

July 16, 1929.

R. E. DE LAND

1,721,146

RADIO RECEIVING SYSTEM

Filed Aug. 31, 1927

2 Sheets-Sheet 1

Fig. 1

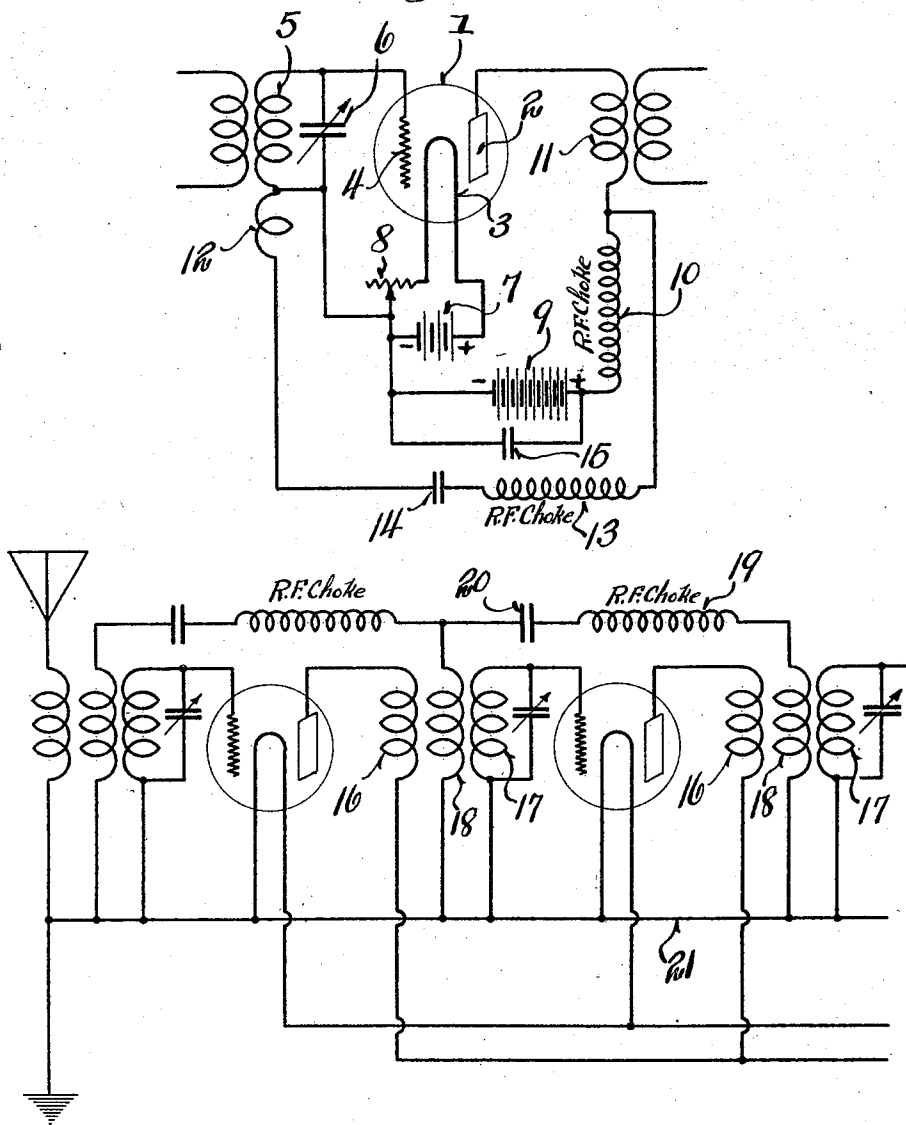


Fig. 2

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Fig. 3

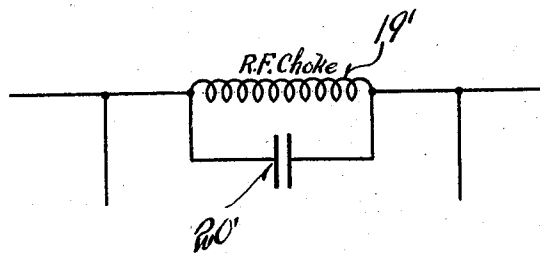
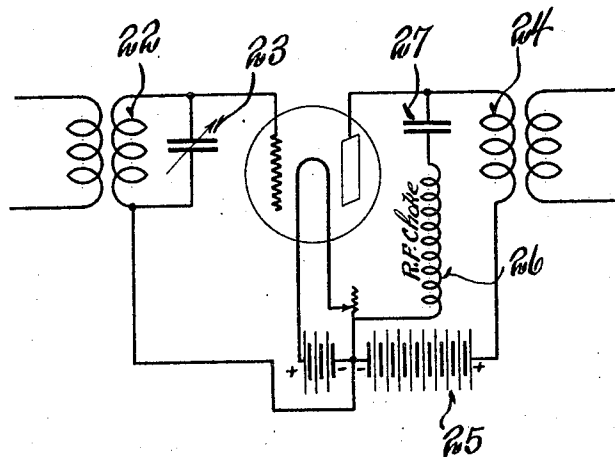


Fig. 4



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UNITED STATES PATENT OFFICE.

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RADIO RECEIVING SYSTEM.

Application filed August 31, 1927. Serial No. 216,676.

This invention relates to a radio receiving system.

In radio receiving systems, it is a well known fact that the interelectrode coupling furnished by the tube between the output and input circuits is such that a certain amount of energy is fed back from the output to the input circuit and the system is thrown into violent oscillation, particularly if an inductance is employed in both the plate and in the grid circuit or other resonant means used.

Attempts have been made to correct this defect by neutralizing the coupling through the tube, but it has been found that these attempts are unsatisfactory, for it is apparent that the coupling through the tube is greater for the high frequencies and lesser for the low frequencies. The balancing due to the neutralizing action of the devices added, must necessarily be where the greatest feed back occurs, namely, at the highest frequencies, and consequently, the coupling between the output and the input circuit is too great for the lower frequencies, and the set does not therefore operate at anywhere near its maximum efficiency over the entire range of frequencies but it is most efficient at one point only, and rapidly falls off as this point is passed.

This invention is designed to overcome the defects enumerated above, and objects of this invention are to provide a novel form of radio receiving system in which equal amplification over the entire active band of frequencies is obtained, in which an auxiliary circuit is provided which causes a feed back of energy from the output to the input circuits in gradually increasing amounts as the frequency decreases, and in which the total feed back due to the interelectrode coupling and the action of the auxiliary circuit is constant and independent of the frequency, or, in other words, to provide a system in which the algebraic sum of the energy fed back from the plate to the grid, and the energy fed back due to the auxiliary circuit, is of constant value.

