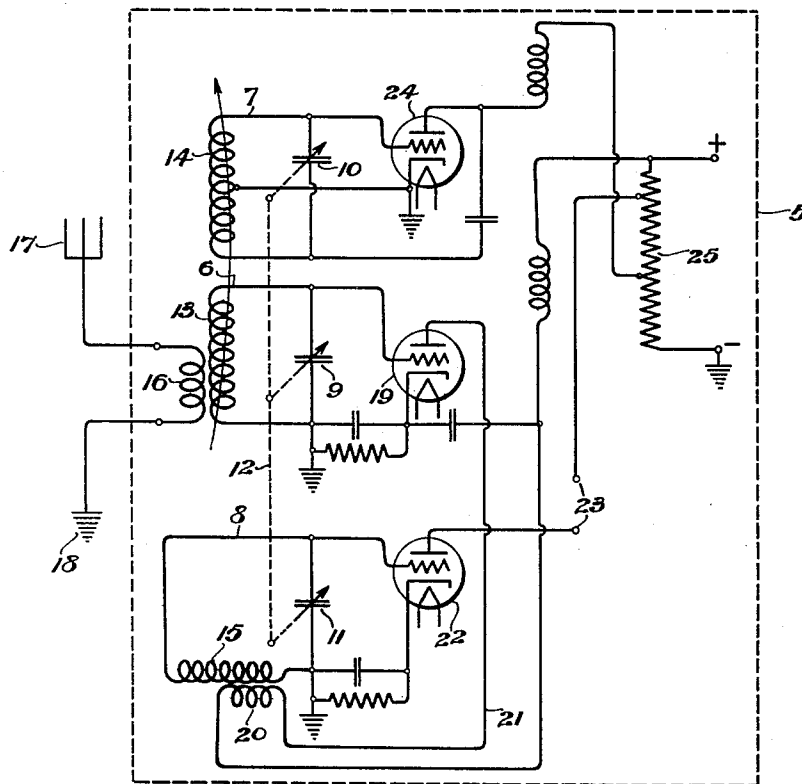


Nov. 7, 1933.

A. G. D. WEST
RADIO RECEIVING SYSTEM

1,933,778

Filed July 30, 1931



INVENTOR.
Arthur Gilbert Dixon West,

BY *J. R. Goldsborough*
HRS ATTORNEY.

UNITED STATES PATENT OFFICE

1,933,778

RADIO RECEIVING SYSTEM

Arthur Gilbert Dixon West, Beckenham, England

Application July 30, 1931, Serial No. 553,934, and
in Great Britain August 21, 1930

14 Claims. (Cl. 250-20)

The present invention relates to supersonic heterodyne radio receiving systems.

It is well known that when such a receiver is tuned for the most efficient reception of any particular signal, a definite relation should exist between the resonance frequencies of the aerial or signal input circuit or circuits, the local oscillator circuit, and the tuned circuits or circuits of the intermediate frequency amplifier, the latter being tuned usually to a fixed frequency. If however, it is desired to vary also the intermediate frequency circuits for wide wave length range of tuning with proper selectivity and image frequency rejection and if L_1C_1 , L_2C_2 , and L_3C_3 represent respectively, the inductance and capacity in these circuits, this completely variable relation can be expressed by the equation

$$(1) \quad \frac{1}{2\pi\sqrt{L_1C_1}} \pm \frac{1}{2\pi\sqrt{L_2C_2}} = \frac{1}{2\pi\sqrt{L_3C_3}}$$

This expresses in an obvious form the condition that the sum or difference of the frequencies of the input and oscillator circuits must equal the frequency of the intermediate circuit, which is the relation necessary for superheterodyne operation. It should be noted that according to this invention C_1 , C_2 and C_3 are all simultaneously variable and substantially equal in capacity value throughout a predetermined variable tuning range.

