Dec. 26, 1933. N. P. HINTON 1,941,305

WIRELESS RECEIVING CIRCUIT

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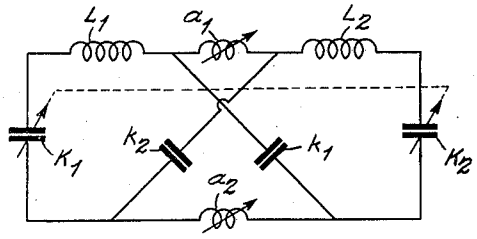


Fig. 1

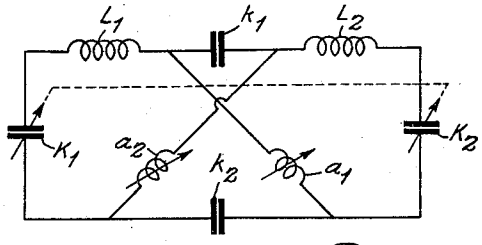


Fig. 2

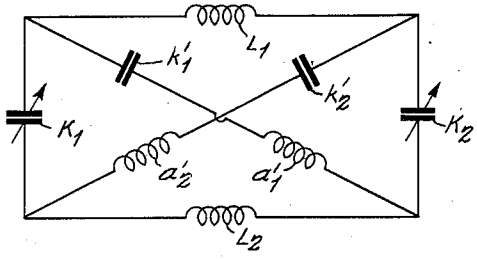


Fig. 3

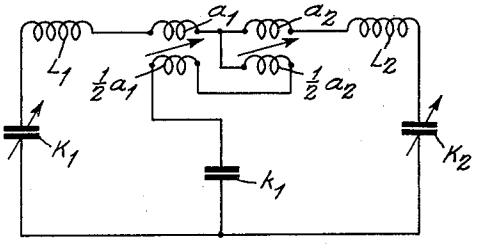


Fig. 4

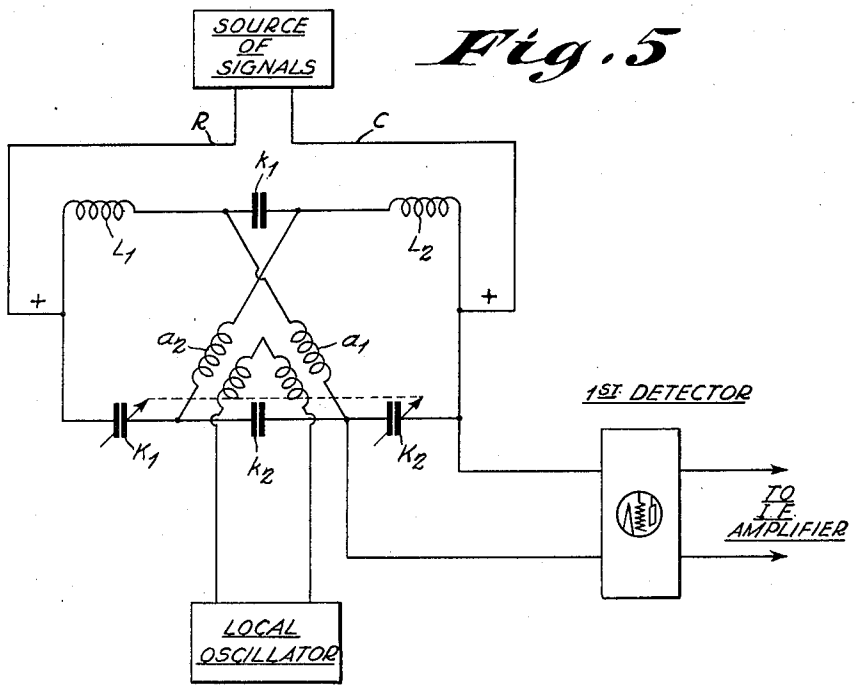


Fig. 5

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WIRELESS RECEIVING CIRCUIT

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1 Claim. (Cl. 250—20)

This invention relates to tunable resonant circuit arrangements, and has for its object to provide an improved tunable circuit arrangement suitable for use for tuning, for example, a wireless receiver. Though not limited to its application thereto the invention is particularly well suited to provide a tunable circuit arrangement, which may be controlled from a single control handle and which is adapted to give what may be termed a band pass response characteristic.

