver. Is it possible to build a receiver at home that has better quality than the quality of a commercial receiver of the same type? Surely it is possible, because no commercial receiver has been designed so well that it cannot be improved, and the necessary improvement can be done just as well at home as in the laboratory, provided that the home builder knows what to do or takes the advice of those who do.

The commercial receiver must be designed and built so as to meet keen competition successfully. Manufacturers are quick to take advantage of the weak points in the buying public's armour, and one of these weak points is the public's inability to judge good quality. Some manufacturers make receivers to "get by" and depend largely on the ability of the advertising copy writer to convince the public that the quality of certain sets is really supreme.

The quality of a set is largely determined by the audio amplifier. Least trouble of serious nature will be obtained with transformer-coupled circuits, hence nearly all commercial receivers contain this form of coupling. Now, transformers are not always capable of the very best quality, as all versed in the subject know. The home constructor does not even have to select transformer coupling if he is convinced that better quality can be obtained with resistance coupling. But the man who buys a commercial set has to accept a certain form of coupling. He has no choice.

Poor Transformers

The fact that many transformers are not capable of delivering as good quality as correctly designed resistance-coupled circuits is not in itself sufficient to condemn transformer circuits, because there really are excellent transformers on the market, transformers of such excellence that not even the keenest judge can tell that the highest form resistance coupling is not used. But transformers of this type cost real money and manufacturers cannot put them into sets that are to be sold in competition. One of the first sacrifices a manufacturer makes is the quality of the transformers. This should not be blamed on the engineers working out the designs of the receivers but rather against the financial policy of the company making the sets. This policy in turn is dictated by the public's choice of sets costing little. No one can receive good quality for little money.

Just as some manufacturers skimp on the transformers so they skimp on other parts. For example, they often include cheaper condensers than those offered the home set builder. These condensers do not tune as well as those of better construction. Selectivity is poorer and equalizing adjustments do not last as long.

One point where skimping is the rule is in the power supply. Filament transformers are made just large enough to deliver the necessary current to operate the tubes. The transformer may get very hot in service, but "that goes" as long as it does not get so hot as to burn anything. It may be hot enough to burn a hand that touches it, but the argument is that the hand is not supposed to touch a transformer that is in operation. If commercial power transformers were constructed on the same basis, the electric companies would go bankrupt in a short time, or the rate for electric energy would be nearly doubled.

High Voltage Transformer

The high voltage transformer is designed on the same scale as the filament transformer. Likewise the choke coils used to smooth out the rectified current are made too small. The voltage divider is proportioned on the same diminutive scale. The result is that the regulation of the device is poor, which in turn adversely affects the quality of the tone emitted.

Another point where skimping is practised is in the by-pass condensers. In the first place that voltage rating is not sufficient to allow ample margin of safety against break-down. Replacements may have to be made frequently, and these are costly in the long run. Moreover, they cause interruptions in service.

Not only is skimping practiced in the voltage rating of condensers but also in the capacity. It is well known that if the by-pass condensers are not large enough there will be considerable feedback through the B supply, and this feedback will cause oscillation, called motorboating, or serious distortion of the signal at frequencies not usually included in the term "motorboating."

It is understood that not all commercial receivers are built on these diminutive lines. There are some excellent ones. Anybody can buy a first class receiver if he is willing to pay for it.

Advantages of Home-Built Sets

There are numerous advantages in home-built receivers of which the ready-built buyer cannot take advantage. The amateur set-builder usually has studied the subject of radio considerably. He has certain ideas of his own. He knows, for example, the advantages of a Superheterodyne, and of various types of Superheterodynes. If he wishes a circuit of this type he can build one that just suits his fancy. While the commercial type receiver is excellent, it may not suit the particular taste of the home set builder.

If the home set builder desires some other type of circuit he can select that. He can buy parts, or make some of them, if he prefers, for any receiver that he may set his heart on.

Commercial sets, as a rule, come complete. They contain the radio frequency amplifier, the audio frequency amplifier, the power supply, the cabinet, and in most instances, the speaker. All these components are the selections of somebody else and may not meet the tastes of one who has his own ideas, either in part or as a whole.

If he builds his own receiver he can select the type of radio frequency amplifier that suits his fancy. He can use regeneration, tuned radio frequency, the Neutrodyne principle, the Superheterodyne principle, or any other, and he can use as many tubes as he likes as well as the kind of tubes he likes. He can emphasize sensitivity or selectivity, or he can place equal emphasis on these two features as far as equality can be applied to two different things. He can also guard the quality by incorporating band pass filters.

The Detector Open to Choice

There are several types of detectors. In a commercial set one type is used and there is no simple way of changing it to another. The man who builds his own receiver can select the type of detector which best suits his ideas, his power supply, and his audio amplifier. Moreover, he can arrange his receiver so that he can change easily from one type to another.

When it comes to the audio amplifier the amateur builder can select any type which appeals to him at the moment. He can use resistance, impedance, Clough type, push-pull, transformer, or non-reactive coupling. And he is able to build an amplifier of any one of these types which is better than the average commercial amplifier. To be sure, the amplifier he selects may cost a little more than the amplifier built into the commercial receiver, but he is well paid in satisfaction. In most cases the man who really understands amplifiers will build one capable of superior quality at a cost which is only a small fraction of the cost of an amplifier found in many commercial sets, even if extreme economy has been practiced by the designer of that commercial amplifier.

The case is the same when it comes to the power supply. The amateur builder can assemble one with ample by-pass condensers of adequate voltage rating, with power transformer which will not get excessively hot, with chokes large enough not to saturate, with a voltage divider that does not get red hot. He can do this without expending a fortune provided that he shops around for parts.

Receivers Outclass Commercial

NEGATIVE

By Adrian Brooks

IF ALL factors affecting the worth of a radio receiver are taken into consideration, there can be no doubt that the commercial receiver is superior to the home-constructed set. If, on the other hand, particular attributes are considered to the exclusion of all others, it may be that doubt is justified, because certain properties of a receiver may be given such importance in forming a judgment that overall efficiency may be discounted.

If we are to make a fair comparison between commercial and home-constructed receivers we cannot argue in general terms. We must be specific with respect to sensitivity, selectivity, tone quality, original cost, expense of maintenance, appearance, ease of operaton, and reliability. Obviously, it would not be fair to compare the most elaborate commercial set with the cheap hastily thrown-together amateur receiver, nor would it be fair to compare the cheapest commercial set with the de luxe home-built receiver which is the handicraft of a radio engineer or a skillful home-builder. If we make such comparisons the premises preclude all arguments and divergence of opinion.

Basis of Comparison

It is difficult to find a true basis of comparison because there are so many different sets of both kinds. As regards cost and expense of maintenance there is no difficulty. But when we try to put a dollar value on sensitivity, selectivity, quality, appearance, ease of operation, and reliability we meet difficulty. For example, how much more in dollars and cents is one set worth because it looks better than another set? One man, or woman most likely, will say, "I would rather pay more for the attractive set even if it does not sound so well." Some one else will say, "Give me the receiver with the better quality." Still another will say, "The difference even in appearance is not commensurate with the difference in price." The judgment is individual. Hence to make a comparison we must compare similar characteristics in commercial and home-built recevers rather than the two types of receivers.

Let us start with sensitivity. This is certainly one of the most important characteristics of any receiver. In this respect which is the better set, or which is more likely to excel? It is understood that we must compare similar types of receivers in the two classes.

The commercial receiver has been designed by engineers of the highest skill in a fully equipped laboratory. Only the optimum combinations of parts as determined by the results of careful measurements and expert interpretation will go into the final model. The home constructor cannot hope to duplicate the results for he lacks both the knowledge and the equipment. From this point of view the commercial receiver must be superior by a wide margin, provided that the manufacturing technique is such that the laboratory model can be equalled in quantity production. The success of quantity production as conducted in modern factories depends entirely on the possibility of making exact replicas, and no one has the temerity to say that quantity production is not a success. A large part of the preliminary engineering concerns itself with the practical possibility of making true replicas. There can be no doubt that the factory made set is superior.

Selectivity and Quality

What has just been said in connection with sensitivity can be repeated word for word in discussing selectivity and quality, and it would be equally applicable to either, or both in conjunction. A home constructor can take virtually the same parts as an engineer and with them build a set which is not nearly as selective as the set the engineer would build. Perhaps only a slight difference in the placement of some minor part would account for the difference. The engineer would prescribe exactly to the workers in the factory how to place the parts, and there would be no deviation. If deviations should result precise tests on the finished receiver would reveal them and the particular set would be rejected or corrected.

The home builder would not know what to do, even if he were aware of the defect.

The same applies to tone quality. The home constructor might think that he is a keen judge of quality, but the engineer has instruments which are infinitely keener than any human ear can be. Yes, not only much keener but absolutely impartial and unbiased. The human ear does not convey the same impression to the brain of two similar stimuli two seconds apart. The instruments remain unchanged for years. When there is a slight defect in the laboratory model the engineer knows simple remedies which he can apply, with practically no extra cost. The home constructor would probably not be aware of the defect, and even if he were, he would not know what to do about it. So it seems reasonable that the commercial set should be superior on these points.

Original Cost

The argument in favor of the home-constructed receiver has always been that it costs less. It was once true that a home-made set cost less, but now it is far from true. The commercial receiver of comparable quality and performance is much less expensive. There are many reasons for this. In the first place, there is keen competition among manufacturers. It is necessary to keep the cost of the raw materials down to minimum, which is done by quantity buying. Then they have to be satisfied with reasonable profits. Indeed, at times they have to be satisfied with "breaking even." If the home set builder should purchase comparable parts he would have to pay much higher prices for them, for he would have to pay higher profits. He could not hope to obtain as favorable terms in buying parts for one set as the manufacturer who buys in tens of thousands or even hundreds of thousands.

The cost of assembly of parts in the factory is so small that the saving effected on this item is negligible. Moreover, the home builder should charge the value of his own time against the receiver, and this time in many instances may be more than a complete factory-made set would cost.

Regarding the expense of maintenance there should be no difference between the home-made and the factory-built receiver, provided they are of the same type with respect to kind and number of tubes. Some difference may be due to improper design of voltage and current supply, and this as a rule is against the home-built set. For example, the filament voltages may be too high, which would shorten the life of tubes. Likewise the plate voltages may be too high, or the grid voltages may be too low, which would tend to shorten the life of the tubes by rapidly exhausting the emission reserve. Again, the B supply may be so designed as to require more current from the rectifier than is needed for satisfactory operation of the receiver. This would shorten the life of that tube. The factory-made set has been designed so that the life of all tubes is the maximum that is consistent with good performance. The engineer knows where to effect savings without sacrificing performance whereas most home builders believe that the higher the voltage, filament and plate, the better the circuit will perform. This is only true in some parts of the circuit.

Appearance

While appearance does not always have a dollar value, in most instances the good looking receiver is preferred. Just what constitutes good appearance is a matter of individual judgment, but it is a fact that most factory-made sets look better to the average radio listener than the home-constructed set. Should the amateur attempt to install his set in a cabinet as attractive as the cabinets housing factory sets the cost of the receiver would be out of all proportion. This is true whether he buys an attractive cabinet or makes one himself. It will be particularly expensive if he builds his own.

The home-built receiver has always been known to be very unattractive and unsightly. It is only occasionally that one of them compares favorably with the average factory set. Now and then a factory set has also been unattractive, but a noteworthy fact about such receivers is the rapidity with which they have disappeared from the market. The buying public will have none of them.

Ease of Operation

The factory-made receiver in nearly all instances is easier to operate. As a rule there is a single control for tuning, a control which really does effect tuning. There is only one control for volume, and sometimes this is quite automatic. Besides this, there is only an on-off switch. While a home-made set could be constructed in the same manner, it is seldom that this is done successfully. If the several tuned circuits in the set are controlled by one knob the tuned circuits are seldom lined up properly. It is not that it cannot be done just because the set is made at home, but that the builder does not want to go to the trouble involved, or that he does not know how to go about it. It is true that many set builders do trim up their receivers even better than factories do, but these are really amateur engineers, and probably could do as well in a laboratory as some of the professionals.

Simplification of receivers with respect to ease of operation has been a feature of recent development in all radio laboratories, and the results already are about as good as can be expected. Home builders of sets find it more convenient to use more than one tuning control than to go through the necessary adjustments for successful one-dial control. Many home-made sets are still of the multi-dial type, so complex that it requires a great deal of experience to get much out of them.

Short-Wave A

ELEVEN different designs for short wave adapters are illustrated herewith. In Figs. 1, 2, 3, 4, 5 and 6 a plug cable is used, and the circuits are shown for AC and battery-operated filament tubes. The constants are given except for the coils. All eleven adapters use the same coils, that fit in four-prong (UX) sockets, so provide two of these sockets for each adapter. The theory of all the adapters except Figs. 1 and 2, is that a mixer is built, so that your broadcast receiver, tuned to its most sensitive frequency (usually the highest frequency, around 1,700 kc.) serves as intermediate frequency amplifier, second detector and audio amplifier. So plug into the detector socket for Figs. 1 and 2 and into the first RF socket for Figs. 3, 4, 5 and 6.

Three different coils, two of each type, total of six coils, are required. You can use the base of an old UX tube and solder the coil terminals to the proper prongs. Both windings are in the same direction. Use No. 24 silk covered wire. The three coils have the number of turns shown, on 1¼ inch diameter.

Coil No. 1: primary (G, F— of socket), 5; secondary (P, F+), 7.

Coil No. 2: primary (G. F—), 7; secondary (P, F+), 11.

Coil No. 3: primary (G, F—), 10; secondary (P, F+), 20.

In Figs. 1 and 2 there is an extra coil, L. This consists of 10 turns of wire, any insulated kind, of No. 28 or larger diameter, on a 1½" form, and is placed over the socket, to be in inductive relationship to the coil that goes into that socket.

Fig. 1 is for battery sets having a 201A detector. Plug into the detector socket.

