

Dec. 24, 1940.

M. G. CLAY

2,226,488

RADIO FREQUENCY REJECTOR CIRCUIT

Filed Nov. 24, 1937

2 Sheets-Sheet 1

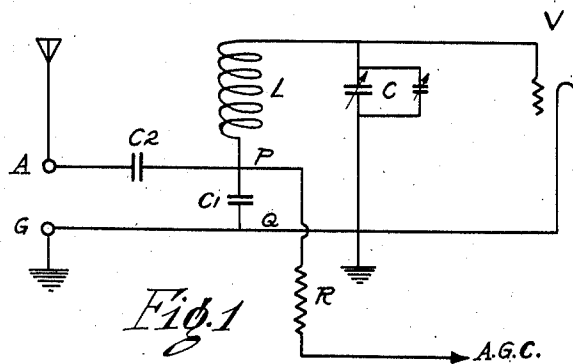


Fig. 1

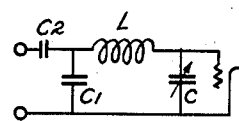


Fig. 1a

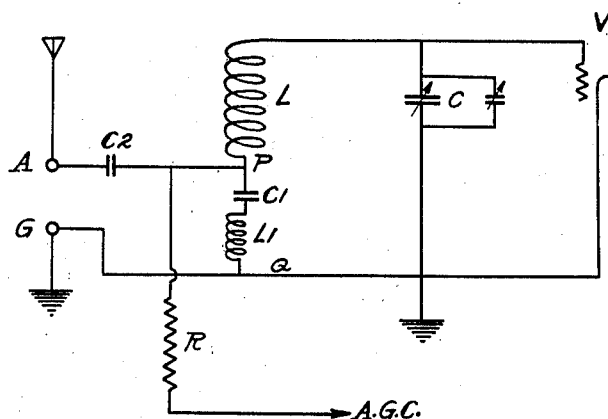


Fig. 2

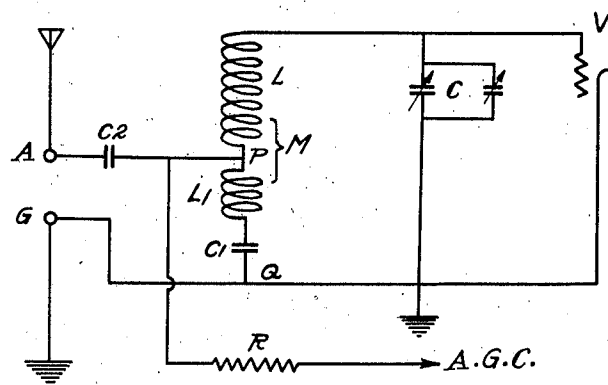


Fig. 3

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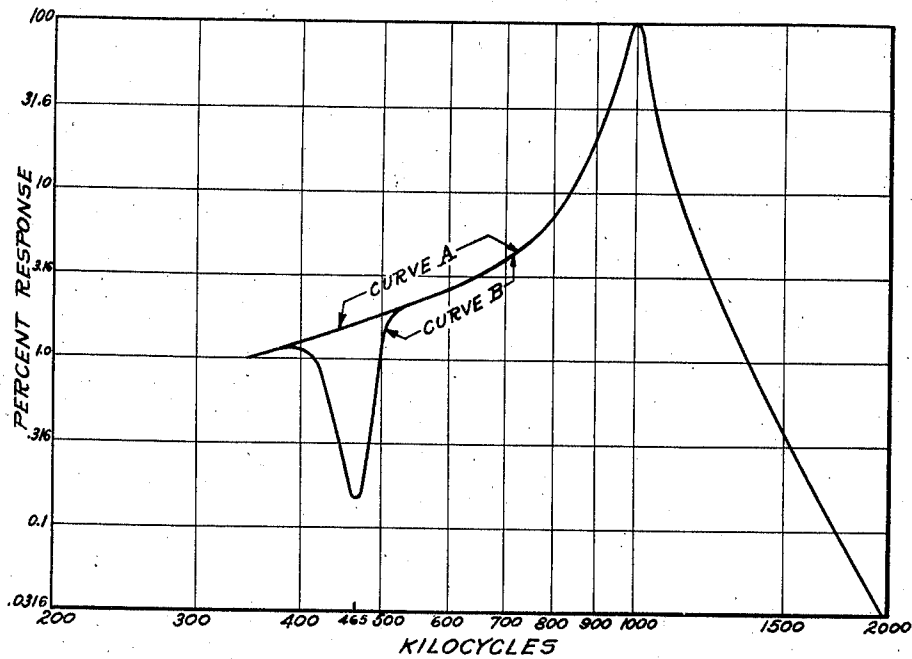
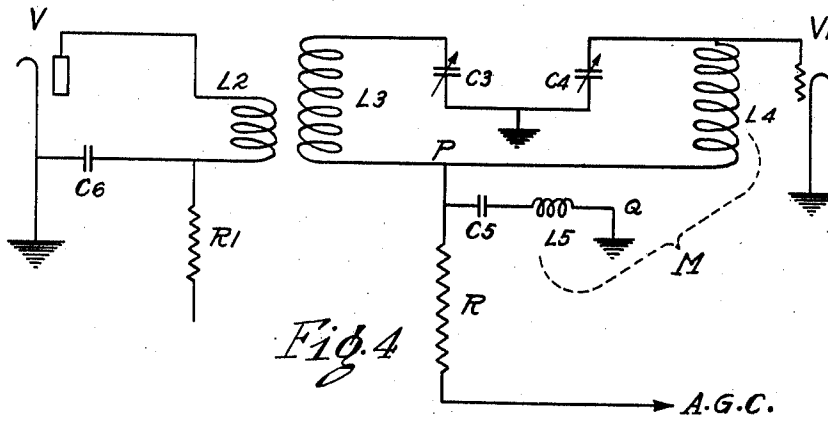
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2 Sheets-Sheet 2