In radio receiving systems as heretofore constructed, it is a recognized fact that the type of coils or inductances used must be of the highest quality with the minimum of distributed capacity. This necessarily increases the cost of the system. This invention, however, is designed for the use of very cheap coils which have a high distributed capacity

and, consequently, may be most cheaply constructed. The system itself utilizes the very defects of these coils to improve the overall efficiency of the set and to maintain constant amplification throughout the entire wave band as will appear in the detailed description following.

Further objects are to produce a system which may be very cheaply constructed, which may be readily tuned by an unskilled operator without any chance of throwing the set into oscillation, and which is so made that the maximum amplification, without throwing the set into oscillation, is obtained.

Embodiments of the invention are shown in the accompanying drawings in which:

Figure 1 is a diagrammatic view showing one form of the invention;

Figure 2 is a view showing another form thereof;

Figure 3 is a modification showing a different arrangement that may be employed with the form shown in connection with Figure 2, for instance;

Figure 4 is a further form of the invention.

Referring to Figure 1, it will be seen that a vacuum tube 1 has been illustrated as provided with the usual plate 2, filament 3, and grid 4. The grid circuit is tuned by means of the input coil 5 and variable condenser 6, or in any other suitable manner. The terminals of the tuned input circuit are connected to the grid and filament. The usual filament battery 7 is employed in connection with the filament controlling rheostat 8, if desired, and the usual B battery 9 is connected to the plate. This B battery is connected through a radio frequency choke 10 and an output coil 11, such for instance, as the primary of a radio frequency transformer.