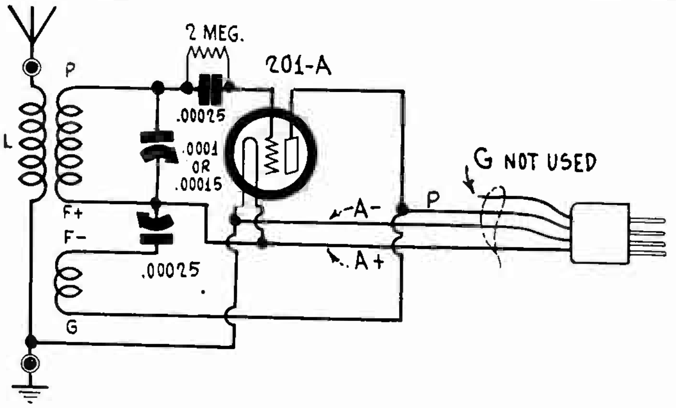

Fig. 1

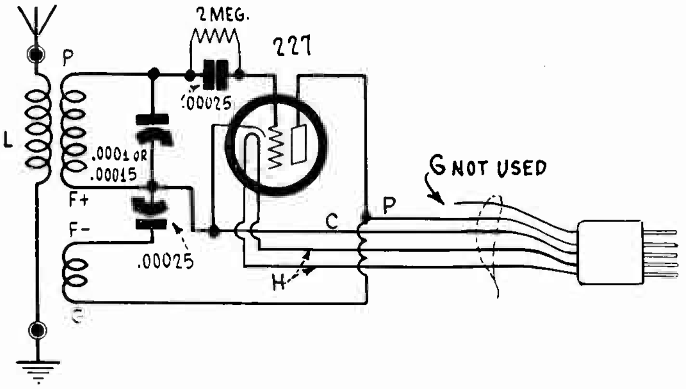

Fig. 2

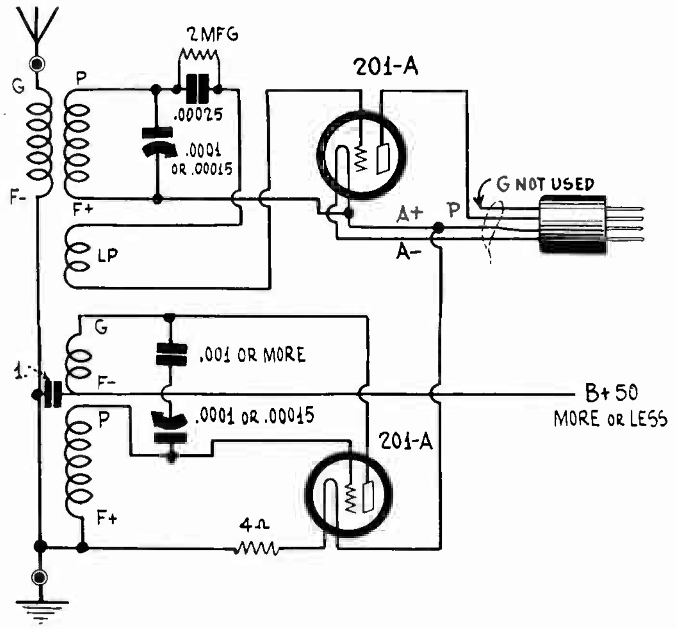

Fig. 3

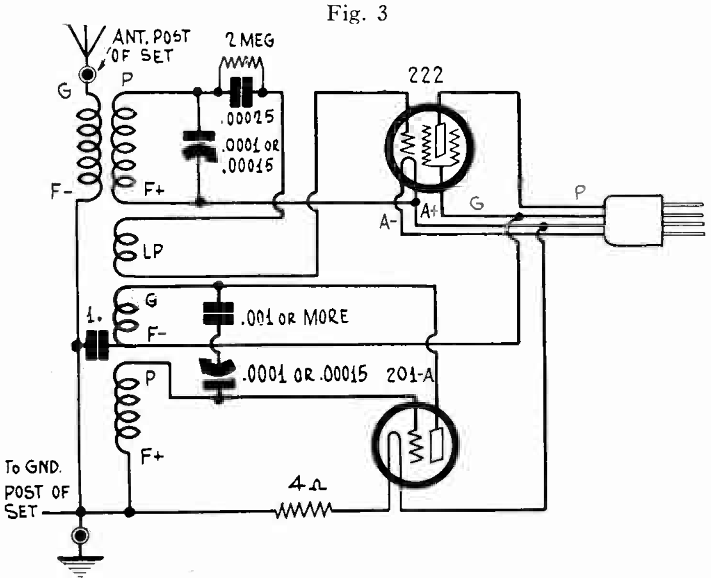

Fig. 4

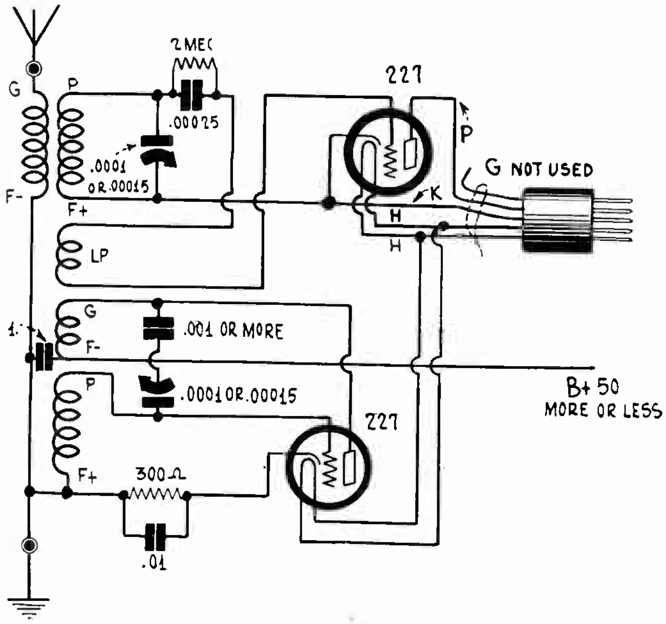

Fig. 5

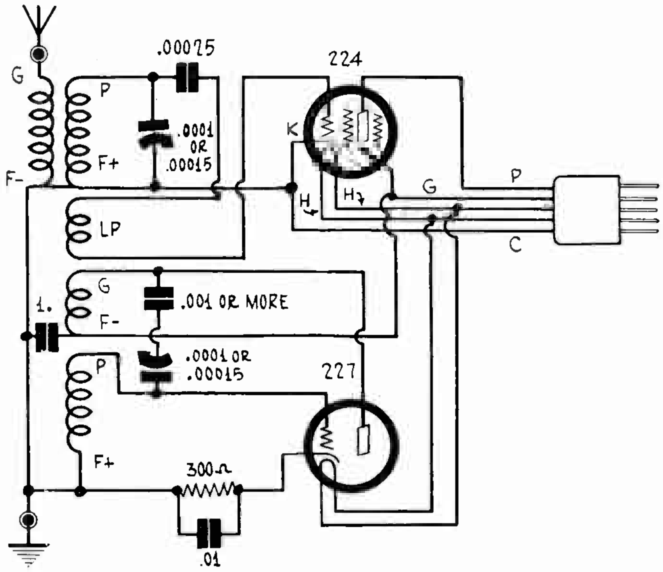

Fig. 6

dapter Designs

Fig. 2 is for AC sets that have a 227 detector. Plug into the detector socket.

Fig. 3 is for battery sets with 201A as first RF. Plug into the first RF socket and supply about 50 volts from the B battery (45 will do) for the lead marked "B+50 more or less."

Fig. 4 is for sets having 222 screen grid tube as first RF, otherwise similar to Fig. 3.

Fig. 5 is for AC sets having 227 first RF.

Fig. 6 is for AC sets having 224 first RF.

Fig. 7 is different from the rest. Here for the first time no tube is removed from the receiver, and no plug is used, but the output is connected to the antenna and ground posts of any set. The diagram is shown for battery operation of the adapter because you may not have AC.

Fig. 8 is similar to Fig. 7, works with any receiver, but is powered by a filament transformer and a B voltage from your receiver (50 volts or more).

Fig. 9 is the same as Fig. 7, except that a stage of 201A RF is used ahead of the modulator.

Fig. 10 incorporates a stage of RF, as in Fig. 9, but for AC operation.

Fig. 11 is the same as Fig. 10, except that the RF tube is a 224, instead of 227, and the B supply is a part of the adapter.

The pickup coil LP in all the diagrams, except Figs. 1 and 2, is the same as the antenna coil L in Figs. 1 and 2.

All these adapters have been tried out and they work. The construction of Fig. 8 was described in the March 1st issue of Radio World, and that of Fig. 10 in the March 15th issue.

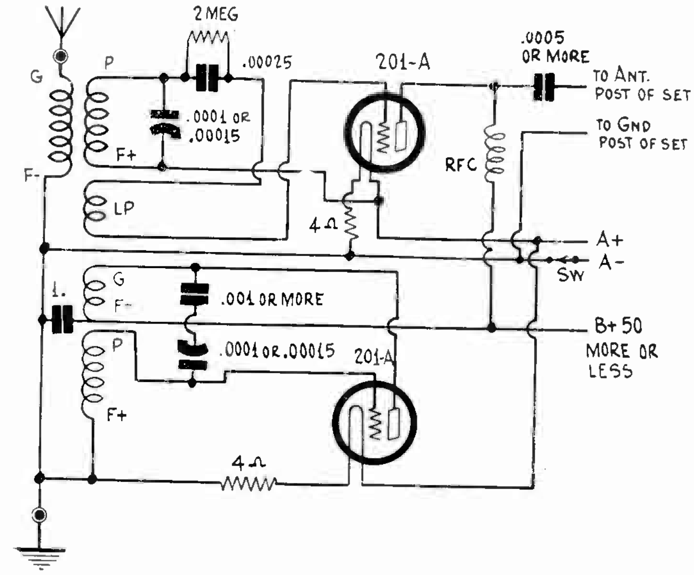

Fig. 7

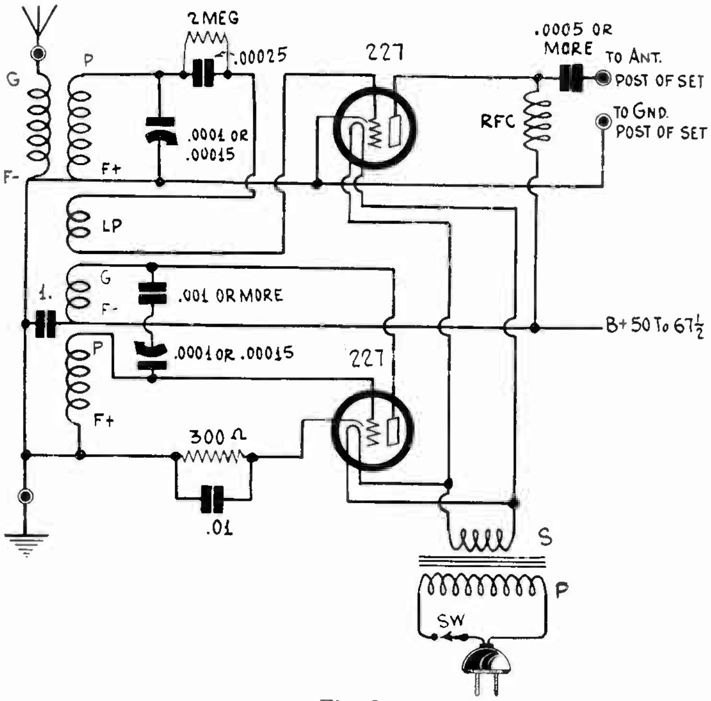

Fig. 8

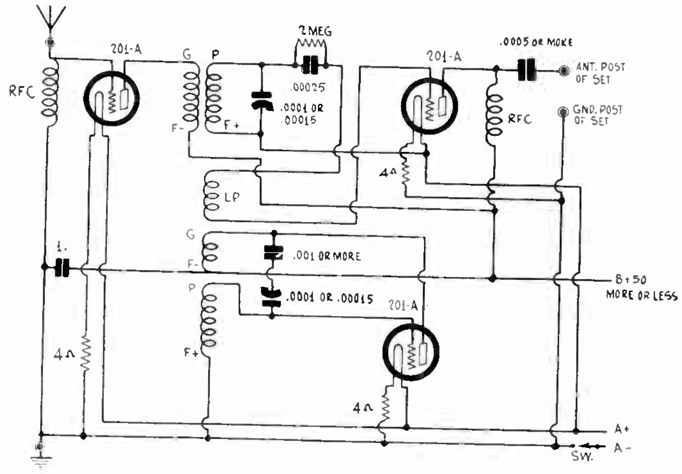

Fig. 9

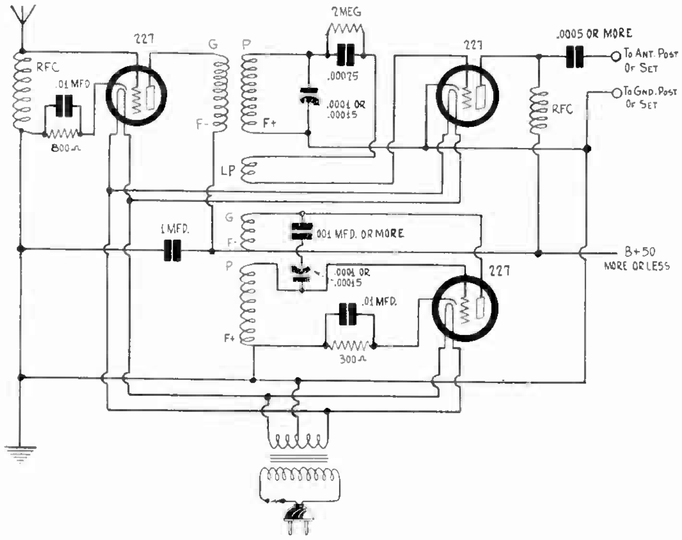

Fig. 10

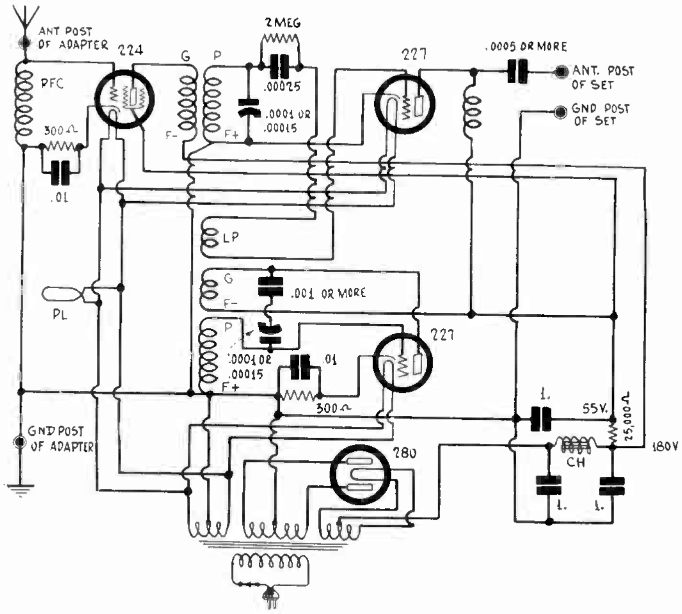

Fig. 11

A 4-Tube DX Design

Compact Assembly Brings 'em in Loud From Far Off

By Jack Tully

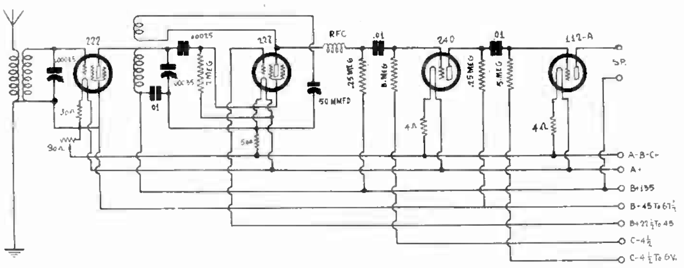

FIG. 1

CIRCUIT OF A GOOD PERFORMER IN THE FOUR-TUBE CLASS.

