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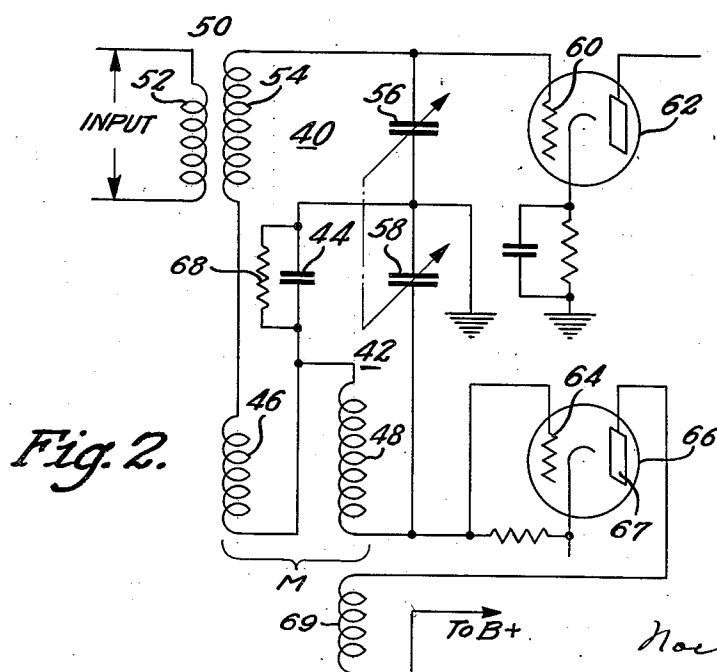
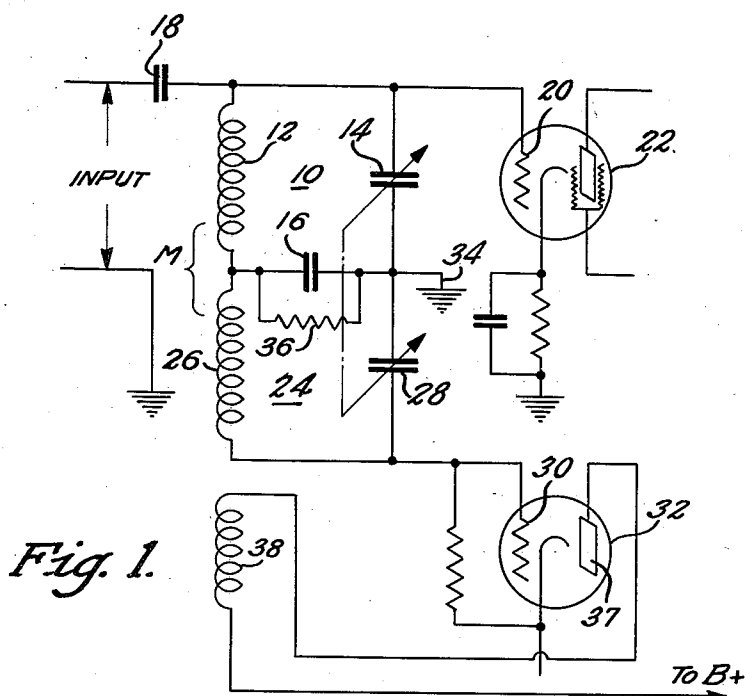
N. L. KEEFER