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RADIO FREQUENCY REJECTOR CIRCUIT

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2 Claims. (Cl. 178—44)

My present invention relates to electrical tuned circuits and more particularly to a circuit for coupling such tuned circuits whereby desirable coupling characteristics are obtained over a wide band of frequencies but with substantially zero coupling at some selected frequency which may or may not be within the desired operating range of the system.

Heretofore simple circuits have been available for the purpose of coupling two or more oscillatory systems, but these circuits have not provided appreciable discrimination against certain unwanted signals which have sometimes been within, but have generally been outside of, the normal operating frequency range of the system. As a result of this, particularly in the case of the superheterodyne type receiver which embodies a fixed frequency amplifier of high gain following one or more tuned radio frequency selector circuits, strong undesired signals, generally close to the frequency of the fixed frequency amplifier in the case of the superheterodyne, get through to the detector after which they are amplified and reproduced from the loudspeaker.

Accordingly, it may be stated that the principal object of this invention is to provide a circuit arrangement whereby, in combination with certain practical coupling and tuning systems, interfering signals may be subjected to any desired degree of attenuation at any required frequency.

The novel features which I believe to be characteristic of my invention are set forth in particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, will best be understood by reference to the following description, taken in connection with the drawings, in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

Fig. 1 shows a conventional tuned radio frequency circuit coupled to an antenna system. This circuit is familiar to those acquainted with the prior art and is shown for the purpose of analyzing the present invention.

Fig. 1a illustrates schematically the fundamental circuit of Fig. 1;

Fig. 2 is similar to Fig. 1 except for the addition of one circuit element for the embodiment of the present invention in one of its aspects;

Fig. 3 is similar to Fig. 2 and represents an embodiment of the present invention in another of its aspects;

Fig. 4 shows a pair of tuned radio frequency circuits, which may or may not be band passed, embodying the present invention in still another of its aspects;

Fig. 5 is a graph which indicates qualitatively in "Curve A" the selectivity characteristic of the

system of the prior art shown in Fig. 1, while "Curve B" indicates one of the many possible selectivity characteristics obtainable from the use of the present invention.

Referring now to the accompanying drawings, wherein similar circuit elements are denoted by corresponding reference numerals and letters, it is first pointed out that the general purpose of the circuit arrangements to be hereinafter disclosed is to make it possible to reduce, or substantially eliminate, strong interfering signals (which may be, but generally are not, within the normal tuning range of the system) with the utmost simplicity and economy. In order to point out the features of the present invention whereby these objects are accomplished, there is shown in Fig. 1 a conventional tuned radio frequency circuit, of the prior art, coupled to an antenna system.

The inductance L is tuned mainly by the tuning condenser and trimmer C. However, a small portion of the total tuned impedance appears across the series condenser C1 which ordinarily has a capacity value at least ten times that of the tuning condenser, and is shunted with the reactance appearing at points P and Q due to the antenna system. Thus the antenna and the tuned circuit are coupled by the common impedance through P, Q which, at the resonant frequency of the tuned circuit, is nearly a pure resistance approximately equal to, but slightly less than,

$$Z_L \left(\frac{C}{C_1 + C} \right)$$

in which Z_L is the resonant impedance appearing across L. However, at frequencies considerably below the frequency to which the resonant circuit; L, C, and C1 is tuned, the antenna system "looks into" a capacitive reactance at P, Q, which is mainly due to C1, and which increases with decreasing frequency. Thus, as the input frequency is lowered, this antenna coupling system degenerates into the circuit of Fig. 1a which will be recognized as constituting a low-pass filter. C2 is a blocking condenser of high capacity which serves to prevent loss of automatic gain control (AGC) voltages in case the antenna becomes grounded. "Curve A" of Fig. 5, indicates qualitatively the response versus frequency characteristics which may be obtained with the circuit tuned to the middle of the American broadcast band. It should be noted that while the response falls off rapidly at points above resonance, below resonance the response falls off less rapidly approaching a constant value considerably above that obtained at the same frequency increment above resonance.