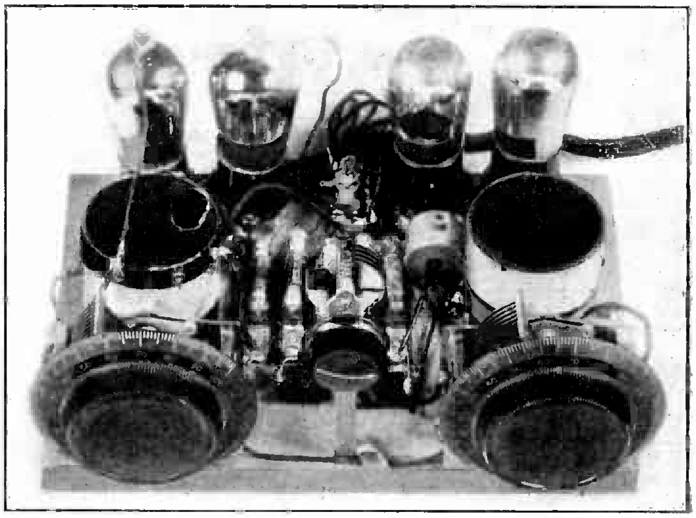

FIG. 2

VIEW OF THE WIRED RECEIVER.

THIS is the season when fans are looking around for small receivers to be used on camping trips and travel in general. Some of the essential characteristics of receivers to be used for these purposes are compactness, lightness of weight, good sensitivity, and moderate filament and plate requirements. While the ideal receiver for these purposes is one which operates effectively on a loop antenna, this requires so high radio frequency amplification that it becomes bulky and therefore unsuitable for the purpose. Therefore, when the essential characteristics enumerated above are to be met it becomes practically necessary to use an open circuit antenna.

The four-tube battery-operated receiver has always been a favorite among the fans, especially where there is regeneration in the circuit. Some of the finest distance records have been established with circuits of this type. Hence it seems timely to describe such a receiver, making it as light and compact, as is consistent with good results.

Selectivity is not one of the prime requisites in a receiver which might be used for entertainment in camp and on the road, but, of course, it should be as selective as possible without sacrificing sensitivity. In the simple receiver about to be presented the circuit has been arranged so that the optimum compromise has been effected between these two qualities.

Type of Tuner Used

The circuit contains two tuners, one being between the antenna and the first radio frequency amplifier and the other between this amplifier and the detector. Direct tuned impedance coupled is used because this gives the greatest sensitivity. A fixed tickler is used to provide regeneration, the degree of which is controlled by means of a 50 micro-microfarad midget condenser. The control of regeneration is exceptionally satisfactory in that the circuit may be set for extreme sensitivity, and selectivity as well, without any troublesome instability. It is possible to hold the circuit for an indefinite time at the most sensitive point for the reception of long distance stations. Part of this stability is due to the fact that the regeneration control condenser is grounded on that side which comes in contact with, or nearest to, the operating hand.

It will be observed that space-charge detection is used that the detector is followed by a resistance coupled audio amplifier. This combines the advantages of high sensitivity and good output quality. Not only that, but it also permits compact construction and a minimum weight. The output of the circuit is sufficient to operate a loudspeaker. This is true because the output tube is a 112A and the voltage amplifier ahead of that tube is a 240. In these days of multi-tube receivers it seems strange that this simple four-tube receiver should be so sensitive and capable of such output, but it is quite natural when one remembers the excellent four-tube receivers in the past.

It should not be assumed that this receiver is only suitable for camp or for traveling. It is equally suitable for home reception. Indeed, it was designed for this purpose. Hence it may be called a universal receiver, the universality referring to the places where it may be used rather than to the tuning range. It is strictly a broadcast receiver. When used in the home one has the advantage of using it with an outdoor antenna, which is recommended. The circuit retains its selectivity even on a long outdoor antenna because most of the selectivity results from the regeneration.

Care in Assembly

The arrangement of parts is shown in the picture, and great care should be exercised in the placement so that the compactness does not defeat the purpose of the set, that is, stable reception. The coils are placed sufficiently far apart so that the interaction between them will be negligible even when no shielding is used. The separation indicated in the picture is ample.

The wiring of the receiver is extremely simple, and all the leads are short as a result of the compactness. The tuning coils should be placed so that the grid ends are as far from the subpanel as practicable. This also makes the grid leads short, since they only have to run from the top of the coil to the top of the tube, or to the grid post on the socket in the case of the detector.

Those who wish to panel-mount the parts, a 7x12x1/8 inch bakelite or hard rubber panel should be obtained, with a subpanel of similar material. A wood sub-panel may also be used.

All the design constants are given on the circuit diagram with the exception of the tuning coils. Since the condensers are specified as .00035 mfd. capacity units the coils should be wound for these, for which standard coils are available.

While a magnetic speaker is recommended for traveling because of its simplicity, either as a dynamic or a magnetic may be used at home. As far as this statement is concerned an inductor dynamic is magnetic. Good home volume can be expected, and strange as this may seem, an even greater apparent volume can be obtained in a camp where everything is quiet. However, since the range of the set depends on the length of the antenna, and as only a short antenna can usually be used outdoors, a greater range may be expected at home.

Testing the Set

Since the receiver is very simple to wire there is no need of describing this phase of the work, except to call attention to the circuit diagram.

After the wiring has been completed a continuity test should be conducted with the aid of a voltmeter, preferably a high resistance meter, and a suitable battery. First connect a six-volt battery across the filament terminals and measure the voltages at each socket. Then insert the tubes and measure again. The voltage across either of the screen grid tube filaments should be approximately 3.3 volts and that across either of the other tubes should be 5 volts, or slightly less, down to 4½ volts. Of course, all the filaments should light.

Having tested the fiament circuit, remove the tubes and the battery and connect the B battery as specified at the binding posts. Now measure the voltages on the plates of the tubes. The voltages on the first and the last tubes should be practically equal to the applied voltages, assuming that the speaker has been connected, and the voltages on the plates of the other tubes should be very low. On these it is sufficient if an indication of voltage is obtained since the voltage is measured through the coupling resistons.

When the plate voltage has been tested the tubes may be inserted and the filament battery connected. Now test the set for signals. If all the work has been done carefully signals should roll in aplenty.

Forum

MANY articles on the construction and operation of receiving circuits designed for reception of the short waves have appeared from time to time in the pages of RADIO WORLD, many of which I have successfully constructed myself as I have been a reader since 1923, but an article dealing with the peculiarities of short waves, such as the rapid fading, distortion, skip effect and other phenomena encountered, has never to my knowledge appeared. One who has never had the opportunity of hearing how these signals are received, when operating a receiver for the first time will think that something serious is wrong with his receiver, even if the set is functioning perfectly, by the way signals are received. In operating my first short-wave receiver for the first time I was under the impression that it was a hopeless failure, and after rebuilding it many times, trying various sizes of grid leaks, and using different spacing and locations of the various components and doing everything else that I could think of to remedy what I thought a fault of the receiver, finally after hearing a relay of the English transmitter 5-SW from a local station two years ago, picked up by a receiver designed and built by a radio engineer whose name is familiar to almost every radio experimenter in the U. S. A., I learned that nothing was wrong with my set. This rapid fading, boiling, gushiness and what-not, encountered, in short-wave reception, was actually due to the way signals are received and not a fault of my set. I have since then built several short-wave receivers, even to a seven-tube Superheterodyne very successfully. An article in RADIO WORLD dealing with the peculiarities of short waves, written by a competent authority, would no doubt be a great benefit to many readers of your magazine, who are thinking that they have some trouble with their set from this cause.

The foreign relays through the networks are picked up with elaborate receiving equipment, with specially designed receiving antenna, and provisions for overcoming the rapid fading that causes the layman so much trouble, and antennas are located in places that have been found to be far better suited for distant reception than the locations found where the home-made short-wave receiver are used. Reception on a par with that obtained by RCA must not be expected from the average short-wave receiver.

It is very important that the receiving antenna used for short waves be very taut, so that it will not sway in the wind, as this on the lower wavelengths will ruin reception by causing severe swinging of the signals received and inability to control the oscillation.

It is very easy to obtain reception from broadcast stations 8,000 miles distant in good loudspeaker volume at the time or season of the year favorable for the signals to come through.

It is futile to attempt to tune in a very distant station after dark if this station is using a wavelength under 20 meters, and darkness in Winter is less likely to yield any DX than in Summer. I have been noticing the signals for the past two years of G-5-SW in England on 25.53 meters, and of PCJ at Eindhoven, Holland on 31.4 meters, and I am giving the times of best reception from these two transmitters in this locality, and being in touch with other fans in different parts of the country I find that this locality is no exception to this rule.

In favorable weather both of these stations are easily received at strong loudspeaker volume on a good four-tube receiver.

The transmissions of G-5-SW at Chelmsford, England, are made daily, except Saturday and Sunday, from 12.30 to 13.30 Greenwich Mean Time (7:30 to 8:30 A.M. Eastern standard time) and from 19.00 to 24.00 G. M. T. (2:00 to 7:00 P.M. E. S. T.) with an extra 2 hour program of records from 00.01 to 02.00 G. M. T. Tuesday and Thursday (7 to 9 P.M., Monday and Wednesday E. S. T.) The transmissions from 7:30 to 8:30 A.M. here are generally inaudible. At times the carrier wave can be heard and on rare occasions I have heard signals at readable strength at this period. During the months from October until March. The evening transmissions (2:00 until 7:00 P.M., E. S. T.) usually reach maximum strength around 3:00 P.M., and as the evening advances begin to grow weaker and by 5 P. M. are faded out entirely. There are rare exceptions to this rule, however, and during the months of February and October the signals generally hold good later in the evening than in the mid-Winter months. Exceptions to this rule occur as G-5-SW. gained in strength and was at strong loudspeaker volume on February 9th and 10th, 1930, at 7:00 P.M., E. S. T. During the months of April, May, September and October 5-SW reaches maximum strength at about 5:00 P. M., E. S. T. and often grows weaker as the evening advances.

During the mid-Summer months the signal always hold good until the station has signed off. The volume of the signal is considerably greater in the Spring and Summer months than in the Winter months. I have found that the same conditions prevail in the mid-west part of the United States and East of the Rocky Mountains.

The Atlantic States are better for reception and a good signal may be had in the Atlantic States while at the same time the signal here is poor. I have not had any reports from the West Coast covering any period of time. The great strength of 5-SW on February 9th and 10th was noted by a listener in Iowa who reported it to me, and I verified it by my own reception, an exception for that season of the year.

The signals of PCJ are seldom audible here in the Winter months, but in the Summer months are at good loudspeaker strength after 7:00 P.M., Eastern time.

The knack of DX tuning on the broadcast band is easily learned, as darkness and Winter months yield the desired DX. but the knack of DX tuning on the short-waves is learned only by long experience, as the best reception of any one particular wavelength varies considerably according to the season of the year, time of day and other causes.

Two stations from the same locality may be only separated by a few notches on the tuning dial, a difference of maybe four meters in wavelength, and while both can be received at good volume at certain times, the difference in wavelength might permit only one to be received at good strength, even though they were operating simultaneously, and either one could be well received at the time best for its particular frequency.

A short-wave station may be received at strong loudspeaker volume, and yet the signals may not be 100 per cent readable due to the prevalent gushiness or high-speed fading.

W-2-XAF has a terrific signal here, but often between 10 P.M. and 8 A.M. they are so weak as to be unintelligible owing to skip effect. Often signals fade and increase to maximum strength many times in a second's time, and have a tremulo effect from this cause, while again the steadiness of short-wave signals may rival that of signals from a good 700 kilocycle transmitter.

At times an echo may be heard in the signals of some distant short-wave transmitter. Near sunrise there is a marked change in reception of short-wave stations and a period of one hour may make a difference of an inaudible signal and a loudspeaker signal from a station 4,000 miles distant. This may be noticed on European stations around 16 meters which are inaudible before sunrise here, but become quite loud soon after sunrise, while stations in the vicinity of 30 meters can at times of the year be received at good strength after darkness, and at other times become inaudible at that time, owing to the season of the year.

I have a great amount of data on reception conditions in different parts of the world which I have accumulated by correspondence with many amateurs, in England, New Zealand and other countries. I have not time to write of this as it would require many pages.

I have been a reader of RADIO WORLD for several years, and this is my first letter to you, and the object is to ask you to publish an article or series of articles on the actual reception conditions of short wavelengths, as I believe that an article would be of immeasurable benefit to many who have constructed the various short-wave receivers that you have published, and would throw some light on the subject of short-wave reception, and not leave fans groping in the dark as to the proper time and season for DX tuning on the short wavelengths.

I think an article by one of your capable editorial staff on this subject would be of great benefit to readers who have not been initiated into short-wave reception and remove the doubt of some of them as to the results attainable with short-wave receivers.

I am glad to know that RADIO WORLD has not forsaken the experimenter and constructor, as some of our other magazines have done, and I hope that you will continue your present policy.

FRED EASTER,
3353 Southside Ave.,
Cincinnati, Ohio.

Literature Wanted

C. W. Sturz, 1812 Centre Ave., Brooklyn, N. Y.
R. E. Phillips, 326 S. 4th St., Sunbury, Pa.
Allan H. Saul, 98 Daniels Ave., Pittsfield, Mass.
A. W. Reynders, 119 So. Helen St., Sioux City. Iowa.
E. L. Marksbury, 1314 W. 14th St., Sioux City, Iowa.
Charles Aident, 415 S. Bond St., Baltimore, Md.
C. J. Stephens, 224 Gay St., Tamaqua, Pa.
K. Sargeant, 713 18th Ave. So., Nashville, Tenn.
Glenn E. Riepe, 654 W. 26th St., Des Moines, Iowa.
Edw. E. Maurer, 646 E. 162nd St., Cleveland, Ohio.
A. W. Berggren, 314 E. 164th St., New York City.
Roy C. Hammond, 2150 N. Halstead St., Chicago, Ill.
A. Kirby, 1569 Alexander Ave., Winnipeg, Man., Canada.
Alfred H. Lee, 412 E. 7th Ave., Tarentum, Pa.
A. O. McIntyre, Good Pine, La.
E. Davis, 3805 Morehead Ave., El Paso, Tex.
O. K. Weatherwax, 988 Spring St. N. W., Atlanta, Ga.
Vernon F. Johnson, 702 Boren Ave., Seattle, Wash.
B. C. McDuffie, 210 Morris St., Durham, N. C.
J. Carroll, 899 No. Snelling St., St. Paul, Minn.
John A. Rodal, Aguero 1262, Buenos Aires, Argentina.
O. D. Kennedy, 108 S. 13th Ave., Beech Grove, Ind.
Frank Ausman, Jr., 327 Ocean Center Bldg., Long Beach, Calif.
Alexander Vickers, 2119 Versailles Ave., McKeesport, Pa.
P. H. Rademacher, 6536 Union Ave., Chicago, Ill.
Geo. Evans, 2621 Ames St., Cheyenne, Wyo.
L. T. Tanton, 67 Cedar St., Halifax, N. S., Canada.
O. G. Farr, 414 E. Gorham St., Gainesville, Texas.
H. C. Williams, Box 896, Punta Gorda, Fla.
J. C. Black, Box 410, Temple, Texas
Howard Rosquist, 21-57 Hazen St., Jackson Heights, N. Y.
E. L. Welsh, 1740 Townsend, Detroit, Mich.
Sidney Goldberg, 145 Court St., Brooklyn, N. Y.
H. Palmer, 96 Hamilton St., Toronto, Ont., Canada.