2,052,880

RADIO CIRCUIT

Filed Sept. 21, 1932

2 Sheets-Sheet 1



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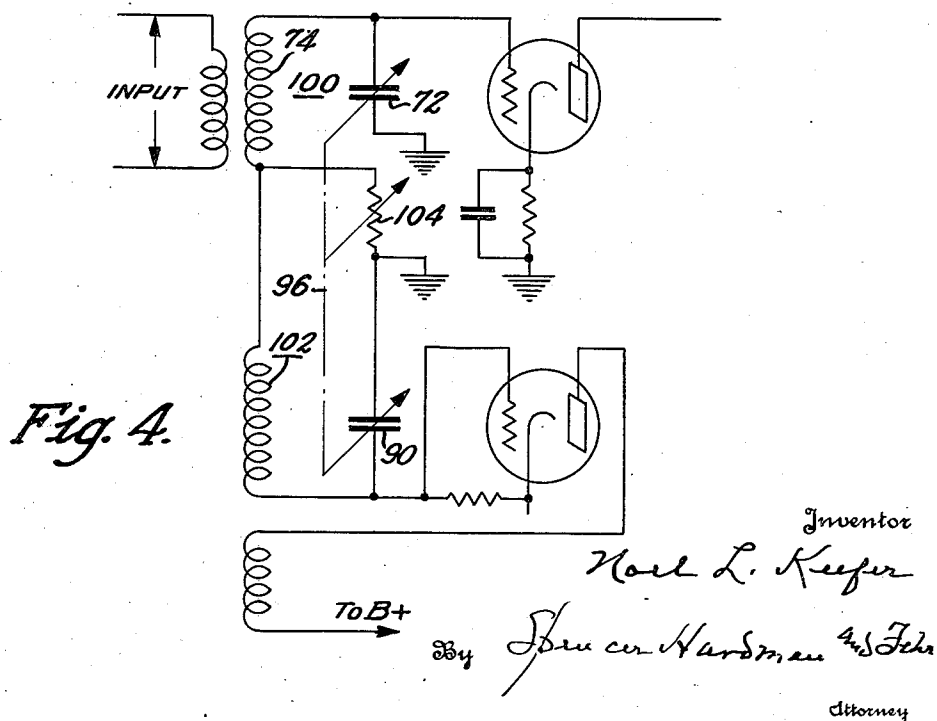
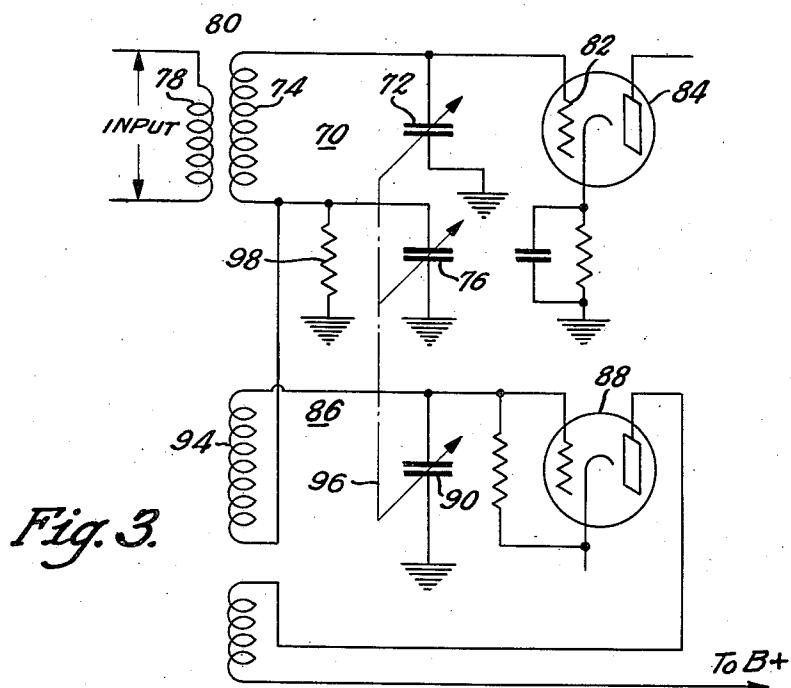
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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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RADIO CIRCUIT

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Delaware

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10 Claims. (Cl. 250—20)