The invention may, also, be utilized to provide a coupling unit whereby two tuned circuits of ordinary construction and arrangement may be associated together in a complex circuit arrangement having band pass characteristics.

A further application of the invention is to superheterodyne receivers in which application the invention may be utilized to associate a local oscillator circuit with a high frequency receiving circuit in such manner as to provide a constant frequency difference (equal to the beat frequency of the receiver) throughout the tuning range of the receiver as a whole.

From its broadest aspect the invention provides a complex circuit arrangement capable of continuous adjustment throughout a tuning range, and having for each position of adjustment throughout that range two different resonant frequencies which are separated from one another by a predetermined frequency difference which frequency difference remains substantially constant (though the difference may be adjustable if desired) as the circuit arrangement is adjusted over its said range. The invention may be regarded as providing a complex circuit arrangement having the property just set forth by associating together two tuned circuits which are simultaneously tuned (gang controlled), the association being effected by means of a coupling unit of simple construction and arrangement and whereby the required constancy of frequency difference is obtained.

An important practical feature of the invention lies, therefore, in the provision of the coupling unit as a self-contained unit which may be manufactured and sold separately and which may be utilized to connect together two simple acceptor circuits having similar tuning reactances (tuning condensers) of any of the normal standardized types adapted for gang control. The acceptor circuits may be separately screened to prevent mutual inductance therebetween, and the coupling unit may be similarly screened. Where the said unit is manufactured for separate sale, it is preferably in the form of a screened unit having external terminals.

The main feature of the invention resides in the association together of two gang controlled tuned circuits by means of a coupling circuit, said tuned circuits in conjunction with added reactance provided by the coupling circuit constituting a complex circuit tunable by operation of a single handle and having for each position of tuning at least two resonant anodes of oscillation at two different frequencies, the whole arrangement being such that mutual inductance between the said tuned circuits is avoided, the required constancy of frequency difference being obtained without such mutual inductance and solely by virtue of the self-inductance and capacities of the reactance elements employed. This results in the important practical advantage that accurate calculation and design and manufacture from such design is a comparatively simple matter; which, of course, is not the case in arrangements depending upon mutual inductance effects which change quantitatively with frequency.

In carrying the invention into practice as applied to band pass tunable filter arrangements, such as are frequently required in radio receivers so as to tune said receivers to any desired radio transmitting station within the range thereof, a constant width of frequency band (e. g. that corresponding to the modulation side bands necessary for good quality musical reproduction) may be arranged for; or, by making the coupling circuit adjustable, an adjustment of the band width may be provided for.

The invention is illustrated in the accompanying diagrammatic drawing in which various arrangements in accordance therewith are shown.

In the drawing,

Fig. 1 shows one embodiment of the invention,

Figs. 2, 3, 4 respectively show different modifications of the arrangement of Fig. 1,

Fig. 5 shows the application of the arrangement of Fig. 2 to a superheterodyne receiver.

Referring to Fig. 1 this shows a circuit arrangement consisting of two equal variable condensers K_1 and K_2; two equal fixed inductances L_1 and L_2; two equal fixed condensers k_1 and k_2; and two further equal variable inductances a_1 and a_2. As will be seen the condenser K_1 is connected at one end to the inductance L_1, and the condenser K_2 is similarly connected at one end to the inductance L_2. The remaining end of L_2 is connected to the remaining end of K_1 through the condenser k_2, and the remaining end of L_1 is connected to the remaining end of K_2 through the condenser k_1.