U. S. and Canadian Stations by Frequency

Frequency Call, Location, Power and Time Sharers Given

LEGEND

Please observe the following code:

* *Channel shared by United States and Canada. The Canadian stations will be found following the United States stations of the same frequency. Expression "Kw" not used for Canada.*

** *Channel exclusively assigned to Canada.*

*** *Frequency change under consideration. See "List of Impending Changes," on page 24.*

CP—Construction permit authorized.

T —Transmitter location, specially given where it differs from main studio location.

Where two powers are given, larger is for daytime use.

Time-sharers are shown in parentheses for U. S. stations.

THE list of stations by frequency published herewith was corrected up to the moment of going to press. The list includes all broadcasting stations in the United States and Canada. The reason for consolidating them is that so many Canadian stations are tuned in that a United States list would require resort to a Canadian list to make the service complete, and that Canadian list might not be at hand.

Following the list of stations by frequency will be found a list of stations by call letters, alphabetically arranged. If the call letters are heard, ascertain the frequency from the second list and refer back to that frequency in the first list for details of location, power and time sharers.

550 KILOCYCLES, 555.6 METERS
WGR—Buffalo, N. Y. ....1 Kw.
T—Amherst, N. Y.
WKRC—Cincinnati, O. 500
KFUO—St. Louis, Mo. (KSD) ....500, 1 Kw.
KFUO—Clayton, Mo. ....500, 1 Kw.
KSD—St. Louis, Mo. (KFUO) 500
KFDY—Brookings, S. D. (KFYR) ....500, 1 Kw.
KFYR—Bismarck, N. D. (KFDY) 500
KOAC—Corvallis, Ore. ....1 Kw.

560 KILOCYCLES, 535.4 METERS
WLIT—Philadelphia, Pa. (WFI) 500
WFI—Philadelphia, Pa. (WLIT) 500
WQAM—Miami, Fla ....1 Kw.
KFDM—Beaumont, Texas ....500, 1 Kw.
KNOX—Knoxville, Tenn. ....1 Kw, 2 Kw.
WIBO—Chicago, Ill. (WPCC, WEBW) ....1 Kw.
T—Desplaines, Ill. ....1½ Kw.
WPCC—Chicago, Ill. (WIBO, WEBW) 500
WEBW—Beloit, Wis. (WIBO, WPCC) 500
KLZ—Denver, Colo. ....1 Kw.
KTAB—Oakland, Calif. ....1 Kw.

570 KILOCYCLES, 526.0 METERS
WNYC—New York, N. Y. (WMCA) 500
WMCA—New York City (WNYC) 500
T—Hoboken, N. J.
WSYR—Syracuse, N. Y. (WMAC) 250
WMAC—Cazenovia, N. Y. (WSYR) 250
WKBN—Youngstown, O. (WEAO) 500
WEAO—Columbus, O. (WKBN) 750
WWNC—Asheville, N. C. ....1 Kw.
KGKO—Wichita Falls, Tex. 250, 500
WSYR—Syracuse, N. Y. 250
WNAX—Yankton, S. D. ....1 Kw.
KXA—Seattle, Wash. 500
KMTR—Hollywood, Calif. 500

***580 KILOCYCLES, 516.9 METERS**
WTAG—Worcester, Mass. 250
WOBU—Charleston, W. Va. (WSAZ) 250
WSAZ—Huntington, W. Va. (WOBU) 250
KGFX—Pierre, S. D. 200
WIBW—Topeka, Kans. (KSAC) ....500, 1 Kw.
KSAC—Manhattan, Kans. (WIBW) ..500, 1 Kw.
CHMA—Edmonton, Alberta 250
CJCA—Edmonton, Alberta 500
CKUA—Edmonton, Alberta 500
CNRE—Edmonton, Alberta 500
CJBC—Toronto, Ontario 500
CJSC—Toronto, Ontario 500
CKCL—Toronto, Ontario 500
CKNC—Toronto, Ontario 500

590 KILOCYCLES, 508.2 METERS
WEEI—Boston, Mass. ....1 Kw.
T—Weymouth, Mass.
WEMC—Berrien Springs, Mich. ....1 Kw.
WCAJ—Lincoln, Nebr. (WOW) 500
WOW—Omaha, Nebr. (WCAJ) ....1 Kw.
KHQ—Spokane, Wash. (2KW) ....1 Kw.

***600 KILOCYCLES, 499.7 METERS**
WCAC—Storrs, Conn. (WGBS) 250
WCAO—Baltimore, Md. 250
WGBS—New York City (WCAC) 250
T—Astoria, L. I., N. Y. ....500, LS (Exp.)
WREC—Memphis, Tenn. (WOAN) 500
T—Whitehaven, Tenn. ....1 Kw.
WOAN—Lawrenceburg, Tenn. (WREC) 500
WMT—Waterloo, Iowa 500
KFSD—San Diego, Cal. ....1 Kw., 500
CFCH—Iroquois Falls, Ontario 250
CJRW—Fleming, Saskatchewan 500
CJRM—Moose Jaw, Saskatchewan 500

610 KILOCYCLES, 491.7 METERS
WJAY—Cleveland Ohio 500
WFAN—Philadelphia, Pa. (WIP) 500
WIP—Philadelphia, Pa. WFAN) 500
WDAF—Kansas City, Mo. ....1 Kw.
KFRC—San Francisco, Calif. ....1 Kw.

620 KILOCYCLES, 483.6 METERS
WLBZ—Bangor, Maine 500
WFLA—WSUN—Clearwater, Fla. .2½ Kw.,1 Kw.
WTMJ—Milwaukee, Wis. ....1 Kw., 2½ Kw.
T—Brookfield, Wis. ....2½ Kw.
KGW—Portland, Ore. ....1 Kw.
KTAR—Phoenix, Ariz. ....1 Kw., 500

***630 KILOCYCLES, 475.9 METERS**
WMAL—Washington, D. C. 500, 250
WOS—Jefferson City, Mo. (WGBF, KFRU) 1 Kw., 500
KFRU—Columbia, Mo. (WOS, WGBS) 500
WGBF—Evansville, Ind. (WOS, KFRU) 500
CFCT—Victoria, British Columbia 500
CNRA—Moncton, New Brunswick 500
CJGX—Yorkton, Saskatchewan 500

640 KILOCYCLES, 468.5 METERS
WAIU—Columbus, Ohio 500
WOI—Ames, Iowa ....5 Kw.
KFI—Los Angeles, Calif. ....5 Kw.

650 KILOCYCLES, 461.3 METERS
WSM—Nashville, Tenn. ....5 Kw.

660 KILOCYCLES, 454.3 METERS
WEAF—New York City ....50 Kw.
T—Bellmore, N. Y.
WAAW—Omaha, Neb. ....500—W

670 KILOCYCLES, 447.5 METERS
WMAQ—Chicago, Ill. ....5 Kw.
T—Addison, Ill.

680 KILOCYCLES, 440.9 METERS
WPTF—Raleigh, N. C. ....1 Kw.
KFEQ—St. Joseph, Mo. ....2½ Kw.
KPO—San Francisco, Cal. ....5 Kw.

690 KILOCYCLES, 434.5 METERS
CFAC, CFCN—Calgary, Alberta 500
CHCA, CJCJ, CNRC—Calgary, Alberta 500

700 KILOCYCLES, 428.3 METERS
WLW—Cincinnati, Ohio ....50 Kw.
T—Mason, Ohio

710 KILOCYCLES, 422.3 METERS
WOR—Newark, N. J. ....5 Kw.
T—Kearny, N. J.
KEJK—Beverly Hills, Calif. 500

720 KILOCYCLES, 416.4 METERS
WGN, WLIB—Chicago, Ill. ....25 Kw.
T—Elgin, Ill.

****730 KILOCYCLES, 410.7 METERS**
CHLS, CKCD—Vancouver, British Columbia 50
CKFC, CKMO—Vancouver, British Columbia ..50
CKWX—Vancouver, British Columbia 1000
CHYC—Montreal, Quebec 500
CKAC—Montreal, Quebec 1000
CNRM—Montreal, Quebec 1650

740 KILOCYCLES, 405.2 METERS
WSB—Atlanta, Ga. ....5 Kw.
KMMJ—Clay Center, Neb. ....1 Kw.

750 KILOCYCLES, 399.8 METERS
WJR—Detroit, Mich. ....5 Kw.

760 KILOCYCLES, 394.5 METERS
WJZ—New York, N. Y. ....30 Kw.
T—Boundbrook, N. J.
WEW—St. Louis, Mo. ....1 Kw.
KWI—Tacoma, Wash. ....1 Kw.
T—Des Moines, Wash.

770 KILOCYCLES, 389.4 METERS
KFAB—Lincoln, Nebr. (WBBM, WJBT) ..5 Kw.
WBBM, WJBT—Chicago, Ill. (KFAB) ...25 Kw.
T—Glenview, Ill.

***780 KILOCYCLES, 384.4 METERS**
WEAN—Providence, R. I. 500, 250
WTAR, WPOR—Norfolk, Va. 500
WMC—Memphis, Tenn. ....1 Kw., 500
(C. P. issued to move to Bartlett, Tenn.)
KELW—Burbank, Calif. (KTM) 500
KTM—Los Angeles, Calif. (KELW) 500
T—Santa Monica, Calif. ....1 Kw.
CKX—Brandon, Manitoba 500
CKY, CNRW—Winnipeg, Manitoba 5000

790 KILOCYCLES, 379.5 METERS
WGY—Schenectady, N. Y. ....50 Kw.
T—So. Schenectady, N. Y.
KGO—Oakland, Calif. ....7½ Kw.

800 KILOCYCLES, 374.8 METERS
WBAP—Ft. Worth, Tex. (WFAA) ....50 Kw.
T—Grapevine, Texas (Licensed at present for 5 Kw. only)
WFAA—Dallas, Tex. (WBAP) ....5 Kw., 50 Kw.
T—Grapevine, Texas
C. P. to increase pwr. to 50 Kw.

810 KILOCYCLES, 370.2 METERS
WPCH—New York, N. Y. 500
T—Hoboken, N. J.
WCCO—Minneapolis, Minn. ....7½ Kw.
T—Anoka, Minn.

*****820 KILOCYCLES, 365.6 METERS**
***WHAS—Louisville, Kentucky ....10 Kw.
T—Jeffersontown, Kentucky

830 KILOCYCLES, 361.2 METERS
WHDH—So. Boston, Mass. ....1 Kw.
T—Gloucester, Mass.
WRUF—Gainesville, Fla. ....5 Kw.
KOA—Denver, Colo. ....12½ Kw.

****840 KILOCYCLES, 356.9 METERS**
CHCT—Red Deer, Alberta 1000
CKLC—Red Deer, Alberta 1000
CFCA—Toronto, Ontario 500
CJB—Toronto, Ontario 1000
CKOW—Toronto, Ontario 500
CNRT—Toronto, Ontario 500

850 KILOCYCLES, 352.7 METERS
KWKH—Kennonwood, La. (WWL) ....10 Kw.
WWL—New Orleans, La. (KWKH) ....5 Kw.

860 KILOCYCLES, 348.6 METERS
WABC, WBOQ—New York City ....5 Kw.
T—West of Cross Bay Blvd., Queens Co.
C. P. issued to move & incr. pr. to 50 Kw.—LP
WHB—Kansas City, Mo. 500
KFQZ—Los Angeles, Calif. 250
T—Hollywood, Calif.
KMO—Tacoma, Wash. ....1 Kw., 500

870 KILOCYCLES, 344.6 METERS
WLS—Chicago, Ill. (WENR, WBCN) 5Kw., 50 Kw.
T—Crete, Ill.
WENR, WBCN—Chicago, Ill. (WLS) ....50 Kw.
T—Downers Grove, Ill.

***880 KILOCYCLES, 340.7 METERS**
WGBI—Scranton, Pa. (WQAN) 250
WQAN—Scranton, Pa. (WGBI) 250
WSUI—Iowa City, Iowa 500
KLX—Oakland, Calif 500
KPOF—Denver, Colo. (KFKA) 500
KFKA—Greeley, Colo. (KPOF) ....1 Kw., 500
CJCB—Sydney, N. S. 50
CHCS—Hamilton, Ontario 10
CHML—Hamilton, Ontario 50
CKOC—Hamilton, Ontario 50
CHRC—Quebec, Quebec 25
CKCI—Quebec, Quebec 22
CKCV, CNRQ—Quebec, Quebec 50

***890 KILOCYCLES, 336.9 METERS**
WJAR—Providence, R. I. 400, 250
WKAQ—San Juan, P. R. 500
WMMN—Fairmont, W. Va. 500, 250
WMAZ—Macon, Ga. (WGST) 500, 250
WGST—Atlanta, Ga. (WMAZ) 500, 250
KGJF—Little Rock, Ark. 250
WILL—Urbana, Ill. (KUSD, KFNF) 500, 250
KUSD—Vermillion, S. D. (WILL, KFNF) 750, 500
KFNF—Shenandoah, Iowa (WILL, KUSD) 1 Kw., 500
CFBO—St. John, New Brunswick 50

***890 KILOCYCLES, 336.9 METERS**
WFBL—Syracuse, N. Y. (WMAK) 750
(Also authorized to operate full time on 1490 kc—1 Kw.)
WMAK—Buffalo, N. Y. (WFBL) 750
T—Martinsville, N. Y.
WRDA—Buffalo, N. Y. ....1 Kw.
T—Orchard Park, N. Y. (C. P. only)
WKY—Oklahoma City, Okla. ....1 Kw.
WJAX—Jacksonville, Fla. ....1 Kw.
WLBL—Stevens Point, Wis. ....2 Kw.
KHJ—Los Angeles, Calif. ....1 Kw.
KSEI—Pocatello, Idaho 250
KGBU—Ketchikan, Alaska 500

****910 KILOCYCLES, 329.5 METERS**
CJGC—London, Ontario 500
CNRL—London, Ontario 500
CFQC—Saskatoon, Saskatchewan 500
CJHS—Saskatoon, Saskatchewan 250
CNRS—Saskatoon, Saskatchewan 500

920 KILOCYCLES, 325.9 METERS
WBSO—Wellesley Hills, Mass. 500, 250
WWJ—Detroit, Mich. ....1 Kw.
KPRC—Houston, Texas ....2½ Kw., 1 Kw.
T—Sugarland, Texas
WAAF—Chicago, Ill. 500
KOMO—Seattle, Wash. ....1 Kw.
KFEL—Denver, Colo. (KFXF) 500
KFXF—Denver, Colo. (KFEL) 500

***930 KILOYCLES, 322.4 METERS**
WIBG—Elkins Park, Pa. 50
WDBJ—Roanoke, Va. 500, 250
WBRC—Birmingham, Ala. ....1 Kw., 500
KGBZ—York, Nebr. (KMA) ....1 Kw., 500
KMA—Shenandoah, Ia. (KGBZ) ....1 Kw., 500
KFWI—San Francisco, Cal. (KFWM) 500
KFWM—Oakland, Calif. (KFWI) ....1 Kw., 500
T—Richmond Calif.
CHNS—Halifax, Nova Scotia 500
CKIC—Wolfville, Nova Scotia 50
CFRC—Kingston, Ont. 500
CKPC—Preston, Ont. 50

940 KILOCYCLES, 319.0 METERS
WCSH—Portland, Maine ....1 Kw., 500
WFIW—Hopkinsville, Ky. ....1 Kw.
WHA—Madison, Wis. 750
WDAY—W. Fargo, N. D. ....1 Kw
KOIN—Portland, Ode. ....1 Kw.
T—Sylvan, Ore.
KGU—Honolulu, T. H. ....1 Kw.