This invention relates to a device for producing a beat frequency by combining a predetermined incoming frequency with a locally generated oscillatory current. In the receiving of a high frequency radio signal it is sometimes found advantageous to combine the incoming signal with a locally generated signal having a predetermined frequency so as to produce a beat frequency, sometimes referred to as an intermediate frequency, and which is to be amplified in one or more stages of an intermediate frequency amplifier. Usually the signal selecting coupling units used in the intermediate frequency are designed for a predetermined band of frequencies and cannot be adjusted in changing from one station to another. This is made possible by maintaining a constant frequency difference between the incoming signal and the locally generated oscillations. Theoretically this is easily done, whereas practically, numerous difficulties are encountered. It is very difficult to find a suitable driving mechanism for changing the tuning devices and thereby the local oscillator frequency so that the difference of the frequencies, or the sum of the frequencies as the case may be, is always constant.

An object of my invention is to provide a tuned resonant circuit for selecting the incoming signal and a resonant circuit for the oscillator that are adjusted in unison and that maintain a substantially constant frequency difference. This has been accomplished by a coupling between the resonant circuits that gives a double resonant effect.

One of the resonant circuits is tuned to one frequency and the other tuned to another frequency such that the difference between these two frequencies, which may be called a beat frequency, is of predetermined value. This can be readily accomplished by providing a mutual impedance intermediate the two resonant circuits so that this mutual impedance forms a circuit element within each of the resonant circuits.

The mutual impedance must be one of such characteristics that its value remains constant throughout the range of frequencies carried by this impedance. This may be accomplished either electrically or mechanically. If it is done electrically, no adjustment of impedance is required after it is once properly set so as to give the proper difference between the resonant circuits. If it is done mechanically, it will be necessary to adjust the mutual impedance in unison, preferably with the tuning devices, connected together so that the tuning devices and the mutual

impedance are adjusted together throughout the frequency range through each of the resonant circuits.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of one form of the present invention is clearly shown.

In the drawings:

Fig. 1 discloses a circuit arrangement of my preferred construction.

Fig. 2 discloses a modification somewhat similar to the form disclosed in Fig. 1.

Figs. 3 and 4 disclose two modifications wherein the mutual impedance is adjusted in unison with the tuning devices of the resonant circuits.

In the form disclosed in Fig. 1, a resonant circuit 10 including an inductance 12, a variable condenser 14 and a fixed condenser 16, is connected to an input in any suitable manner, as for example through a blocking condenser 18. The output of the resonant circuit 10 may be connected to a grid 20 of a thermionic vacuum tube 22, or any other suitable output. A second resonant circuit 24, that includes an inductance 26 coupled to the inductance 12, a variable condenser 28 and the condenser 16, is connected at one terminal to the grid 30 of an oscillation generator 32 and is grounded from its other terminal at 34. An inductance coil 38 is connected to an anode 37 of the oscillation generator 32 and is coupled with the inductance 26 to provide a regenerative action. Assuming the condensers 14 and 28 to be similar and to have the same capacity for each setting, the difference between the resonant frequency of the circuit 10 and the resonant frequency of the circuit 24 is dependent upon the magnitude of the common condenser 16 and the reactances of the coils 12 and 26. A resistor 36 by-passing the condenser 16 has a high resistance value and permits a D. C. potential to be applied to the grid 20 of the tube 22. Assuming that the intermediate frequency of the receiver is to be 175 k. c., the difference between the resonant peak of the circuit 10 and that of the circuit 24 should be 175 k. c. If this is the case, the mutual impedance found in the circuits 10 and 24 should be so selected that the difference between the resonant peaks of the circuit 10 and circuit 24 is equal to 175 k. c.