It is very desirable that the condensers employed for tuning all of the above mentioned resonant circuits should be "ganged" or operable from a single control, and in order to make this possible, and at the same time to satisfy the above equation for all positions of the tuning control, it has been proposed to make the inductances in the circuits equal to one another, so that $L_1=L_2=L_3$, and to so arrange the movable plates of the condensers with respect to one another, that with all condensers variable the relation

$$(2) \quad \frac{1}{\sqrt{C_1}} \pm \frac{1}{\sqrt{C_2}} = \frac{1}{\sqrt{C_3}}$$

is satisfied for all positions of the tuning control. This arrangement, however, has the disadvantage that "straight line frequency" condensers having very accurately designed plates must be used.

It is, therefore, an object of the present invention to design a superheterodyne receiver employing a system of ganged condensers for circuits tuned to electrical currents at differing frequencies wherein the use of condensers of the straight line frequency type is not essential.

The invention will be better understood from the following description, when taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims. In the drawing, the figure is a schematic circuit diagram of a portion of a superheterodyne radio receiver embodying the invention.

Referring to the drawing, in accordance with the present invention, in a superheterodyne receiver 5 in which the antenna or radio frequency input circuit 6, the local oscillator circuit 7 and an intermediate frequency circuit 8 are tuned by means of condensers 9, 10, and 11, respectively, operated by means of a single control member 12, the effective values of the inductance of the coils 13, 14 and 15 in said circuits are chosen so as to substantially satisfy a definite relation, this relation being expressed by the equation derived from Equation (1) when $C_1=C_2=C_3$

$$(2) \quad \frac{1}{\sqrt{L_1}} \pm \frac{1}{\sqrt{L_2}} = \frac{1}{\sqrt{L_3}}$$

where L_1 , L_2 , and L_3 or L_2 , L_3 and L_1 may represent the said effective values of the coils 13, 14 and 15 in said input, local oscillation and intermediate frequency circuits, respectively.

In the above equation, since the condenser values are all assumed to be equal at any position throughout the tuning range it will be seen that Equation (2) is derived from Equation (1) by removing therefrom the fixed values and retaining therein only the variables, which is possible under the condition of operation assumed.

The basic idea underlying the invention is to utilize an ordinary ganged condenser for the purpose of tuning input, oscillator and intermediate circuits of a superheterodyne receiver. Accordingly, any ganged condenser in which the individual sections are accurately matched may be used, each gang having any convenient capacity value and plate shape. The choice of values for the inductances of the three circuits is governed by Equation (2) and any convenient values may be given to two of the inductances, the third being chosen to enable the equation to be satisfied. Thus for example— $L_1=100$ microhenries and $L_3=10,000$ microhenries; L_2 may have a value of either 105.5 or 94.5 microhenries. L_1 should preferably be chosen to give the required tuning range and L_3 should be as large as possible to give a low frequency for the intermediate amplification.

In the present example, the antenna or radio

frequency circuit 6 is energized with signal currents through the inductance 13 from a suitable coupling coil 16 associated with said inductance and connected with an antenna 17 and ground 18 as a source of radio frequency or other signals.

As has been pointed out above, if a ganged condenser in which $C_1=C_2=C_3$ over the entire range of variation, and further, if the inductances of the three coils satisfy Equation (2), then the aerial or radio frequency oscillator and intermediate circuits will maintain the superheterodyne relation for all frequencies to which the receiver is tunable.

It is, of course to be understood that the effective values of the inductance in the circuits, though largely determined by the coils themselves, are also influenced by the coupling existing between the coils and other circuit components.

The antenna or input circuit 6 is directly connected with a detector or frequency changer tube 19 which in turn is coupled with the intermediate frequency circuit 8 by a suitable coupling coil 20 in the detector output circuit 21 associated with the inductance 15.

An intermediate frequency amplifier tube 22 is connected with the intermediate frequency circuit 8 as indicated and is provided with output terminals 23 which may be connected with other apparatus (not shown) forming part of the receiver, as is well known.