950 KILOCYCLES, 315.6 METERS
WRC—Washington, D. C. 500
KMBC—Kansas City, Mo. ....1 Kw.
T. Independence, Mo.
KFWB—Hollywood, Calif. ....1 Kw.
KGHL—Billings, Mont. 500

****960 KILOCYCLES, 312.3 METERS**
CJBC—Toronto, Ontario.
CFRB—Toronto, Ontario 4000
CFCY—Charlottetown, Prince Edward Island...250
CHCK—Charlottetown, Prince Edward Island ...30
CHWC—Pilot Butte, Saskatchewan 500
CJBR—Regina, Saskatchewan 500
CHCK—Regina, Saskatchewan 500
CNRR—Regina, Saskatchewan 500

970 KILOCYCLES, 309.1 METERS
WCFL—Chicago, Ill. ....1½ Kw.
KJR—Seattle, Wash. ....5 Kw.

980 KILOCYCLES, 303.9 METERS
KDKA—Pittsburgh, Pa. ....50 Kw.
T—Wilkins Twp., Pa.
C. P. issued to move near Saxonburg, Pa.

990 KILOCYCLES, 302.8 METERS
WBZ—Springfield, Mass (WBZA) ....15 Kw.
T—E. Springfield, Mass.
WBZA—Boston, Mass. (WBZ) 500

1000 KILOCYCLES, 299.8 METERS
WHO—Des Moines, Ia. (WOC)..............5 Kw.
WOC—Davenport, Ia. (WHO) ....5 Kw.
KFVD—Culver City, Calif. 250

***1010 KILOCYCLES, 296.9 METERS**
WQAO, WPAP—New York, N. Y. (WHN, WRNY) 250
T—Cliffside, N. J.
WHN—New York, N. Y. (WQAO, WPAP, WRNY) 250
WRNY—New York, N. Y. (WQAO, WPAP, WHN) 250
T—Coytesville, N. J.
KGGF—Picher, Okla. (WNAD) 500
WNAD—Norman, Okla. (KGGF) 500
WIS—Columbia, S. C. ....1 Kw., 500
(C. P. only)
CKCR—Waterloo, Ont. 50
CFLC—Prescott, Ont. 50
CKSH—St. Hyacinthe, Que. 50
KQW—San Jose, Calif. 500

*****1020 KILOCYCLES, 293.9 METERS**
WRAX—Philadelphia, Pa. 250
KYW, KFKX—Chicago, Ill. ....10 Kw.
T—Bloomingdale, Ill.

****1030 KILOCYCLES, 291.1 METERS**
CJOR—Sea Island, B. C. 50
CNRV—Vancouver, B. C. 500
CFCF—Montreal, Que 1650

*****1040 KILOCYCLES, 288.3 METERS**
WKEN—Buffalo, N. Y. ....1 Kw.
T—Grand Island, N. Y.
WKAR—East Lansing, Mich. ....1 Kw.
KTHS—Hot Springs National Park, Ark. (KRLD) ....10 Kw.
KRLD—Dallas, Tex. (KTHS) ....10 Kw.

1050 KILOCYCLES, 285.5 METERS
KFKB—Milford, Kansas ....5 Kw.
KNX—Hollywood, Calif. ....50 Kw., 5 Kw.
T—Los Angeles, Calif.

1060 KILOCYCLES, 282.8 METERS
WBAL—Baltimore, Md. (WTIC) ....10 Kw.
T—Glen Morris, Md.
WTIC—Hartford, Conn. (WBAL) ....50 Kw.
T—Avon, Conn.
WJAK—Norfolk, Nebr. ....1 Kw.
KWJJ—Portland, Ore. 500

*****1070 KILOCYCLES, 280.2 METERS**
WAAT—Jersey City, N. J. 300
(Day until 6 PM. but not after sunset at Cleveland, O.)
WTAM—Cleveland, Ohio ....50 Kw.
T—Brocksville Village, O.
WCAZ—Carthage, Ill. 50
WDZ—Tuscola, Ill. 100
KJBS—San Francisco, Calif 100

*****1080 KILOCYCLES, 277.6 METERS**
WBT—Charlotte, N. C. ....5 Kw.
WCBD—Zion, Ill. (WMBI) ....5 Kw.
WMBI—Chicago, Ill. (WCBD) ....5 Kw.
T—Addison, Ill.

*****1090 KILOCYCLES, 275.1 METERS**
KMOX, KFQA—St. Louis, Mo. .....50 Kw., 5 Kw.
T—Kirkwood, Mo.

1100 KILOCYCLES, 272.6 METERS
WPG—Atlantic City, N. J. (WLWL) ....5 Kw.
WLWL—New York City (WPG) ....5 Kw.
T—Kearny, N. J.
(6 P.M. to 8 P.M.)
KGDM—Stockton, Calif. 250, 50
(C. P. to incr. pwr. to 250 W—D)

*****1110 KILOCYCLES, 270.1 METERS**
WRVA—Richmond, Va. ....5 Kw.
T—Mechanicsville, Va.
KSOO—Sioux Falls, S. D. ....2 Kw.

***1120 KILOCYCLES, 267.7 METERS**
WDEL—Wilmington, Del. 350, 250
WDBO—Orlando, Fla. 500
WTAW—College Station, Tex. (KTRH) 500
KTRH (formerly KUT)—Austin, Texas.. (WTAW) (C. P. only)..........................500
WISN—Milwaukee, Wis. (WHAD) 250
WHAD—Milwaukee, Wis. (WISN) 250
KFSG—Los Angeles, Calif. (KMIC)............500
KRSC—Seattle, Wash. 50
KMIC—Inglewood, Calif. (KFSG) 500
CHGS—Sunnyside, Prince Edward Island........25
CJOC—Lethbridge, Alberta 50
CJRX—Middlechurch, Manitoba................2000
CFJC—Kamloops, British Columbia..............15

*****1130 KILOCYCLES, 265.3 MTERS**
WOV—New York City ....1 Kw.
T—Secaucus, N. J.
Daytime to 6 P.M.
WJJD—Mooseheart, Ill. ....20 Kw.
KSL—Salt Lake City, Utah ....5 Kw.

*****1140 KILOCYCLES, 263.0 METERS**
WAPI—Birmingham, Ala. (KVOO) ....5 Kw.
KVOO—Tulsa, Okla. (WAPI) ....5 Kw.

*****1150 KILOCYCLES, 260.7 METERS**
WHAM—Rochester, N. Y. ....5 Kw.
T—Victor Township

*****1160 KILOCYCLES, 258.5 METERS**
WWVA—Wheeling, W. Va. (WOWO)........5Kw.
WOWO—Ft. Wayne, Ind. (WWVA)........10 Kw.

*****1170 KILOCYCLES, 256.3 METERS**
WCAU—Philadelphia, Pa. ....10 Kw.
T—Byberry, Pa.
KTNT—Muscatine, Iowa ....5 Kw.

*****1180 KILOCYCLES, 254.1 METERS**
WDGY—Minneapolis, Minn. (WHDI).........1 Kw.
WHDI—Minneapolis, Minn. (WDGY)...........500
KEX—Portland, Ore. (KOB) ....5 Kw.
KOB—State College, N. M. (KEX) ....20 Kw.

1190 KILOCYCLES, 252.0 METERS
WICC—Bridgeport, Conn. 500
T—Easton, Conn.
WOAI—San Antonio, Tex. ....5 Kw.
C. P. issued to increase power to 50 Kw.

***1200 KILOCYCLES, 249.9 METERS**
WABI—Bangor, Maine 100
WCAT—Rapid City, S. D. 100
WNBX—Springfield, Vt. (WCAX) 10
WCAX—Burlington, Vt. (WNBX) 100
WORC—Worcester, Mass. 100
T—Auburn, Mass.
WIBX—Utica, N. Y. 300, 100
WFBE—Cincinnati, Ohio 100
WHBC—Canton, Ohio (WNBO) 10
(Sundays)
WLAP—Louisville, Ky. 30
WLBG—Petersburg, Va. 250, 100
T—Ettrick, Va.
WNBO—Washington, Pa. (WHBC) 100
(Sundays)
WEHC—Emory, Va. 100
WCOD—Harrisburg, Pa. (WKJC) 100
WKJC—Lancaster, Pa. (WCOD) 100
WNBW—Carbondale, Pa. 10
WABZ—New Orleans, La. (WJBW)............100
WJBW—New Orleans, La. (WABZ) 30
WBBY—Charleston, S. C. 75
WBBZ—Ponca City, Okla. 100
WFBC—Knoxville, Tenn. 50
WRBL—Columbus, Ga. 50
(C. P. only)
KBTM—Paragould, Ark. 100
WJBC—LaSalle, Ill. (WJBL) 100
WJBL—Decatur, Ill. (WJBC) 100
WWAE—Hammond, Ind. (WRAF) 100
WRAF—Laporte, Ind. (WWAE) 100
KFJB—Marshalltown, Ia. 250, 100
KGCU—Mandan, N. D. 100
WCAT—Rapid City, S. D. 100
KGDY—Oldham, S. D. 15
KFWF—St. Louis, Mo. (WMAY, WIL)........100
KGDE—Fergus Falls, Minn. 100, 50
KGFK—Hallock, Minn. 50
WCLO—Kenosha, Wis. 100
WHBY—Green Bay, Wis. 100
T—West De Perc, Wis.
WIL—St. Louis, Mo. (KFWF, WMAY)....250, 100
WMAY—St. Louis, Mo. (KFWF, WIL)...250, 100
KGFJ—Los Angeles, Calif. 100
KXO—El Centro, Calif. 100
KSMR—Santa Maria, Calif. 100
KWG—Stockton, Calif. 100
KGEK—Yuma, Colo. (KGEW) 50
KGEW—Ft. Morgan, Colo. (KGEK) 100
KFHA—Gunnison, Colo. 50
KVOS—Bellingham, Wash. 100
KGHI—Little Rock, Ark. 100
KGY—Lacey, Wash. 50, 10

***1210 KILOCYCLES, 247.8 METERS**
WJBI—Redbank, N. J. (WCOH, WGBB)....100
WGBB—Freeport, N. Y. (WCOH, WJBI)......100
WCOH—Yonkers, N. Y. (WJBI, WGBB)......100
T—Greenville, N. Y.
WOCL—Jamestown, N. Y. 25
WLCI—Ithaca, N. Y. 50
WPAW—Pawtucket, R. I. (WDWF, WLSI)....100
WDWF, WLSI—Providence, R. I. (WPAW).100
T—Cranston, R. I.
WMAN—Columbus, Ohio 50
WJW—Mansfield, Ohio 100
WEBE—Cambridge, Ohio 100
WBAX—Wilkes-Barre, Pa. (WJBU)............100
T—Plains Twp., Pa.
WJBU—Lewisburg, Pa. (WBAX) 100
WMBG—Richmond, Va. 100
WBBL—Richmond, Va. (WMBG) 100
WSIX—Springfield, Tenn. 100
WRBU—Gastonia, N. C. 100
WJBY—Gadsden, Ala. 50
(C. P. only)
KGMP—Elk City, Okla. 100
WRBQ—Greenville, Miss. 250, 100
WGCM—Gulfport, Miss. 100
T—Mississippi City, Miss.
Now Licensed.
KWEA—Shreveport, La. 100
KDLR—Devils Lake, N. D. 100
KGCR—Watertown, S. D. 100
KFOR—Lincoln, Nebr. 250, 100
WHBU—Anderson, Ind. 100
KFVS—Cape Girardeau, Mo. (WEBQ) 100
WEBQ—Harrisburg, Ill. (KFVS).................100
WSBC—Chicago, Ill. (WEDC, WCRW)........100
WCRW—Chicago, Ill. (WEDC, WSBC).........100
KGNO—Dodge City, Kansas 100
(C. P. only)
WEDC—Chicago, Ill. (WSBC, WCRW).........100
WCBS—Springfield, Ill. (WTAX) 100
WTAX—Streator, Ill. (WCBS) 50
WHBF—Rock Island, Ill. 100
WIBA—Madison, Wis. 100
WOMT—Manitowoc, Wis. 100
KMJ—Fresno, Calif. 100
KFXM—San Bernardino, Calif. (KPPC)........100
KDFN—Casper, Wyo. 100
KPPC—Pasadena, Calif. (KFXM) 50
CHWK—Challiwick, British Columbia 5
CFNB—Fredericton, New Brunswick 50
CFCO—Chatham, Ontario 50
CKMC—Cobalt, Ontario 15
CKPC—Preston, Ontario 50

1220 KILOCYCLES, 245.8 METERS
WCAD—Canton, N. Y. 500
WDAE—Tampa, Fla. ....1 Kw.
WCAE—Pittsburgh, Pa. ....1 Kw.
WREN—Lawrence, Kans. (KFKU) ......1 Kw.
KFKU—Lawrence, Kans. (WREN) ....1 Kw.
KWSC—Pullman, Wash. ....2 Kw., 500

1230 KILOCYCLES, 243.8 METERS
WAAC, WBIS—Boston, Mass. (T. Quincy, Mass.) ....1 Kw.
WPSC—State College, Pa. 500
WSBT—South Bend, Ind. (WFBM) 500
WFBM—Indianapolis, Ind. (WSBT) ....1 Kw.
KFIO—Spokane, Wash. 100
KGGM—Albuquerque, N. M. 500, 250
KYA—San Francisco, Calif. ....1 Kw.
KFQD—Anchorage, Alaska 100

1240 KILOCYCLES, 241.8 METERS
WGHP—Detroit, Mich. ....1 Kw.
KSAT—Fort Worth, Texas (WACO) ....1 Kw.
T—Birdsville, Texas
WACO—Waco, Texas (KSAT) ....1 Kw.

