Feb. 14, 1928. 1,659,417

B. WASHINGTON

SINGLE CONTROL RECEIVER

Filed Oct. 16, 1926

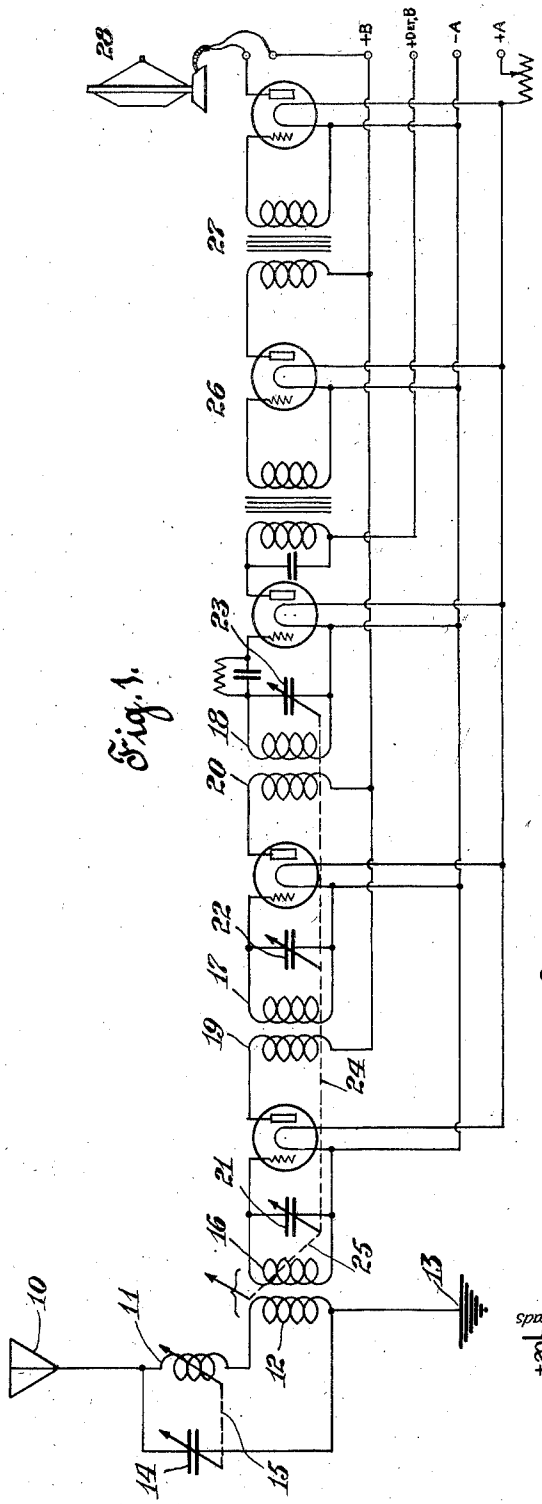


Fig. 1.

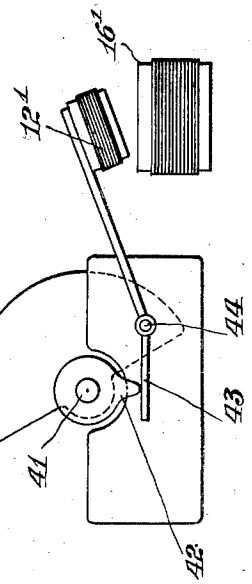


Fig. 4.

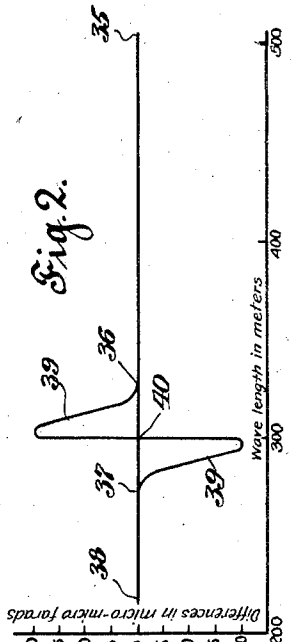


Fig. 2.

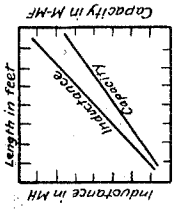


Fig. 3.

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SINGLE-CONTROL RECEIVER.

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One object of my invention is to increase the efficiency and decrease the cost of manufacture of radio receivers embodying several tuned circuits, which are varied as to period simultaneously, by means of one manual control.