In the modification disclosed in Fig. 2, the resonant circuit 40 and the resonant circuit 42 are provided with a mutual impedance that includes a fixed condenser 44 and coils 46 and 48

having a mutual coupling. The input is supplied to the resonant circuit 40 through a coupler 50 with a primary winding 52 coupled to a secondary winding 54. Tuning of the device is accomplished by adjusting the variable condensers 56 and 58 in unison so as to maintain a constant frequency difference. The output of the resonant circuit 40 is connected to a grid 60 of a detector 62, and the output of the resonant circuit 42 is connected to a grid 64 of an oscillation generator 66. A resistor 68 by-passes the condenser 44 and has a high resistance value that permits a D. C. biasing potential to be applied to the grid 60 of the detector 62. An inductance coil 69 is connected to an anode 67 of the oscillation generator 66 and magnetically coupled to the inductance 48 to provide a regenerative action.

In the modification disclosed in Figs. 3 and 4 the mutual impedance in the two resonant circuits is maintained constant mechanically rather than electrically. As disclosed in Fig. 3, a resonant circuit 70, including a variable tuning condenser 72, an inductance 74 and a variable condenser 76, has an input that includes a primary 78 of a transformer 80, that is coupled to the inductance 74. The output is supplied to the grid 82 of a detector 84. Resistor 98 has a high resistance value and permits a D. C. biasing potential to be by-passed across condenser 76 and applied to the grid 82 of the detector 84. An oscillation generator 88 includes in its circuit a variable tuning condenser 90, an inductance 94 and the variable condenser 76. The variable condenser 76 is the mutual impedance found intermediate and common to the resonant circuit 70 and the resonant circuit 86. As is well known to those skilled in the art the impedance of a condenser varies inversely as the frequency. This being the case, it has been found necessary to change the impedance of the condenser 76 in unison with the adjusting of the tuning devices or condensers 72 and 90. This may be accomplished by driving the tuning condensers 72 and 90 and the variable condenser 76 from a common control or driving means 96. By providing a suitable driving means 96, the impedance of the variable condenser 76 forming the mutual impedance between the two resonant circuits may be adjusted so that the circuits have a constant frequency difference throughout the range of each resonant circuit.

In the modification disclosed in Fig. 4, resonant circuits 100 and 102 are similar to those disclosed in Fig. 3 where like reference characters indicate like parts, excepting that instead of the variable condenser 76, a variable impedance device 104 has been disclosed. This impedance device is actuated from the driving means 96 that drives the variable condensers 72 and 90 whereby the impedance 104 is thus suitably varied to maintain the frequency difference between the resonant circuits substantially constant. The impedance device may be a complete element in itself or may be composed of a capacity and an inductance.

The various forms of the invention as disclosed in the four figures of the drawings are merely illustrative, and are not to be construed as a limitation upon the invention, as any other method of providing a mutual impedance between two resonant circuits, such that the resonant frequencies of two resonant circuits are maintained at the frequency difference throughout the range, may be used.

While the form of embodiment of the present

invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. In a circuit for mixing radio frequency signals with locally generated oscillations of a different frequency to produce a constant resultant frequency for any signal frequency within a predetermined band, the combination comprising, a resonant circuit having an output terminal and being tunable to the frequency of the desired incoming signal, a second resonant circuit tunable to said different oscillation frequency also having an output terminal and magnetically coupled with the first mentioned resonant circuit, an impedance common to both of said resonant circuits, a common control for tuning both of said resonant circuits in unison over said band, a detector connected to an output terminal of the first mentioned resonant circuit, a thermionic oscillation generator connected to an output terminal of the second resonant circuit and having an anode therein, said impedance and magnetic coupling being proportioned to maintain the resultant frequency constant in value over said band, and an inductance coil connected with said anode and magnetically coupled with said second resonant circuit.

2. In a signal utilization circuit for a radio receiver, a thermionic tube having a grid, a thermionic oscillator tube also having a grid, magnetically coupled tunable resonant circuits each having a terminal connected to one of said grids, an impedance common to and connected in both of said resonant circuits, signal input means coupled with one of said resonant circuits, one of the resonant circuits being tunable over a signal frequency range, the other resonant circuit being tunable over an oscillator frequency range differing from the signal range by a desired beat frequency, means for tuning said resonant circuits in unison, said magnetic coupling and impedance being proportioned to maintain the beat frequency constant in value over said ranges.