1250 KILOCYCLES, 239.9 METERS
WGCP—Newark, N. J. (WODA, WAAM) 250
KFMX—Northfield, Minn. ....1 Kw.
WODA—Paterson, N. J. (WGCP, WAAM) 1 Kw.
WAAM—Newark, N. J. (WODA, WGCP) 1 Kw., 2 Kw.
WDSU—New Orleans, La. ....1Kw.
WLB, WGMS—Minneapolis, Minn. (WRHM, KFMX, WCAL) ....1 Kw., 50
(C. P. to move locally and increase power to 1 Kw.
WRHM—Minneapolis, Minn. (WLB, KFMX, WCAL) ....1 Kw.
T—Fridly, Minn.
KFMX—Northfield, Minn. (WLB, WRHM, WCAL) ....1 Kw.
WCAL—Northfield, Minn. (WLB, WRHM, KFMX) ....1 Kw.
KFOX—Long Beach, Calif. ....1 Kw.
KIDO—Boise, Idaho ....1 Kw.

1260 KILOCYCLES, 238.0 METERS
WLBW—Oil City, Pa. ....1 Kw., 500
KWWG—Brownsville, Texas (KRGV).......500
WTOC—Savannah, Ga. 500
KRGV—Harlingen, Texas (KWWG).............500
KOIL—Council Bluffs, Ia. ....1 Kw.
KVOA—Tucson, Arizona 500

1270 KILOCYCLES, 236.1 METERS
WEAI—Ithaca, N. Y. 500
WFBR—Baltimore, Md. 250
WASH—Grand Rapids, Mich. (WOOD)........500
WOOD—Grand Rapids, Mich. (WASH) 500
T—Furnwood.
WJDX—Jackson, Miss. ....1 Kw., 500
KWLC—Decorah, Iowa (KGCA)................100
KGCA—Decorah, Iowa (KWLC).................50
KTW—Seattle, Wash. (KOL) ....1 Kw.
KOL—Seattle, Wash. (KTW) ....1 Kw.
KFUM—Colorado Springs, Colo...............1 Kw.

1280 KILOCYCLES, 234.2 METERS
WCAM—Camden, N. J. (WOAX, WCAP).....500
WCAP—Asbury Park, N. J. (WCAM, WOAX) 500
WOAX—Trenton, N. J. (WCAM, WCAP)......500
WDOD—Chattanooga, Tenn. ....2½ Kw., 1 Kw.
WRR—Dallas, Tex. 500
KFBB—Great Falls, Montana (KGIR).......1 Kw.

1290 KILOCYCLES, 232.4 METERS
WNBZ—Saranac Lake, N. Y......................50
WJAS—Pittsburgh, Pa. ....1 Kw.
T—North Fayette Twp., Pa.
KTSA—San Antonio, Texas (KFUL) 2 Kw., 1 Kw.
KFUL—Galveston, Texas (KTSA) 500
KLCN—Blytheville, Ark. 50
WEBC—Superior, Wis. ....2½ Kw., 1 Kw.
(C. P. to incr. pr. to 2½ Kw., L. S.)
KDYL—Salt Lake City, Utah ....1 Kw.

1300 KILOCYCLES, 230.6 METERS
WBBR—Rossville, N. Y. (WHAP, WEVD, WHAZ) ....1 Kw.
T—Staten Island.
WHAP—New York, N. Y. (WBBR, WEVD, WHAZ) ....1 Kw.
T—Carlstadt, N. J.
WEVD—New York, N. Y. (WBBR, WHAP, WHAZ) 500
T—Forest Hills, N. Y.
WHAZ—Troy, N. Y. (WBBR, WHAP, WEVD) 500
WIOD, WMBF—Miami Beach, Fla........1 Kw.
KFH—Wichita, Kansas (WOQ) ....1 Kw.
WOQ—Kansas City, Mo. (KFH) ....1 Kw.
KGEF—Los Angeles, Calif. (KTBI) ....1 Kw.
KTBI—Los Angeles, Calif. (KGEF).............750
KFJR—Portland, Oregon (KTBR) 500
KTBR—Portland, Oregon (KFJR) 500

1310 KILOCYCLES, 288.9 METERS
WKAV—Laconia, N. H. 100
WEBR—Buffalo, N. Y. 200, 100
WMBO—Auburn, N. Y. 100
WNBH—New Bedford, Mass. 100
WOL—Washington, D. C. 100
WGH—Newport News, Va. 100
WRK—Hamilton, Ohio 100
WAGM—Royal Oak, Mich. 50
WFDF—Flint, Michigan 100
WHAT—Phiadelphia, Pa. (WFKD).............100
WFKD—Philadelphia, Pa. (WHAT)...............50
WJAC—Johnstown, Pa. (WFBG) 100
WFBG—Altoona, Pa. (WJAC) 100
WRAW—Reading, Pa. (WCAL) 100
WGAL—Lancaster, Pa. (WRAW) 100, 15
(C. P. to 100 watts)
WSAJ—Grove City, Pa. 100
WBRE—Wilkes-Barre, Pa. 100
WKBC—Birmingham, Ala. 100
WRBI—Tifton, Ga. 20
WOBT—Union City, Tenn. 250, 100
WNBJ—Knoxville, Tenn. 50
KRMD—Shreveport, La. (KTSL) 50
KTSL—Shreveport, La. (KRMD)................100
T—Cedar Grove, La.
WSJS—Winston-Salem, N. C. 100
(C. P. only)
WCSC—Charleston, S. C. 250, 100
(C. P. only)
KFPM—Greenville, Texas 15
KTSM—El Paso, Texas (WDAH) 100
WDAH—El Paso, Texas (KTSM) 100
KFPL—Dublin, Texas 100
KFXR—Oklahoma City, Oklahoma 100
WKBS—Galesburg, Ill. 100
WCLS—Joliet, Ill. (WKBB)......................100
WKBB—Joliet, Ill. (WCLS) 100
KWCR—Cedar Rapids, Iowa (KFGQ, KFJY)..100
KFJY—Fort Dodge, Iowa (KFGQ, KWCR)..100
KFGQ—Boone, Iowa (KWCR, KFJY)...........100
KGFW—Ravenna, Nebr. 100
WBOW—Terre Haute, Ind. 100
WJAK—Marion, Ind. (WLBC) 50
WLBC—Muncie, Ind. (WJAK) 50
KGBX—St. Joseph, Missouri 100
(Does not operate when WOQ operates)
WIBU—Poynette, Wis. 100
KFIU—Juneau, Alaska 10
KFBK—Sacramento, Calif. 100

KGMC—Jerome, Ariz. 100
(C. P. only)
KGCX—Wolf Point, Mont. 250, 100
KGEZ—Kalispell, Mont. 100
KFUP—Denver, Colo. (KFXJ) 100
KFXJ—Edgewater, Colo. (KFUP) 50
KMED—Medford, Ore. 50
KXRO—Aberdeen, Wash. 75
KIT—Yakima, Wash. 50

1320 KILOCYCLES, 277.1 METERS

WADC—Tallmadge, Ohio ....1 Kw.
WSMB—New Orleans, La. 500
KGIQ—Twin Falls, Idaho (KID) 250
KGHF—Pueblo, Colo. 500, 250
KGMB—Honolulu, Hawaii 500
KID—Idaho Falls, Idaho (KGIQ)....500, 250

1330 KILOCYCLES, 225.4 METERS

WDRC—New Haven, Conn. 500
WSAI—Cincinnati, Ohio 500
T—Mason, Ohio
WTAQ—Eau Claire, Wis. (KSCJ) ....1 Kw.
T—Township of Washington, Wis.
KSCJ—Sioux City, Iowa (WTAQ) ..2½ Kw., 1 Kw.
KGAR—Tucson, Ariz. 250, 100
KGB—San Diego, Calif. 250

1340 KILOCYCLES, 223.7 METERS

WSPD—Toledo, Ohio ....1 Kw., 500
WCOA—Pensacola, Fla. 500
KFPY—Spokane, Wash. ....1 Kw., 500

1350 KILOCYCLES, 222.1 METERS

WBNY—New York, N. Y. (WMSG, WCDA, WKBQ) 250
WMSG—New York, N. Y. (WBNY, WCDA, WKBQ) 250
WCDA—New York City (WBNY, WMSG, WKBQ) 250
T—Cliffside Park, N. J.
WKBQ—New York City (WBNY, WMSG, WCDA) 250
KWK—St. Louis, Mo. ....1 Kw.

1360 KILOCYCLES, 220.4 METERS

WFBL—Syracuse, N. Y. ....1 Kw.
WMAF—S. Dartmouth, Mass. (WLEX, WSSH) 500
WLEX—Lexington, Mass. (WMAF, WSSH) 500
WQBC—Vicksburg, Miss. 300
WJKS—Gary, Ind. (WGES)....500, 1250
WGES—Chicago, Ill. (WJKS)....500, 1 Kw.
KFBB—Great Falls, Mont. (KGIR)....500, 1 Kw.
(C. P. to incr. pr. to 1 Kw.—L. S. on 1280 Kycs.)
KGIR—Butte, Mont. (KFBB) 500
KGER—Long Beach, Calif. (KPSN)..1 Kw., 250
KPSN—Pasadena, Calif. (KGER)....1 Kw.

1370 KILOCYCLES, 218.8 METERS

WQDM—St. Albans, Vermont (C.P. only)....5
WSVS—Buffalo, N. Y. 50
WPOE—Patchogue, N. Y. 100
WCBM—Baltimore, Md. 250, 100
WHBD—Mt. Orab, Ohio 100
WHDF—Calumet, Mich. 250, 100
(C. P. to increase power to 250)
WLEY—Lexington, Mass. 100
WJBK—Ypsilanti, Mich. (WIBM) 50
WIBM—Jackson, Mich. (WJBK) 100
WRAK—Erie, Pa. 50
WELK—Philadelphia, Pa. 100
WFDV—Rome, Ga. 100
WRBJ—Hattiesburg, Miss. 10
WHBQ—Memphis, Tenn. 100
WRBT—Wilmington, N. C. 100
KGFG—Oklahoma City, Okla. (KCRC)....100
KCRC—Enid, Oklahoma (KGFG)....250, 100
WMBR—Tampa, Florida 100
KGCI—San Antonio, Texas (KONO)....100
KONO—San Antonio, Texas (KGCI)....100
KGKL—San Angelo, Texas 100
KFLX—Galveston, Texas 100
WGL—Ft. Wayne, Indiana 100
WBTM—Danville, Virginia (WLVA)....100
(C. P. only)
WLVA—Lynchburg, Virginia (WBTM)....100
(C. P. only)
KGDA—Dell Rapids, S. D. 50
C. P. to move to Mitchell, S. D.
KFJM—Grand Forks, N. D. 100
KWKC—Kansas City, Missouri 100
WRJN—Racine, Wisconsin 100
KGAR—Tucson, Arizona 250, 100
(C. P. to incr. pr. to 250)
KOH—Reno, Nevada 100
KRE—Berkeley, California 100
KLO—Ogden, Utah 200, 100
KOOS—Marshfield, Ore. 100
KFBL—Everett, Wash. (KVL) 50
KVL—Seattle, Wash. (KFBL) 100
KFJI—Astoria, Ore. 100
KGFL—Raton, N. M. 50

1380 KILOCYCLES, 217.3 METERS

WSMK—Dayton, Ohio. (KQV) 200
KQV—Pittsburgh, Pa. (WSMK) 500
KSO—Clarinda, Ia. (WKBH) 500
WKBH—LaCrosse, Wis. (KSO) ....1 Kw.

1390 KILOCYCLES, 215.7 METERS

WHK—Cleveland, Ohio. T—Village of Seven Hills ....1 Kw.
KLRA—Little Rock, Ark. (KUOA)....1 Kw.
KUOA—Fayetteville, Ark. (KLRA) ....1 Kw.
KOY—Phoenix, Ariz. 500

1400 KILOCYCLES, 214.2 METERS

WCGU—Brooklyn, N. Y. (WSGH-WSDA, WLTH, WBBC) 500
WSGH-WSDA—Brooklyn, N. Y. (WCGU, WLTH, WBBC) 500
WLTH—Brooklyn, N. Y. (WCGU, WSGH, WSDA, WBBC) 500
WBBC—Brooklyn, N. Y. (WCGU, WSGH-WSDA, WLTH) 500
KOCW—Chickaska, Okla. 250, 500
WCMA—Culver, Ind. (WBAA, WKBF) 500
WKBF—Indianapolis, Ind. (WBAA, WCMA)..500
WBAA—W. Lafayette, Ind. (WCMA, WKBF) 500

1410 KILOCYCLES, 212.6 METERS

WBCM—Bay City, Mich. Hampton Twp., Mich. 500
WLEX—Lexington, Mass. 100
KGRS—Amarillo, Texas (WDAG)....1 Kw.
WMAF—South Dartmouth, Mass. (WELX, WSSH) 500
WODX—Mobile, Ala. (WSFA)....500
T—Springhill, Ala.
WSFA—Montgomery, Ala. (WODX)....500
(C. P. only)
WSSH—Boston, Mass. (WLEX, WMAF)....500
WDAG—Amarillo, Texas (KGRS) 250
KFLV—Rockford, Ill. (WHBL) ....500, 1 Kw.
WHBL—Sheboygan, Wis. (KFLV)....500

1420 KILOCYCLES, 211.1 METERS

WHDL—Tupper Lake, N. Y. 10
WMJR—Jamaica, N. Y. 10
WTBO—Cumberland, Md. 100, 50
WILM—Wilmington, Del. 100
WEDH—Erie, Pa. 30
WMBC—Detroit, Mich. 250, 100
WKBP—Battle Creek, Mich. 50
WHIS—Bluefield, W. Va. 100
WIBR—Steubenville, Ohio 50
WFDW—Talladega, Ala. 100
(C. P. only)
WJBO—New Orleans, La. 100
KTAP—San Antonio, Tex. 100
KTUE—Houston, Texas 100
KFYO—Abilene, Texas 250, 100
WSPA—Spartansburg, N. C. 250, 100
(C. P. only)
KICK—Red Oak, Iowa 100
WIAS—Ottumwa, Iowa 100
WLBF—Kansas City, Kans. 100
WMBH—Joplin, Mo. 250, 100
KLPM—Minot, N. D. 100
WEHS—Evanston, Ill. (WKBI, WHFC)....100
WHFC—Cicero, Ill. (WKBI, WEHS)....100
WKBI—Chicago, Ill. (WHFC, WEHS)....50
KFIZ—Fon du Lac, Wis. 100
KFXY—Flagstaff, Ariz. 100
KGIX—Las Vegas, Nev. 100
(C. P. only)
KFQU—Holy City, Calif. (KGGC)....100
KFXD—Jerome, Idaho 50
KGIW—Trinidad, Colo. 100
KGKX—Sandpoint, Idaho 100
KGGC—San Francisco, Calif. (KFQU)....50
KXL—Portland, Oregon (KFIF)....100
KFIF—Portland, Oregon (KXL) 100
KORE—Eugene, Ore. 100
KFQW—Seattle, Wash. 100

1430 KILOCYCLES, 209.7 METERS

WHP—Harrisburg, Pa. (WBAK, WCAH)....500
T—Lemoyne, Pa.
WBAK—Harrisburg, Pa. (WHP, WCAH) ....1 Kw., 500
WCAH—Columbus, Ohio (WHP, WBAK)....500
C. P. to incr. pr. to 1 Kw.
WGBC—Memphis, Tenn. (WNBR) 500
KGNF—North Platte, Nebraska 500
(C. P. only)
WNBR—Memphis, Tenn. (WGBC)....500
KECA—Los Angeles, Calif. ....1 Kw.