In general receivers of this type have several stages of tuned radio frequency amplification, a detector and several stages of audio frequency amplification.

As receivers of this type used for broadcast reception are usually in the hands of persons unskilled in the handling of scientific or electrical apparatus, it is admittedly desirable to reduce the number of manual controls to a minimum. For this reason the variable tuning elements, usually variable condensers, are frequently made as similar as manufacturing accuracies will allow and are driven simultaneously either by mounting on the same shaft or through a series of belts, connecting rods, racks and pinions or other mechanical devices, or by placing their adjusting members in position to be simultaneously operated by one or more fingers of the same hand.

In order to secure maximum efficiency, it is necessary that the simultaneously tuned radio frequency stages should be each tuned to the same period as the others. This is a comparatively simple matter in all stages except the first, as the primary of each stage, except the first, is connected to the plate of a vacuum tube and the secondary to the grid of a similar vacuum tube. The primary of the first stage radio frequency transformer, however, is connected to the antenna and ground, which throughout a certain portion of the frequency range, over which the receiver is designed to operate, causes the variable tuning element of this stage to be of differing value from those of the remaining stages for best reception. In my invention I propose to correct this difficulty.

Referring to the drawing, Fig. 1 shows a simple schematic wiring diagram of one embodiment of my invention.

Fig. 2 shows a laboratory curve of the variation of capacity of the condenser in the first tuned radio frequency stage from that of the remaining condensers caused by the antenna when my invention is not employed.

Fig. 3 shows the general relation of inductance to capacity of the average single wire receiving antenna.

Fig. 4 shows a mechanical structure applicable to my invention.

In Fig. 1 the antenna 10 is connected through the variable inductance 11 and the movable primary inductance 12 to the ground 13. The antenna 10 is also connected to the ground 13 through the variable condenser 14. The variation of this condenser and of the inductance 11 is effected simultaneously as indicated by the dotted line 15. 16, 17 and 18 are the secondary windings of the three tuned radio frequency transformers. 19 and 20 are the primary windings of the second and third transformers. These transformers are tuned by the variable condensers 21, 22 and 23 which are operated simultaneously as indicated by the dotted line 24. The coupling between the coils 12 and 16 is also simultaneously varied throughout a certain portion of the total variation of the condensers as indicated by the dotted line 25. Two audio frequency amplifying stages are shown at 26 and 27 and a loud speaker at 28.

To fully explain my invention, some of the laboratory work leading to its inception may be described:

A receiver was made with exactly similar transformers and condensers, the condensers being separately operable and a curve taken in the following manner:

A signal of a given wavelength was chosen and each condenser separately varied until maximum response of the receiver as a whole was secured. An out-put meter was used to insure more exact tuning than can be accomplished by ear. Then all connections were carefully removed from the condensers and their capacity accurately measured and the variation of their relative values plotted. Another wavelength was chosen and the process repeated and so on over the whole broadcast band. A curve similar to that delineated in Fig. 2 was obtained. Between the points 35 and 36 the capacity of all three condensers was alike. Between the points 36 and 37 the capacity of the condensers of the 2nd and 3rd tuned circuits remained alike but the capacity of the condenser in the first stage, whose primary circuit contains the antenna, went through a variation such as is shown by the curve 39, Fig. 2, but at the point 37 its value became that of the remaining two condensers and continued to be so throughout the rest of the wavelength range. The part of the

curve 39 above the zero line in Fig. 2 represents the extent of the increase of the capacity of the condenser 21 over the capacities of the condensers 22 and 23 while the part below the line represents the decrease.

It can be proved both experimentally and mathematically that this phenomenon occurs between two points upon either side of the point at which the primary inductance of the first radio frequency transformer resonates the antenna circuit to the received wave. As this point is approached the antenna circuit acquires more and more inductive reactance, at resonance it becomes a pure resistance and then becomes capacitative. Therefore, if all three condensers are operated simultaneously and unless some steps are taken to compensate for this effect throughout that part of the frequency range wherein this effect is of some considerable magnitude, the first radio frequency stage will be out of tune and the over all response will not be maximum.

My invention consists of an easy, mechanical and automatic means for making this compensation. Experiments have shown that the average single wire antenna, such as is generally used for broadcast reception, possesses a uniform linear relation between its length, its capacity and its inductance, as shown in Fig. 3.

