March 23, 1926. 1,577,613

F. W. DUNMORE

RADIO RECEIVING APPARATUS

Filed Feb. 4, 1925 2 Sheets-Sheet 1

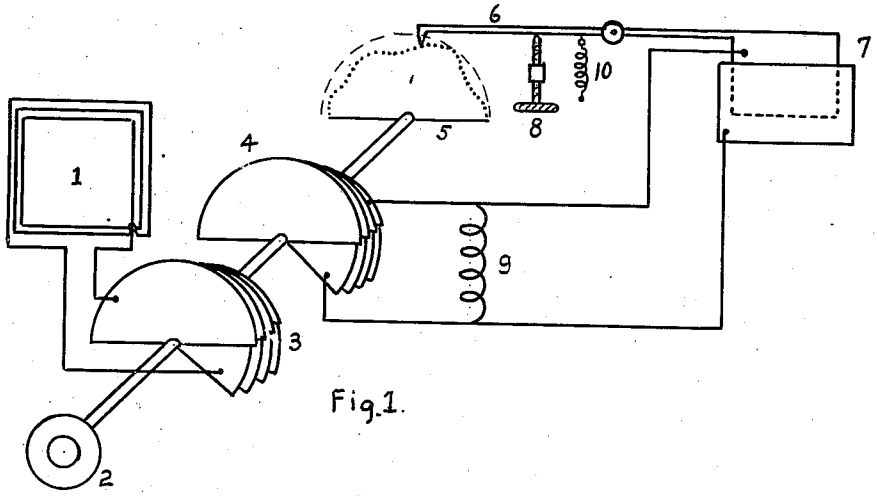


Fig. 1.

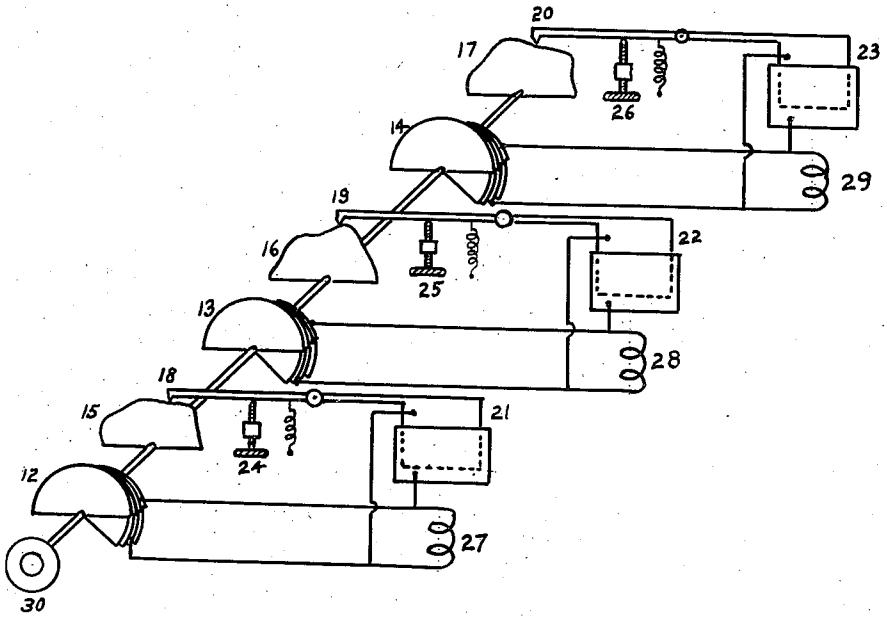


Fig. 2.

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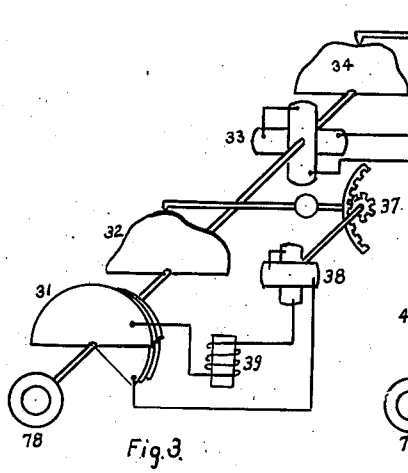


Fig. 3.

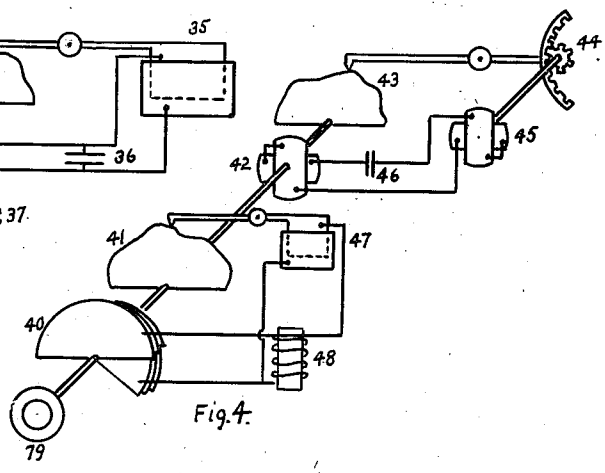


Fig. 4.