1440 KILOCYCLES, 208.2 METERS

WHEC-WABO—Rochester, N. Y. (WOKO)..500
WOKO—Poughkeepsie, N. Y. (WHEC-WABO).500
T—Mt. Beacon, N. Y.
WCBA—Allentown, Pa. (WSAN)....250
WSAN—Allentown, Pa. (WCBA) 250
WNRC—Greensboro, N. C. 500
WTAD—Quincy, Ill. (WMBD) 500
WMBD—Peoria Hgts., Ill. (WTAD)....1 Kw., 500
KLS—Oakland, Calif. 250

1450 KILOCYCLES, 206.8 METERS

WBMS—Hackensack, N. J. (See Note)....250
WHOM—Jersey City, N. J. (WBMS, WNJ, WKBO) 250
WNJ—Newark, N. J. 250
WKBO—Jersey City, N. J. 250
WSAR—Fall River, Mass. 250
(Note: WBMS, WNJ, WIBS and WKBO divide time with each other)
WCSO—Springfield, Ohio (WFJC) 500
WFJC—Akron, Ohio (WCSO) 500
WTFI—Toccoa, Ga. 500
KTBS—Shreveport, La. ....1 Kw.

1460 KILOCYCLES, 205.4 METERS

WJSV—Mt. Vernon Hills, Va. ....10 Kw.
KSTP—St. Paul, Minn. ....10 Kw.

1470 KILOCYCLES, 204.0 METERS

WTNT—Nashville, Tenn (WLAC)....5 Kw.
WLAC—Nashville Tenn. ....5 Kw.
KGA—Spokane, Wash. ....5 Kw.

1480 KILOCYCLES, 202.6 METERS

WKBW—Buffalo, N. Y. ....5 Kw.
T—Amherst, N. Y.
KFJF—Oklahoma City, Okla. ....5 Kw.

1490 KILOCYCLES, 201.2 METERS

WFBL—Syracuse, N. Y. ....1 Kw.
(Also operates ½ time with 750 w. on 900 kc.)
WCHI—
T—Deerfield, Ill. ....5 Kw.
WCKY—Covington, Ky. ....5 Kw.
WTNT—Nashville, Tenn. (WLAC)....5 Kw.
T—Crescent Springs, Ky.
WLAC—Nashville, Tenn. (WTNT)....5 Kw.
WORD—Chicago, Ill (WJAZ, WCHI, WCKY) ....5 Kw.
KPWF—Westminster, Calif. ....5 to 10 Kw.
(C. P. only)
WJAC—Mt. Prospect, Ill. (WORD, WCKY, WCHI) ....5 Kw.

1500 KILOCYCLES, 199.9 METERS

WMBA—Newport, R. I. 100
WLOE—Boston, Mass (WMES)....250, 100
T—Chelsea, Mass.
WMES—Boston, Mass. (WLOE) 50
WNBF—Binghamton, N. Y. 100, 50
(C. P. to incr. pr. to 100 w.)
WMBQ—Brooklyn, N. Y. (WLBX, WCLB, WWRL) 100
WCLB—Long Beach, N. Y. (WLBX, WMBQ, WWRL) 100
WLBX—Long Island City, N. Y. (WMBQ) WCLB, WWRL) 100
WWRL—Woodside, N. Y. (WMBQ, WLBX, WCLB) 100
WKBZ—Ludington, Mich. 50
WMPC—Lapeer, Mich. 100
WPEN—Philadelphia, Pa. 250, 100
WMBJ—Penntownship, Pa. 100
WOPI—Bristol, Tenn. 100
KGKY—Scottsbluff, Nebr. 100
(C. P. only)
KGFI—Corpus Christi, Tex. 100
KUT—Austin, Texas 100
KGKB—Brownwood, Texas 100
KTLC—Houston, Texas 100
WKBV—Connersville, Ind. 150, 100
KPJM—Prescott, Ariz. 100
KVEP—Portland, Ore. 15
KDB—Santa Barbara, Calif. 100
KREG—Santa Ana, Calif. 100
KUJ—Long View, Wash. 100
(½ time)
KGMD—Roswell, N. M. 100
(C. P. only)
KGIZ—Grant City, Mo. 50
(C. P. only)
KPCB—Seattle, Wash. 100
KPG—Wenatchee, Wash. 50

List of Impending Changes, Not Yet in Effect

[Stations marked (***) on list by Frequencies are under consideration for change in frequencies as follows:]

Station Location	*Present kc.*	*Proposed kc.*
WHAS—Louisville, Kentucky	820	1020
KYW—Chicago, Illinois	1020	1140
KTHS—Hot Springs, Arkansas } KRLD—Dallas, Texas }	1040	1070
WTAM—Cleveland, Ohio	1070	1080
WBT—Charlotte, North Carolina	1080	1040
KMOX—St. Louis, Missouri	1090	1110
WRVA—Richmond, Virginia	1110	1150
KSL—Salt Lake City, Utah	1130	1090
WAPI—Birmingham, Alabama	1140	1130
KVOO—Tulsa, Oklahoma	1140	1130
WHAM—Rochester, N. Y.	1150	1160
WOWO—Fort Wayne, Indiana	1160	1180
WWVA—Wheeling, West Virginia	1160	1180
WCAU—Philadelphia, Pa.	1170	820
KOB—State College, New Mexico	1180	1170
KEX—Portland, Oregon	1180	1170
WMBI—Chicago, Illinois	1080	1040

Following Proposed Changes Involve Limited Time and Day Transmission:

WCBD—Zion City, Illinois	1080	1040
WHDI—Minneapolis, Minn.	1180	1170
WDGY—Minneapolis, Minn.	1180	1170
WJJD—Mooseheart, Illinois	1130	1090
WKEN—Grand Island, N. Y.	1040	1160
WKAR—Lansing, Michigan	1040	830
WCAZ—Carthage, Illinois } WDZ—Tuscola, Illinois }	1070	No Change
KSOO—Sioux Falls, S. Dakota	1110	1100
KTNT—Muscatine, Iowa	1170	1160

List of Stations in U. S. and Canada by Call Letters

If you know the call letter, ascertain the frequency from this list, and obtain the rest of the information about the station from the List of Stations by Frequency:

CANADA

Station	kc
CFAC	690
CFBO	890
CFCA	840
CFCF	1030
CFCH	600
CFCN	690
CFCO	1210
CFCR	960
CFCT	630
CFCY	960
CFJC	1120
CFLC	1010
CFNB	1210
CFQC	910
CFRB	960
CFRC	930
CHCA	690
CHCK	960
CHCS	880
CHCT	840
CHGS	1120
CHLS	730
CHMA	580
CHML	880
CHNS	930
CHRC	880
CHWC	960
CHWK	1210
CHYC	730
CJBC	580, 840, 960, 690
CJBR	960
CJCA	580
CJCB	880
CJCJ	690
CJGC	910
CJGX	630
CJHS	910
CJOC	1120
CJOR	1030
CJRM	600
CJRW	600
CJRX	1120
CJSC	580
CKAC	730
CKCD	730
CKCI	880
CKCK	960
CKCL	580
CKCO	890
CKCR	1010
CKCV	880
CKCF	730
CKGW	690
CKIC	930
CKLC	840
CKMC	1210
CKMO	730
CKNC	580
CKOC	880
CKOW	840
CKPC	1210
CKPR	930
CKSH	1010
CKUA	580
CKWX	730
CKX	540
CKY	780
CNRA	630
CNRC	690
CNRD	840
CNRE	580
CNRL	910
CNRM	730
CNRO	600
CNRQ	880
CNRR	960
CNRS	910
CNRT	840
CNRV	1030
CNRW	780
CNRX	690

UNITED STATES

Station	kc
WAAF	920
WAAM	1250
WAAT	1070
WAAW	660
WABC	860
WBOQ	860
WABI	1200
WABZ	1200
WACO	1240
WADC	1320
WAGM	1310
WAIU	640
WAPI	1140
WASH	1270
WBAA	1400
WBAK	1430
WBAL	1060
WBAP	800
WBAX	1210
WBBC	1400
WBBL	1210
WBBM	770
WJBT	770
WBBR	1300
WBBY	1200
WBBZ	1200
WBCM	1410
WBMS	1450
WBNY	1350
WBOW	1310
WCLB	1500
WCLO	1200
WCLS	1310
WCMA	1400
WCOA	1340
WCOD	1200
WCOH	1210
WCRW	1210
WCSC	1310
WCSH	940
WCSO	1450
WDAE	1220
WDAF	610
WDAG	1410
WDAH	1310
WDAY	940
WDBJ	930
WDBO	1120
WDEL	1120
WDGY	1180
WDOD	1280
WDRC	1330
WDSU	1250
WDWF	1210
WLSI	1210
WDZ	1070
WEAF	660
WEAI	1270
WEAN	780
WEAO	570
WBRC	930
WBRE	1310
WBSO	920
WBT	1080
WBTM	1370
WBZ	990
WBZA	990
WCAC	600
WCAD	1220
WCAE	1220
WCAH	1430
WCAJ	590
WCAL	1250
WCAM	1280
WCAO	600
WCAP	1280
WCAU	1170
WCAX	1200
WCAZ	1070
WCBA	1440
WCBD	1080
WCBM	1370
WCBS	1210
WCCO	810
WCDA	1350
WCFL	970
WCGU	1400
WCHI	1490
WCKY	1490
WEBC	1290
WEBE	1210
WEBQ	1210
WEBR	1310
WEBW	560
WEDC	1210
WEDH	1420
WEEI	590
WEHC	1490
WEHS	1420
WELK	1370
WEMC	590
WENR	870
WBCN	870
WEVD	1300
WEW	760
WFAA	800
WFAN	610
WFBC	1200
WFBE	1200
WFBG	1310
WFBL	1360
WFBM	1230
WFBR	1270
WFDF	1310
WFDV	1370
WFDW	1420
WFI	560

Station	kc
WFIW	940
WFJC	1450
WFKD	1310
WFLA	620
WSUN	620
WGAL	1310
WGBB	1210
WGBC	1430
WGBF	630
WGBI	880
WGBS	600
WGCM	1210
WGCP	1250
WGES	1360
WGH	1310
WGHP	1240
WGL	1370
WGN	720
WLIB	720
WGR	550
WGST	890
WGY	790
WHA	940
WHAD	1120
WHAM	1150
WHAP	1300
WHAS	820
WHAT	1310
WHAZ	1300
WHB	860
WHBC	1200
WHBD	1370
WHBF	1210
WHBL	1410
WHBQ	1370
WHBU	1210
WHBY	1200
WHDF	1370
WHDH	830
WHDI	1180
WHDL	1420
WHEC	1440
WABO	1440
WHFC	1420
WHIS	1420
WHK	1390
WHN	1010
WHO	1000
WHOM	1450
WHP	1430
WIAS	1420
WIBA	1210
WIBG	930
WIBM	1370
WIBO	560
WIBR	1420
WIBU	1310
WIBW	580
WIBX	1200
WICC	1190
WIL	1200
WILL	890
WILM	1420
WIOD	1300
WMBF	1300
WIP	610
WIS	1010
WISN	1120
WJAC	1310
WJAG	1060
WJAK	1310
WJAR	890
WJAS	1290
WJAX	900
WJAY	610
WJAZ	1490
WJBC	1200
WJBI	1210
WJBK	1370
WJBL	1200
WJBO	1420
WJBU	1210
WJBW	1200
WJBY	1210
WJDX	1270
WJJD	1130
WJKS	1360
WJR	750
WJSV	1460
WJW	1210
WJZ	760
WKAQ	890
WKAR	1040
WKAV	1310
WKBB	1310
WKBC	1310
WKBF	1400
WKBH	1380
WKBI	1420
WKBN	570
WKBO	1450

Station	kc
WKBP	1420
WKBQ	1350
WKBS	1310
WKBV	1500
WKBW	1480
WKBZ	1500
WKEN	1040
WKJC	1200
WKRC	550
WKY	900
WLAC	1470
WLAP	1200
WLB	1250
WLBC	1310
WLBF	1420
WLBG	1200
WLBL	900
WLBW	1260
WLBX	1500
WLBZ	620
WLCI	1210
WLEX	1410
WLEY	1370
WLIT	560
WLOE	1500
WLS	870
WLTH	1400
WLVA	1370
WLW	700
WLWL	1100
WMAC	570
WMAF	1410
WMAK	900
WMAL	630
WMAN	1210
WMAQ	670
WMAY	1200
WMAZ	890
WMBA	1500
WMBC	1420
WMBD	1440
WMBG	1210
WMBH	1420
WMBI	1080
WMBJ	1500
WMBO	1310
WMBQ	1500
WMBR	1370
WMC	780
WMCA	570
WMES	1500
WMMN	890
WMPC	1500
WMRJ	1420
WMSG	1350
WMT	600
WNAC	1230
WBIS	1230
WNAD	1010
WNAX	570
WNBF	1500
WNBH	1310
WNBJ	1310
WNBO	1200
WNBR	1430
WNBW	1200
WNBX	1200
WNBZ	1290
WNJ	1450
WNOX	560
WNRC	1440
WNYC	570
WOAI	1190
WOAN	600
WOAX	1280
WOBT	1310
WOBU	580
WOC	1000
WOCL	1210
WODA	1250
WODX	1410
WOI	640
WOKO	1440
WOL	1310
WOMT	1210
WOOD	1270
WOPI	1500
WOQ	1300
WOR	710
WORC	1200
WORD	1490
WOS	630
WOV	1130
WOW	590
WOWO	1160
WPAW	1210
WPCC	560
WPCH	810
WPEN	1500
WPG	1100