The local oscillator circuit 7 is connected with an oscillator tube 24 as a source of oscillations, and the inductances 13 and 14 are coupled as indicated as a means for transferring the oscillations to the frequency changer or detector tube 19. A suitable source of anode potential for the tubes is indicated by the tapped potential divider resistor 25. Other circuit details do not concern the invention and accordingly are not described.

It is clear that the only other condition necessary, in order that Equation (1) should be satisfied for all positions of the tuning control, is that $C_1=C_2=C_3$; that is to say, the capacities of the tuning condensers should equal one another at all positions of the tuning control.

Thus in a supersonic heterodyne receiver having its inductance coils which may be of any suitable type, so wound that their values satisfy Equation (2), the tuning of the oscillatory circuits may be effected by any system of ganged condenser, such for example as are used in tuning the circuits of a thermionic amplifier for high frequency electrical oscillations.

The advantage in tuning all circuits, including the intermediate frequency amplifier is, primarily, the reduction of the image frequency response in the higher frequency range of operation wherein the selectivity is normally reduced, as is well known. By tuning the intermediate frequency circuits, thereby providing for a variable intermediate frequency, a desired image frequency separation may be maintained throughout the tuning range.

It will be seen that the intermediate frequency circuit is variably tuned simultaneously with the input or radio frequency circuit. This arrangement has the further advantage that the intermediate frequency may be made low at one end of the range, as is desirable to reduce the tendency of generated harmonics to be fed back to the input. However, as is well known, for the purpose of preventing image frequency response, the intermediate frequency should preferably be

high and it will further be seen that by the tuning arrangement provided, this desired result is obtained at the other end of the range, to which, under present conditions, the majority of broadcasting stations are allocated.

I claim as my invention:

1. In a radio receiving apparatus of the heterodyne type, the combination of a tuned resonant oscillator circuit, a tuned resonant intermediate frequency circuit, a tuned resonant input circuit, and means for simultaneously changing the resonance points of each of said tuned circuits.

2. In a radio receiving apparatus of the heterodyne type, the combination of an oscillator circuit including a tuning inductance, an intermediate frequency circuit including a second tuning inductance, and means including a tuning condenser associated with each of said inductances for simultaneously tuning each of said circuits, said condensers being of substantially equal capacity.

3. In a radio receiving apparatus of the heterodyne type, the combination of an oscillator circuit including a tuning inductance, an intermediate frequency circuit including a second tuning inductance, a signal input circuit including a third tuning inductance, and a variable condenser having substantially duplicate condenser sections one of which is connected with each of said inductances and arranged for simultaneously tuning said circuits.

4. In a superheterodyne receiver, the combination of a signal input circuit, a local oscillator circuit, and an intermediate frequency circuit, an inductance and a condenser connected in each of said circuits to provide a tuning means therefor, said condensers being adjustable to substantially equal capacity values and the inductances in the input, oscillator and intermediate frequency circuits having values which satisfy an equation

$$\frac{1}{\sqrt{L_1}} \pm \frac{1}{\sqrt{L_2}} = \frac{1}{\sqrt{L_3}}$$

in which L_1 , L_2 , and L_3 represent the values of said inductances.

5. A superheterodyne radio receiving apparatus having a signal input circuit, an oscillator circuit and an intermediate frequency circuit, a tuning inductance in each of said circuits, said inductances being related in value to each other in accordance with the formula

$$\frac{1}{\sqrt{L_1}} \pm \frac{1}{\sqrt{L_2}} = \frac{1}{\sqrt{L_3}}$$

in which L_1 , L_2 , and L_3 represent the values of said inductances in the input, local oscillator and intermediate frequency circuits respectively, and means for varying the capacity to substantially the same value in each circuit.

6. A superheterodyne radio receiving apparatus having a tuned signal input circuit, a tuned oscillator circuit and a tuned intermediate frequency circuit, the inductance values of said tuned circuits being related to each other in accordance with the formula

$$\frac{1}{\sqrt{L_1}} \pm \frac{1}{\sqrt{L_2}} = \frac{1}{\sqrt{L_3}}$$

in which L_1 , L_2 , and L_3 represent said inductance values of the input, local oscillator and intermediate frequency circuits respectively, and a gang type variable condenser having duplicate units one in each circuit, for simultaneously tuning said circuits.