The circuit of Fig. 2 is different from that of Fig. 1, in that a small inductance L1 is added for the purpose of realizing the advantage of a

principle of the present invention. In this case the value of inductance L_1 is chosen to resonate with the capacity C_1 to some frequency which it is desired to attenuate. At this frequency the common impedance coupling the antenna system to the tuned circuit becomes a resistance the value of which is very much less than the reactance of the condenser C_1 , thus greatly reducing the coupling between the antenna and the grid circuits, resulting in an attenuation of the undesired frequency.

"Curve B" of Fig. 5 indicates qualitatively the response versus frequency characteristics which may be obtained, with this embodiment of the present invention, with the system tuned to the middle of the American broadcast band. Note that, while this curve is similar to the first mentioned curve over a considerable portion of its range, at some selected frequency the response dips to a considerably lower value.

As an example of a useful application of this invention in one of its practical aspects the following description is given:

A superheterodyne receiver having an "intermediate frequency" of 465 kilocycles was designed to cover a frequency range from 550 to 1500 kilocycles on one of its tuning bands. This receiver employed two tuned radio frequency circuits, the first of which was similar to that shown in Fig. 2 in which a value of 5,000 mmf. was chosen for capacitor C_1 as providing suitable antenna circuit "gain" in conjunction with the highly efficient secondary inductor used for L_1 . L_1 was then chosen to have a value of approximately 24 microhenries to resonate with C_1 to 465 kilocycles in order to considerably attenuate code signals and other forms of interference which would otherwise reach the converter stage with sufficient intensity to be amplified by the intermediate frequency amplifier which operated at 465 kilocycles.

In Fig. 3 is shown a modification of Fig. 2 representing a practical embodiment of the present invention in another of its aspects. In this case inductors L and L_1 are coupled to each other in order to produce the mutual inductance M . By suitable choice of the polarity of M and the magnitudes of M and L_1 , a voltage may be induced in L which is equal and opposite to that appearing across points P and Q at some selected frequency. A very great effective attenuation is readily attainable in this case since L_1 and C_1 act, as previously described, to greatly reduce the coupling between the antenna and the tuned circuit at the selected frequency, while, in addition, the small mutual induction M opposes the minute voltage which would otherwise remain.

In Fig. 4 are shown two tuned radio frequency circuits used to couple the output element of an electron discharge device V to the input element of a second electron discharge device V_1 . In this case tuned circuit L_3, C_3 is coupled to tuned circuit L_4, C_4 through the common impedance C_5, L_5 between the points P and Q . Here the two elements of the common coupling impedance are chosen to afford three desirable characteristics to the system as follows:

A. The product of C_5, L_5 is chosen to provide a minimum of coupling at some undesired frequency.

B. The value of C_5 is chosen to provide the

desired coupling at the low frequency end of the tuning range of the system, bearing in mind the fact that this also determines the value of L_5 .

C. The value of L_5 is chosen to provide the desired coupling at the high frequency end of the tuning range of the system, bearing in mind the fact that this also determines the value of C_5 .

A suitable compromise may have to be decided upon for steps B and C after step A has been determined. However, this coupling system is capable of endowing the overall characteristics of the two tuned circuits with any desired balance between the low and high frequency signal efficiencies and, furthermore, is capable of providing a considerable degree of attenuation at some selected frequency.

Again, in the case of Fig. 4, a small amount of mutual induction may be introduced between L_4 and L_5 , as indicated by the dotted bracket M ; a further aspect of the present invention. In this manner, as described in connection with Fig. 3, practically complete attenuation of signals at some selected frequency can be obtained.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What I claim is:

1. A coupling system for coupling the output of one electron discharge device to the input of another electron discharge device comprising a pair of tuned circuits tunable over a desirable frequency range and coupled to the output and input respectively of said electron discharge devices, coupling means for coupling said tuned circuits to each other comprising a capacity and an inductance in series and constituting a common impedance for said tuned circuits, said coupling impedance providing a minimum of coupling at some undesired frequency within the tuning range of said tuned circuit to attenuate said undesired frequency, said inductance of said common impedance being arranged to provide a predetermined amount of mutual induction with one of said tuned circuits to induce voltage in said tuned circuit equal to and opposite in phase to the undesired voltages remaining in the circuit.

2. A radio frequency coupling system for coupling a pair of tuned radio frequency circuits tunable over a desirable frequency range to each other comprising a capacity and an inductance in series and constituting a common impedance for said tuned circuits, said coupling impedance having an oscillation constant to resonate at some selected frequency to reduce the value of the common impedance at said frequency and provide a minimum of coupling of the undesired frequency within the tuning range of said tuned circuits and attenuate the undesired frequency, said inductance of said common impedance being arranged to provide a predetermined amount of mutual induction with one of said tuned circuits to induce voltage in said tuned circuit equal to and opposite in phase to the undesired voltages remaining in the circuit.

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