The inductance a_1 is connected between the ends of L_1 and L_2 remote from the condensers K_1 and K_2, and the inductance a_2 is connected between the other sides of the two condensers K_1 K_2. As will be seen, at one particular frequency, namely that at which K_1 and (L_1+a_1) resonate with one another (K_2 will, of course, resonate with (L_2+a_2) at the same frequency), minimum potentials will exist across the series

tuned circuits (L_1+a_1) and K_1 and (L_2+a_2) and K_2, and it is for this reason that the condensers k_1 and k_2 may be connected across the points indicated.

These condensers K_1 K_2 are the tuning condensers, and are adjusted together (ganged) for tuning. The inductances a_1 a_2 are small relative to the main inductances L_1 and L_2. The whole circuit shown in Fig. 1 has two modes of oscillation, namely around the series loop consisting of K_1 L_1 a_1 L_2 K_2 a_2, and, also, in a figure of eight circuit through K_1 L_1 k_1 K_2 L_2 k_2 back to K_1. The wave length for the first, or series, mode of oscillation will be proportional to:

$$\sqrt{(L_1+a_1)K_1}=\sqrt{(L_2+a_2)K_2} \qquad (1)$$

while for the parallel, or figure of eight, mode of oscillation the wave length will be proportional to:

$$\sqrt{L_1\left(\frac{K_1k_1}{K_1+k_1}\right)}=\sqrt{L_2\left(\frac{K_2k_2}{K_2+k_2}\right)} \qquad (2)$$

In Fig. 1 the coupling circuit consists of the numbers a_1 a_2 k_1 k_2, and this circuit may be manufactured and sold separately as a self-contained screened unit having four external terminals.

Fig. 2 shows a slight modification of the arrangement shown in Fig. 1, the modification consisting in changing the positions of those inductances and condensers indicated by small reference letters. In the case of Fig. 2, the wave length obtained for the series mode of oscillation will be proportional to the quantity (2), above given for the wave length obtained for the figure of eight mode of oscillation in Fig. 1, while the wave length obtained for the figure of eight mode of oscillation in Fig. 2 will be proportional to the quantity (1) which expresses the wave length for the series mode of oscillation in Fig. 1. As in Fig. 1 the coupling circuit, which may be made as a screened and separate unit, consists of the members a_1 a_2 k_1 k_2. In the arrangements of Figs. 1 and 2 the band width may be adjusted by adjusting the values of a_1 and a_2, and in the case of separate unit construction these reactances may be similarly tapped and arranged to be adjustable from a common handle.

Fig. 3 shows a further modification to which neither additional inductances nor additional condensers are included in the circuit through which the series mode of oscillation occurs, but instead two circuits, each consisting of an inductance a'_1 in series with a condenser k'_1 or a'_2 in series with a condenser k'_2, are connected diagonally across the said series circuit as shown in the said Fig. 3. The circuit of Fig. 3 will again have two modes of oscillation, one, the series mode through K_1 L_1 L_2 and K_2, and the other the parallel or figure of eight mode through K_1 a'_2 k'_2 K_2 a'_1 k'_1.

In the series mode the wave length will be proportional to:

$$\sqrt{L_1K_1}=\sqrt{L_2K_2} \qquad (3)$$

while in the figure of eight mode, the wave length will be proportional to:

$$\sqrt{a'_1\left(\frac{K_1k'_1}{K_1+k'_1}\right)}=\sqrt{a'_2\left(\frac{K_2k'_2}{K_2+k'_2}\right)} \qquad (4)$$

In Fig. 3, $L_1=L_2$, and $K_1=K_2$ as before, while $a'_1=a'_2$ and $k'_1=k'_2$. a'_1, is, however, only slightly smaller than L_1 the difference in magnitude between these inductances being determined by the frequency difference required between the frequencies obtained at the two modes of oscillation. The coupling circuit is, therefore, not so advantageous as are the coupling circuits of Figs. 1 and 2 from the point of view of general use as a unit for separate sale, since in Fig. 3 a'_1 and a'_2 are co-related in value (for a given band width) with L_1 and L_2, whereas in Figs. 1 and 2, a_1 and a_2 determine the band width irrespective of L_1 and L_2.