7. A superheterodyne radio receiving apparatus having a signal input circuit, an oscillator circuit and an intermediate frequency circuit, a tuning inductance in each of said circuits, said inductances being related in value to each other in accordance with the formula

$$\frac{1}{\sqrt{L_1}} \pm \frac{1}{\sqrt{L_2}} = \frac{1}{\sqrt{L_3}}$$

10 in which L_1 , L_2 , and L_3 represent the values of said inductances in the input, local oscillator and intermediate frequency circuits respectively, a variable tuning condenser in each of said circuits, and means for simultaneously operating said condensers, said condensers being thereby adjustable to substantially the same capacity for each position of adjustment of the movable control means.

8. In a radio receiving apparatus of the heterodyne type, the combination of a signal input circuit including a tuning inductance, an oscillator circuit including a second tuning inductance, an intermediate frequency circuit including a third tuning inductance, a variable gang condenser having duplicate condenser sections, one of which is connected with each of said inductances for simultaneously tuning said circuits, the values of said inductances being arranged in accordance with the equation

$$\frac{1}{\sqrt{L_1}} \pm \frac{1}{\sqrt{L_2}} = \frac{1}{\sqrt{L_3}}$$

in which L_1 , L_2 , and L_3 represent the values of the first, second and third named inductances respectively.

9. A superheterodyne receiver having three tuned circuits, an oscillator connected with one of said circuits, an intermediate frequency amplifier connected with another of said circuits, means for applying signal energy to another of said circuits, means including an inductance and a condenser in each circuit for simultaneously tuning said circuits, the inductances in each of said circuits being related to each other in accordance with the formula

$$\frac{1}{\sqrt{L_1}} \pm \frac{1}{\sqrt{L_2}} = \frac{1}{\sqrt{L_3}}$$

wherein L_1 , L_2 , and L_3 represent the values of the inductances in the signal input, oscillator, and intermediate frequency circuits respectively, and duplicate tuning capacities in each of said circuits.

10. In a radio receiving apparatus of the heterodyne type, the combination of a plurality of tuned resonant circuits, an oscillator connected with one of said circuits, an intermediate frequency amplifier connected with another of said circuits, and means including a variable tuning condenser in each of said circuits for simultaneously tuning said circuits to predetermined frequencies, said condensers being interconnected for unitary control throughout a predetermined tuning range of operation and being adapted to provide equal capacity values one with respect to the other for any adjustment throughout said range of operation.

11. In a radio receiving apparatus of the heterodyne type, the combination of a tuned resonant oscillator circuit, a tuned resonant intermediate frequency circuit, and means including a variable tuning condenser in each of said circuits for simultaneously changing the resonance point of each of said tuned circuits, said condensers being interconnected for unitary control throughout a predetermined tuning range of operation and being adapted to provide equal capacity values, one with respect to the other, for any adjustment throughout said range of operation.

12. In a radio receiving apparatus of the heterodyne type, the combination of a tuned resonant oscillator circuit, a tuned resonant intermediate frequency circuit, a tuned resonant input circuit, and means including a variable tuning condenser in each of said circuits for simultaneously changing the resonance points of each of said tuned circuits, said condensers being interconnected for unitary control throughout a predetermined tuning range of operation and being adapted to provide equal capacity values, one with respect to the other, for any adjustment throughout said range of operation.

13. A heterodyne radio receiving system having an intermediate frequency amplifying circuit and an oscillator circuit, characterized by the fact that unicontrol means are provided for simultaneously tuning said circuits through differing predetermined frequency ranges.

14. A heterodyne radio receiving system having an intermediate frequency amplifying circuit and an oscillator circuit, characterized by the fact that said circuits are simultaneously tunable through differing predetermined frequency ranges and that the tuning means therefor includes a ganged variable condenser having substantially duplicate units one in each of said circuits.

ARTHUR GILBERT DIXON WEST.