An auxiliary circuit has one end connected to the point between the coil 11 and the choke 10. Its other end is connected through a coil 12 to the filament, or in other words, to one side of the coil 5. The coils 12 and 5 are in inductive relation, whereas the radio frequency choke 10 and the coil 11 are not in inductive relation. This auxiliary circuit includes a radio frequency choke 13 and a condenser 14.

One specific example of the values of the radio frequency chokes may be given, although it is to be distinctly understood that this is merely for the purpose of illustrating

tion and is not to be interpreted in any manner as limiting the invention. For example, in one form the radio frequency choke 10, which has both distributed capacity and inductance, may resonate at approximately 550 meters. The choke coil 13 in the auxiliary circuit may resonate at 150 meters, and it has distributed capacity, resistance, and inductance.

It is to be noted that the poorly constructed chokes have the same effect as parallel resonant circuits, as their distributed capacity and inductance are in parallel. Consequently, at their respective resonant frequencies they offer theoretically infinite impedance.

Assume now that a signal is being received in the low wave length range, or in other words, in the high frequency range. The coupling from the output circuit to the input circuit through the choke 13 and the condenser 14 is such that the energy flow through this auxiliary circuit is suppressed to a large degree, whereas the radio frequency energy flow through the choke 10, is comparatively free. This is due to the above noted fact that both the chokes 10 and 13 have considerable distributed capacity and also have resistance and inductance. They are not, therefore, sharply resonant at their resonant point, but instead are broadly resonant; that is to say, the resonant curve has a peak, but it is not a sharp peak. It gradually rises and thereafter gradually falls in the well known manner for a coil of this type.

It is apparent therefore that whenever the point of resonance of the coil 13 is approached that the energy flow through the auxiliary circuit is reduced to a marked degree and that as the frequency decreases, the resonant point for the coil 10 is approached, and such coil tends to suppress radio frequency energy flow therethrough, whereas the coil 13 permits an increasing amount to pass. The net result of this is that as the frequency decreases, the choke 10 suppresses more and more of the radio frequency energy and the choke 13 bypasses more and more of such energy.

It is apparent that the condenser 14 may be made variable, if desired, and may be adjusted for each set and thereafter fixed, determining the exact amount of energy fed back at any given frequency. If desired, a large bypass condenser 15 may be bridged around the batteries 7 and 9.

The radio frequency energy fed back is fed into the grid circuit or input circuit in gradually increasing amounts as the frequency decreases, or, in other words, as the wave length increases. It is apparent, therefore, that the coupling between the output and input circuit is so made that the algebraic sum of the energy fed back through the

interelectrode coupling of the tube and through the auxiliary circuit is constant, and is wholly independent of the frequency. Thus, the circuit may be adjusted for the maximum amplification possible without throwing the set into violent oscillation, and this relation will be maintained throughout the active band of radio frequencies for which the system is designed. The system, therefore, secures a constant amplification at all frequencies. There is, therefore, no falling off in amplification, as either end of the wave band is approached. The maximum output, therefore, or in other words, the maximum overall efficiency, is obtained by this system.

It is to be noted particularly that inasmuch as the radio frequency choke coils 10 and 13 are intended to be broadly resonant as distinguished from sharply resonant, that therefore cheap coils may be employed, which could not hithertofore be successfully used with the ordinary types of radio frequency amplifying sets. This very markedly reduces the cost of the system and also facilitates its production, for it is well known that the radio frequency chokes which have considerable distributed capacity and resistance, may be formed in a very compact manner, as no especial care is needed in their construction.

It is clear also that the condenser 14 may be either fixed or variable. The condenser after it has once been set, is left fixed throughout the entire operation of the set. Clearly, therefore, fixed condensers could be used, as well as variable ones for the condenser 14.