The first part of my invention consists in giving the antenna circuit the same electrical period at approximately the same constants regardless of its length. This may be done as shown in Fig. 1 by the variable inductance 11 which is mechanically coupled with variable condenser 14. A maximum antenna length should be selected on which the set may be operated, say 150 ft., and when this length is used the inductance 11 and condenser 14 should be at their lowest values. If a shorter antenna is used both of these variables are increased by the difference of inductance and capacity between the shorter antenna and the one chosen as maximum. On account of the simplicity of the relation between antenna length, antenna capacity and antenna inductance, it is not at all difficult to construct the variables 11 and 14 so that they may be simultaneously operable and introduce the correct amount of each property.

By this means variation of tuning of the first radio frequency stage, shown to exist between the points 36 and 37 (Fig. 2) can always be made to occur at the same wavelengths or between the same points on the tuning dial.

It has been found that by loosening the coupling between the inductances 12 and 16 (Fig. 1) at a certain experimentally determined variable rate between the points 36 and 40 (Fig. 2) and closing it again to normal between the points 40 and 37 (Fig. 2) the receiver may be made to give maximum response when the condenser 21 (Fig. 1) is of the same value as the condensers 22 and 23, and as the antenna circuit is approaching or passing through resonance about these points, the proper energy transfer may be effected with looser coupling than is necessary throughout the rest of the tuning range of the receiver, and therefore little or no loss of energy is introduced by this method of correction or compensation for the basic difference in circuit between the first radio frequency stage and the remaining stages.

This variation of coupling between the inductances 12 and 16 (Fig. 1) may be automatically effected at the proper ratio by a cam or other mechanical device operated from the same means which simultaneously operates the tuning condensers.

I do not wish to limit my invention to any particular mechanical method of achieving the desired results, but a suggested arrangement is disclosed in Fig. 4 in which 41 denotes the shaft of the first tuning condenser such as 21 (Fig. 1) upon which is mounted a cam 42, operating against a lever 43, which is pivoted at 44 and carries at its opposite end the primary inductance 12′ which throughout a certain portion of the revolution is raised out of and then lowered into the secondary inductance 16′.

In summation my invention contemplates adjusting the first stage of a tuned radio frequency, or a similar type receiver so that its variable tuning element shall have the same electrical value as those of the remaining stages by, firstly, bringing the antenna circuit to a predetermined period by means of a simultaneously operated variable inductance and variable capacity which can be made to add or subtract these properties so as to make any antenna substantially equal to a chosen maximum antenna in so far as its period, inductance and capacity are concerned, and secondly, by automatically varying the coupling between the first grid circuit and the open or antenna circuit at and about the antenna circuit period.

I claim:

1. In a radio receiver means for ensuring the uniform operation of all tuning units, said means consisting of means for giving the open antenna circuit predetermined constants and means for automatically loosening the coupling of said circuit with its associated circuit, said means operable simultaneously with the tuning control of said associated circuits throughout a part of the frequency range of said receiver and adjacent to the free period of said open circuit.

2. A radio receiver having in its antenna circuit a variable inductance and a variable capacity simultaneously variable, the ratio

of variation of the properties of these elements being substantially the same as the ratio of variation of the similar properties of an antenna with its length, and means for varying the coupling between said antenna circuit and its associated circuit, said means being operable simultaneously with the tuning means of said associated circuit.

3. In a radio receiver a variable inductance in series with the antenna and a variable capacity in parallel, said inductance and said capacity operable simultaneously and so as to give substantially same period, inductance and capacity to the antenna circuit of said receiver regardless of the length of the antenna within specified limits, and means for varying the coupling between said antenna circuit and its associated circuit throughout a portion of the frequency range of the receiver, said portion including said period, said means operable automatically and simultaneously with the frequency control of said receiver.

4. In a radio receiver means for ensuring identical values, at any given frequency adjustment, of the tuning elements in the several tuned circuits of said receiver said means consisting of means for ensuring the occurrence of the detuning of the circuit associated with said antenna circuit throughout a predetermined band of frequencies, and means associated with the frequency control of said receiver for preventing this detuning by loosening the coupling between said antenna circuit and said associated circuit throughout said band of frequencies.

5. In a radio receiver automatic means for varying the coupling between the open antenna circuit and its associated circuit, said means operable simultaneously with the frequency controlling means of said receiver and independently adjustable means for bringing the period of said open antenna circuit to a predetermined value, said variation occurring throughout a short band of frequencies, said frequencies including the free period of the open antenna circuit.

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