Station	kc
WPOE	1370
WPSC	1230
WPTF	680
WQAM	560
WQAN	880
WQAO	1010
WPAP	1010
WQBC	1360
WODM	1370
WRAF	1200
WRAK	1370
WRAW	1310
WRAX	1020
WRBI	1310
WRBJ	1370
WRBL	1200
WRBQ	1210
WRBT	1370
WRBU	1210
WRC	950
WRDA	900
WREC	600
WREN	1220
WRHM	1250
WRJN	1370
WRK	1310
WRNY	1010
WRR	1280
WRUF	830
WRVA	1110
WSAI	1330
WSAJ	1310
WSAN	1440
WSAR	1450
WSAZ	580
WSB	740
WSBC	1210
WSBT	1230
WSFA	1410
WSGH	1400
WSDA	1400
WSIX	1210
WSJC	1310
WSM	650
WSMB	1320
WSMK	1380
WSPA	1420
WSPD	1340
WSSH	1410
WSUI	880
WSVS	1370
WSYR	570
WTAD	1440
WTAG	580
WTAM	1070
WTAQ	1330
WTAR	780
WPOR	780
WTAW	1120
WTAX	1210
WTBO	1420
WTFI	1450
WTIC	1060
WTMJ	620
WTNT	1470
WTOC	1260
WWAE	1200
WWJ	920
WWL	850
WWNC	570
WWRL	1500
WWVA	1160
KBTM	1200
KCRC	1370
KDB	1500
KDFN	1210
KDKA	980
KDLR	1210
KDYL	1290
KECA	1430
KEJK	710
KELW	780
KEX	1180
KFAB	770
KFBB	1280
KFBK	1310
KFBL	1370
KFDM	560
KFDY	550
KFEL	920
KFEQ	680
KFGQ	1310
KFH	1300
KFHA	1200
KFI	640
KFIF	1420
KFIO	1230
KFIU	1310
KFIZ	1420
KFJB	1200
KFJF	1480
KFJI	1370

Station	kc
KFJM	1370
KFJR	1300
KFJY	1310
KFKA	880
KFKB	1050
KFKU	1220
KFLV	1410
KFLX	1370
KFMX	1250
KFNF	890
KFOR	1210
KFOX	1250
KFPL	1310
KFPM	1310
KFPY	1340
KFQD	1230
KFQU	1420
KFQW	1420
KFRC	610
KFRU	630
KFDS	600
KFSG	1120
KFUL	1290
KFUM	1270
KFUO	550
KFUP	1310
KFVD	1000
KFVS	1210
KFWB	950
KFWF	1200
KFWI	930
KFWM	930
KFXD	1420
KFXF	920
KFXJ	1310
KFXM	1210
KFXR	1310
KFXY	1420
KFYO	1420
KFYR	550
KGA	1470
KGAR	1370
KGB	1330
KGBU	900
KBGX	1310
KGBZ	930
KGCA	1270
KGCI	1370
KGCR	1210
KGCU	1200
KGCX	1310
KGDA	1370
KGDE	1200
KGDM	1100
KGDY	1200
KGEF	1300
KGEK	1200
KGER	1360
KGEW	1200
KGEZ	1310
KGFG	1370
KGFI	1500
KGFJ	1200
KGFK	1200
KGFL	1370
KGFW	1310
KGFX	580
KGGC	1420
KGGF	1010
KGGM	1230
KGHF	1320
KGHI	1200
KGHL	950
KGIQ	1320
KGIR	1360
KGIW	1420
KGIX	1420
KGIZ	1500
KGJF	890
KGKB	1500
KGKL	1370
KGKO	570
KGKX	1420
KGKY	1500
KGMB	1320
KGMC	1310
KGMD	1500
KGMP	1210
KGO	790
KGNF	1430
KGNO	1210
KGRS	1410
KGU	940
KGW	620
KGY	1200
KHJ	900
KHQ	590
KICK	1420
KID	1320
KIDO	1250
KIT	1310
KJBS	1070

Station	kc
KJR	970
KLCN	1290
KLO	1370
KLPM	1420
KLRA	1390
KLS	1440
KLX	880
KLZ	560
KMA	930
KMBC	950
KMED	1310
KMIC	1120
KMJ	1210
KMMJ	740
KMO	860
KMOX	1090
KFOA	1090
KMTR	570
KNX	1050
KOA	830
KOAC	550
KOB	1180
KOCW	1400
KOH	1370
KOIL	1260
KOIN	940
KOL	1270
KOMO	920
KONC	1370
KOOS	1370
KORE	1420
KOY	1390
KPCB	1500
KPJM	1500
KPO	680
KPOF	880
KPPC	1210
KPQ	1500
KPRC	920
KPSN	1360
KPWF	1490
KOV	1380
KOW	1010
KRE	1370
KREG	1500
KRGV	1260
KRLD	1040
KRMD	1310
KRSC	1120
KSAC	580
KSAT	1240
KSCJ	1330
KSD	550
KSEI	900
KSL	1130
KSMR	1200
KSO	1380
KSOO	1110
KSTP	1460
KTAB	560
KTAP	1420
KTAR	620
KTBI	1300
KTBR	1300
KTBS	1450
KTHS	1040
KTLC	1500
KTM	780
KTNT	1170
KTRH	1120
KTSA	1290
KTSL	1310
KTSM	1310
KTUE	1420
KTW	1270
KUJ	1500
KUOA	1390
KUSD	890
KUT	1500
KVEP	1500
KVI	760
KVL	1370
KVOA	1260
KVOO	1140
KVOS	1200
KWCR	1310
KWEA	1210
KWG	1200
KWJJ	1060
KWK	1350
KWKC	1370
KWKH	850
KWLC	1270
KWSC	1220
KWWG	1260
KXA	570
KXL	1420
KXO	1200
KXRO	1310
KYA	1230
KYW	1020
KFKX	1020

Remember the wavelength in radio is always less than the velocity, as this aids in remembering a formula. Division is called for, hence wavelength equals the velocity divided by the only remaining known factor, the frequency.

Also, the velocity must exceed the frequency, which calls for multiplication. The only remaining factor is the wavelength. Think of velocity being fast, wavelength slow, as an arbitrary memory aid.

V is always a constant, expressed in meters (300,000,000) or kilometers (300,000). Wavelength and frequency are variable. Given the frequency (say, 1,000,000 cycles), we can determine the wavelength:

$$\lambda = \frac{300,000,000}{1,000,000} \text{ or } 300 \text{ meters}$$

by the formula already presented ($\lambda = V/f$).

Given the wavelength we can compute the frequency, since the frequency is the velocity divided by the wavelength:

$$f = V/\lambda$$

$$f = \frac{300,000,000}{300} = 1,000,000$$

It is well to learn these facts by heart.

High Efficiency Tuning Coils

Wound with non-insulated wire plated with genuine silver, on grooved forms, these coils afford high efficiency because of the low resistance that silver has to radio frequencies. The grooves in the moulded bakelite forms insure accurate space winding, thus reducing the distributed capacity, and keep the number of turns and separation constant. Hence the secondary reactances are identical and ideal for gang tuning.

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The three-circuit tuner has a center-tapped primary, also. This tuner is of the single hole panel mount, but may be mounted on a chassis, if preferred, by using the braced holes.

The secondaries are for .0005 mfd. tuning only. There are no models for .00035 mfd.

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115 Circuit Diagrams

of Latest Commercial Receivers and Power Supplies

SCHEMATIC diagrams of the latest factory-made receivers, giving the manufacturer's name and model number on each diagram, are now obtainable for the first time—including the most important screen grid receivers. These diagrams were collated by John F. Rider, author of "Trouble Shooter's Manual." The 115 diagrams, each in black and white on sheets 8½ x 11 inches, constitute a supplement to the diagrams contained in "Trouble Shooter's Manual."

There is no duplication of the diagrams that appear in the "Manual." The 115 diagrams are additional and being up-to-date the diagram presentation started in the "Manual."

Every Owner of "Manual" Need These Diagrams

YOU triple the value of "Trouble Shooter's Manual" by getting these 115 new diagrams of latest receivers and power supplies. Every service man needs all the diagrams he can get. Here is the list of 115 diagrams, known as Catalog SP-No. 1:

Audiola 30B and 7330 Screen Grid
Balkite Model F
Crosley 41A, 42 A.C.
Crosley 609, 610 A.C.
Crosley 20, 21, 22 screen grid
Crosley 30S, 31S, 33S screen grid
Crosley 804 A.C.
Crosley, 40S, 41S, 42S, 82S screen grid
Crosley 60S, 61S, 62S screen grid
Sonora Electric phonograph 7P
Sonora A30, A32
Sonora B31 screen grid
Sonora A36 Sonora A40 Sonora A44
Kennedy royal 80 Kennedy model 10
Kennedy model 20 screen grid
Stewart-Warner 900 A.C.
Stewart-Warner 950 battery screen grid
Stewart-Warner 950 A.C. screen grid
Stewart-Warner 950 D.C. screen grid
Automatic Electric model B screen grid
Radiola 44 screen grid
Radiola 47 screen grid Radiola 66
Majestic 90
Majestic 9P6 power unit
Majestic 9P3 power unit
Stromberg-Carlson 641 screen grid
Stromberg-Carlson 642 screen grid
Stromberg-Carlson 846 screen grid
Edison R1, R2 and C2
Edison R1, R2 and C2 (25 cycles)
Edison R4, R5 and C4
Parts list for Edison R4, R5 and C4
Edison C1
American Bosch 54 D.C. screen grid
Victor R32 and RE45
Grebe SK 4 A.C. screen grid (early model)
Grebe SK 4 A.C. screen grid (late model)
Grebe SK 4 D.C. screen grid
Grebe 428 DeLuxe console
Traveler A.C. power pack
Erla 224 A.C. screen grid
Silver-Marshall 30B screen grid
Silver-Marshall 30C screen grid
Silver-Marshall 30D screen grid
Silver-Marshall 30E screen grid
Eveready 1, 2, and 3 Eveready series 30
Eveready series 40
Eveready series 50 screen grid
Steinite 40, 50 and 102 Steinite 50 power unit
All American Mohawk 96 screen grid (60 cycle)
All American Mohawk 90 (25 cycle)
All American Mohawk 90 (60 cycle)
All American Mohawk 70, 73 and 75
Gulbranson Model C (early model)
Gulbranson Model C (late model)
Bremer-Tully 7-70 and 7-71
Bremer-Tully 81 and 82
Earl 21, 22 Earl 31, 32 Earl 41, 42
Philco 65 screen grid Philco 76 screen grid Philco 87
Philco 95 screen grid
Peerless Electrostatic series, screen grid
Fada 20 and 20Z Fada 22 battery
Fada 25 and 252 screen grid
Fada 25 and 25Z screen grid with M250 and M250Z Electric units
Fada 35 and 35Z screen grid Fada 75 and 77 screen grid
Brunswick 5 NC8 Radio Chassis Schematic
Brunswick 5 NC8 Audio Chassis Schematic
Brunswick 5 NC8 and 3 NC8 Audio Chassis Schematic
Brunswick 5 NC8 cabinet wiring
Brunswick 3 NC8 Radio Chassis Schematic
Brunswick 3 NC8 cabinet wiring
Brunswick S14, S21, S31, S81, S82 screen grid Radio Chassis Schematic
Brunswick S14, S21, S31, S81, S82 screen grid Radio Chassis Actual
Brunswick S14, S21, S81, S82 Audio Chassis Schematic (25 cycle)
Brunswick S14, S21, S81, S82 Audio Chassis Schematic (60 cycle)
Brunswick S14, S21, S81, S82 Audio Chassis Actual (25 cycle)
Brunswick S14, S21, S81, S82 Audio Chassis Actual (60 cycle)
Brunswick S31, Audio Chassis Schematic (60 cycle)
Brunswick S31 Audio Chassis Actual (60 cycle)
Brunswick 3 KR8 cabinet wiring
Brunswick 3 KR8 Radio Chassis
Brunswick 3 KR8 Audio Chassis Schematic
Brunswick 3 KR8 Audio Chassis Actual
Brunswick 5 NO Radio Chassis Schematic
Brunswick 5 NO Socket Power Schematic
Brunswick 5 NO Socket Power Actual
Brunswick 3 KR0 and 3 KR6 Radio Chassis
Brunswick 3 KR0 and 3 KR6 Socket Power
Brunswick 5KR, 5KRO, 2KRO Socket Power
Brunswick 5KR, 5KRO, 3KRO, 2KRO, 5KR6 Socket Power
Brunswick 5KR, 5KRO, 2KRO, 5KR6 Radio Chassis
Amrad Bel-Canto series
Sparton 89, Sparton 39A, Sparton 49
Sparton ensemble
Sparton 931, 301 D.C., Sparton 931 A.C.
Sparton 110 A.C., Sparton 301 A.C.

Here is an opportunity to obtain these hard-to-get wiring diagrams of modern radio receivers. The sheets are punched with three standard holes for loose-leaf binding. Each diagram is on a separate page. As you will see by glancing through the above list, these diagrams include the popular receivers of the day. Electrical constants are indicated on the majority of the diagrams and in many cases the actual chassis layouts are shown with color coding.

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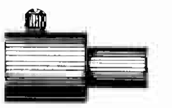

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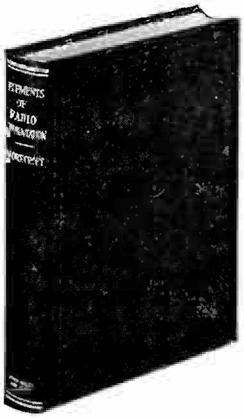

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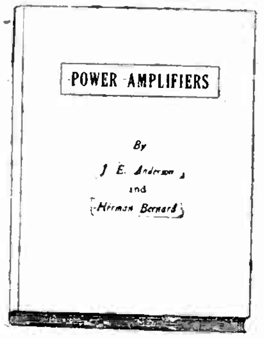

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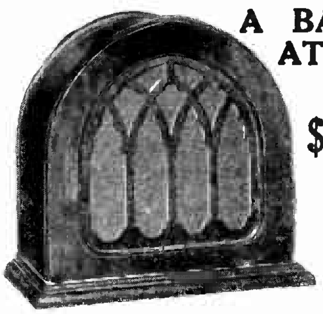

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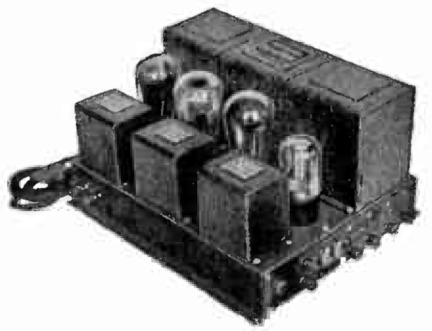

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