3. In a signal utilization circuit for a radio device, the combination comprising, a thermionic tube having a control electrode, a second thermionic tube having control and output electrodes, a resonant circuit tunable over a desired frequency range connected to the control electrode of the first tube, said tunable circuit comprising a pair of inductances, a variable condenser and a fixed condenser, a second resonant circuit tunable over a substantially different frequency range connected to the control electrode of the second tube, said second tunable circuit comprising the said fixed condenser of the first tunable circuit, an inductance magnetically coupled to one of the pair of inductances and a variable condenser mechanically coupled to the first variable condenser, and an inductance connected to said output electrode magnetically coupled with one of said resonant circuits.

4. A circuit for mixing locally generated oscillations with signal oscillations to produce a resultant having a predetermined frequency, comprising in combination, signal input means, a resonant circuit tunable over a desired signal frequency range coupled with said signal input means, a thermionic tube for locally generating oscillations, a resonant circuit tunable over an oscillator frequency range differing from said signal range by said resultant frequency connected with said tube, a variable impedance connected

to and forming a part of both of said resonant circuits for maintaining said resultant frequency constant in value over said ranges, and means for tuning both of said resonant circuits.

5 5. A circuit for controlling the mixture of oscillating energy from two sources of different frequencies to produce constant frequency resultant oscillations for any frequency of one of the sources within a given range, comprising in combination, a plurality of tunable circuits, each resonant to one of said different frequencies, a variable impedance common to said resonant circuits for maintaining the resultant oscillations constant in frequency over said different frequency ranges, and means for tuning said resonant circuits and varying said impedance in unison.

6. In a signalling system, a resonant circuit, means for tuning the circuit over a range of signal frequencies, a second resonant circuit, means for tuning the second circuit over a range of frequencies differing from said signal frequencies, means for simultaneously adjusting the tuning means of both circuits, and reactive impedance means including at least two reactances of opposite sign coupling said two circuits to maintain the frequency difference between the circuits of a constant value at any setting of said adjusting means.

30 7. In a superheterodyne receiver, a first detector circuit tunable over a desired signal frequency range, a local oscillator circuit tunable over a different frequency range, means for simultaneously adjusting the tuning of both circuits, reactive impedance means common to, and coupling, said circuits, and means supplemental to said reactive means, and operative upon actuation of said adjusting means, for maintaining the effective coupling impedance value between said circuits constant over the said frequency ranges.

8. In a superheterodyne receiver, a first detector circuit tunable over a desired signal frequency range, a local oscillator circuit tunable over a different frequency range, means for simultaneously adjusting the tuning of both circuits, reactive impedance means including a condenser common to, and coupling, said circuits, and means including a reactance common to both circuits supplemental to said reactive means, and operative upon actuation of said adjusting means, for maintaining the effective coupling impedance value between said circuits constant over the said frequency ranges.

9. In a superheterodyne receiver, a first detector circuit tunable over a desired signal frequency range, a local oscillator circuit tunable over a different frequency range, means for simultaneously adjusting the tuning of both circuits, reactive impedance means common to, and coupling, said circuits, and means supplemental to said reactive means, and operative upon actuation of said adjusting means, for maintaining the effective coupling impedance value between said circuits constant over the said frequency ranges, said supplemental means comprising a mechanical device for varying the magnitude of the reactive means in unison with actuation of the tuning adjusting means.

10. In combination with a signal receiving circuit including means for tuning it over a desired frequency range, a local oscillator circuit including means for tuning it over a different frequency range, a mutual impedance means coupling said circuits and having a magnitude such that the circuits have resonance peaks spaced apart by a predetermined beat frequency value, and auxiliary means, operative upon tuning of the circuits over said ranges, for maintaining said resonance peak spacing substantially constant.

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