Throughout Figs. 1 to 3 no mutual inductance exists between any two inductances. It is possible, however, in carrying out the invention to magnetically couple together the inductances additional to the main inductances, provided that the resultant inductance is equal to the separate additional inductances as set forth above, i. e. what may be termed the calculated additional inductances. The additional inductances may in practice be mounted in the same housing or screening box employed for the main inductances, provided that either, or both, are wound astatically and so arranged that substantially no voltage is induced from one into the other.

Fig. 4 shows a still further modification wherein a series loop circuit consisting of a condenser K_1, a main inductance L_1, an added small inductance a_1, a second added small inductance a_2, a main inductance L_2 and a condenser K_2 is provided, the circuit being symmetrically bridged across by a series circuit consisting of two further small inductances designated $\frac{1}{2}a_2$ and $\frac{1}{2}a_1$ respectively, and a condenser k_1, the added inductances $\frac{1}{2}a_1$ $\frac{1}{2}a_2$ being equal each to half the magnitude of a_1 or a_2. The inductance $\frac{1}{2}a_2$ is very tightly coupled to the inductance a_2 and the inductance $\frac{1}{2}a_1$ is also very tightly coupled to the inductance a_1. As will be seen the inductances $\frac{1}{2}a_1$ and $\frac{1}{2}a_2$ will carry twice the current that the inductances a_1 and a_2 carry when the whole arrangement oscillates in the bridge mode, and, therefore, for this mode of oscillation the effects produced by the inductances a_1 and a_2 cancel out, while in the series mode of oscillation equal and opposite electromotive forces will be induced in the inductances $\frac{1}{2}a_1$ $\frac{1}{2}a_2$, and no voltage is produced across the bridge for the series mode of oscillation. For Fig. 4 the wave length of the series mode of oscillation will be proportional to:

$$K_1(L_1+a_1)=K_2(L_2+a_2) \qquad (5)$$

while in the bridge mode the wave length will be proportional to:

$$\frac{K_1\frac{k_1}{2}}{K_1+\frac{k_1}{2}}\cdot L_1=\frac{K_2\frac{k_1}{2}}{K_2+\frac{k_1}{2}}\cdot L_2 \qquad (6)$$

Fig. 5 shows the arrangement of Fig. 2 employed for a superheterodyne receiver the circuit shown in Fig. 5 serving to have always two frequencies separated by a predetermined constant difference equal to the desired beat frequency. The local oscillator energy is applied to the coils a_1 and a_2, and the received signal carrier to the leads R C. The couplings should, of course, be such that the ends of the whole circuit arrangement are of like potential as regards local oscillator energy so that re-radiation is avoided. This is indicated by the reference marks + +.

Across the condenser K_2 are the two voltages, (1) the signal carrier, and (2) the local oscillator, with the result that there is fed to the first detector a mixed voltage for rectification to the intermediate frequency. This circuit of Fig. 5 contains a tunable oscillator acceptor circuit, and a tunable pick-up circuit for incoming signal,

with little or practically balanced oscillator signal back to the input aerial.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:

A tunable circuit arrangement designed to be tuned over a range of frequencies and having for each position of tuning two frequencies of response, said frequencies being separated by a predetermined amount which remains substantially constant over that range, said circuit arrangement comprising two similar acceptor circuits each of which consists of a main inductance and a tuning condenser in series, like ends of said acceptor circuits being coupled to one another by condensers which are in series in a loop circuit with the two main inductances and the two tuning condensers, and opposite ends of said acceptor circuits being connected to one another through coupling inductances which are in series in a figure of eight circuit with the said two main inductances and the said tuning condensers, the two said main inductances having substantially no mutual inductance with one another.

NORMAN PULLEN HINTON.