The system shown in Figure 2 discloses a plurality of stages which operate on the general principle disclosed in connection with Figure 1. However, this system differs from Figure 1 in that the input and output transformers for any given tube in the system consist of a primary 16, a secondary 17, and an auxiliary coil 18. The coils 18 are connected through a radio frequency choke 19 having resistance, distributed capacity, and inductance, and through a condenser 20. If desired, these coils may be connected in a continuous circuit from one end of the system to the other, as shown in Figure 2. The other end of each of the coils 18 is connected to the filament busbar 21. In other words, the coils 18 supply energy which is transferred from the output circuit to the input circuit through the medium of the radio frequency choke 19 and the condenser 20. If desired, the condensers 20 may be omitted or may be made variable.

A specific example for this form of the invention for ordinary broadcasting ranges, may be given. In this case, the coil 19 will resonate at 150 meters. It is to be noted that the coil 19 has distributed capacity, inductance

tance, and resistance and therefore acts as a parallel resonant circuit and offers, theoretically, infinite impedance at its resonant frequency. Consequently, the feed back increases as the frequency decreases. It is apparent also that the choke coil may be bridged by the condenser, if desired, as shown in Figure 3, in which the choke coil 19' is bridged by the condenser 20.'

In the form shown in Figure 3, the choke 19' and condenser 20', may have a resonant period jointly at approximately 150 meters, so that at this frequency the auxiliary circuit offers infinite impedance to the passage of radio frequency energy. However, as the frequency decreases and the wave length increases, more and more energy will be permitted to pass.

In the form shown in Figure 4, another method is employed to secure the results heretofore enumerated. In this form of the invention, the input circuit includes the coil 22 and variable condenser 23 which are connected to the grid and filament. The plate is connected through the output coil 24 to the B battery 25. A radio frequency choke 26 is connected through a condenser 27 directly between the plate and filament circuits.

A specific example used as illustrative only and not limiting may be given for this circuit. In the ordinary range of broadcasting frequencies, the radio frequency choke 26 may resonate at 550 meters. This radio frequency choke, similar to those previously described, has distributed capacity, inductance, and resistance, and is not sharply resonant, but is broadly resonant, so that as the critical frequency is approached, more and more retardation to the passage of radio frequency energy is offered, and as the critical frequency is departed from, less and less retardation of the passage of radio frequency energy is produced. Consider, for example, the operation of the system when receiving signals. When the frequency is relatively high, the bypass directly between the filament and plate bypasses a large amount of the radio frequency energy and as the frequency decreases and the wave length increases, the radio frequency choke offers greater and greater retarding action to the radio frequency energy and, consequently, increases the energy flowing through the tube due to interelectrode coupling between the output and the input circuits. In other words, the effect of this coil is to force more and more radio frequency energy back to the input

circuit as the frequency decreases and to bypass more and more of the radio frequency energy as the frequency increases. It also gradually increases the radio frequency energy flow through the coil 24 as the frequency decreases.

It is to be noted that in all forms of the invention the radio frequency chokes may be bridged by condensers in order to form parallel resonant circuits. However, as previously described, the poorly constructed radio frequency chokes really have sufficient distributed capacity to produce a parallel resonant circuit and these condensers are not ordinarily needed.

It will be seen, therefore, that a system of radio frequency amplification has been disclosed which gives an equal amplification throughout the entire band of wave lengths for which the system is designed.

Also, it is to be noted particularly that with this system, very cheap and poorly constructed radio frequency chokes may be used as their relatively high distributed capacity and resistance does not detract from their usefulness in this system, but instead these very characteristics are employed for producing the effects discussed above. Thus, the system may be constructed with relatively cheap instrumentalities and consequently the cost of production may be reduced to a very low amount.

Further than this, the resistance of the poorly constructed radio frequency chokes is utilized to produce the broadly resonant effect. This result may be enhanced by using resistance wire for the chokes, if desired.

Although the invention has been described in considerable detail, such description is intended as illustrative rather than limiting as the invention may be variously embodied and as the scope of such invention is to be determined as claimed.

I claim:

A radio receiving system comprising a vacuum tube having a grid, a filament and a plate, a coil connected to said plate and constituting an output element, a coil connected to said grid and constituting an input element, a pair of coils inductively related to the input and output elements and connected through a radio frequency choke and a condenser.

In testimony that I claim the foregoing I have hereunto set my hand at Milwaukee, in the county of Milwaukee and State of Wisconsin.

ROBERT E. DE LAND.