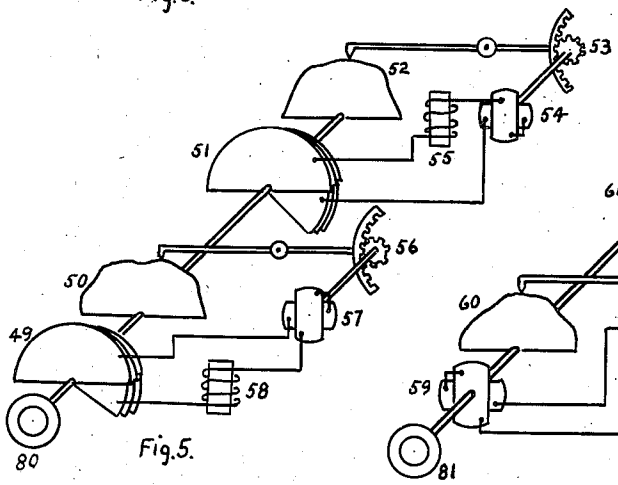


Fig. 5.

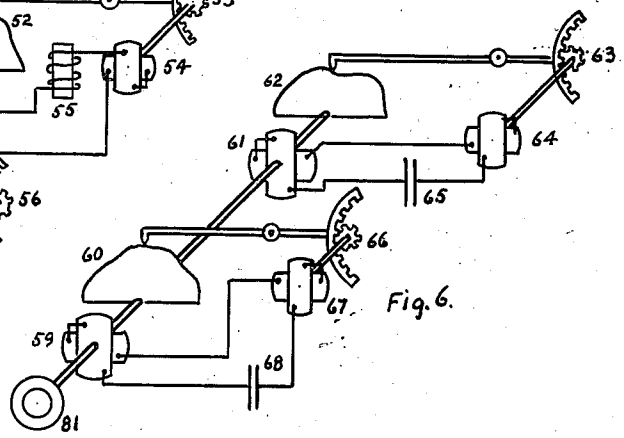


Fig. 6.

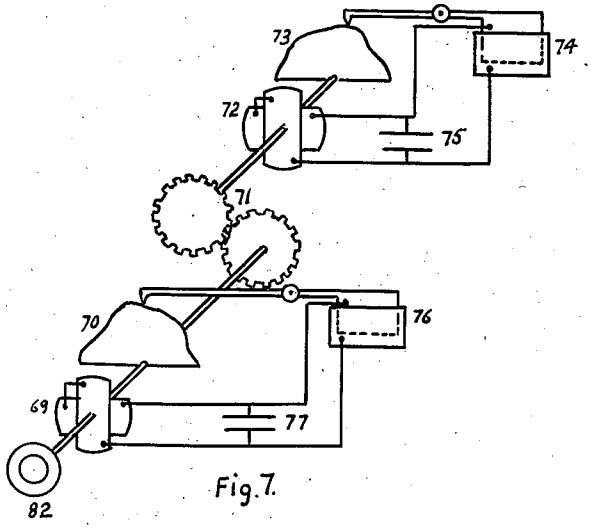


Fig. 7.

Inventor

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Patented Mar. 23, 1926. 1,577,613

UNITED STATES PATENT OFFICE.

FRANCIS W. DUNMORE, OF WASHINGTON, DISTRICT OF COLUMBIA.

RADIO RECEIVING APPARATUS.

Application filed February 4, 1925. Serial No. 6,898.

To all whom it may concern:

Be it known that I, FRANCIS W. DUNMORE, citizen of the United States, residing at Washington, District of Columbia, have invented certain new and useful Improvements in Radio Receiving Apparatus, of which the following is a specification.

My present invention relates broadly to radio receiving apparatus and more particularly to means for simplifying the operation of such apparatus. The object of the invention is to provide means whereby by means of one manual control the electrical constants of two or more different circuits may be maintained in a definite relation with respect to each other as the constants of each circuit are varied.

One of the best methods of obtaining selectivity in radio receiving apparatus is either by means of the Armstrong superheterodyne principle of Letters Patent, 1,342,885 dated June 8, 1920 where a beat frequency is made use of, or by tuned multi-stage radio frequency amplification, each stage being tuned to be resonant to the same frequency either by means of a tuning condenser or variable inductance in each stage. In the former case two variable controls, loop or antenna tuning and heterodyne oscillator tuning are required. In the latter case, a variable tuning control for each tuned stage is necessary. Naturally, this multiplicity of controls complicates the operation of the apparatus. It is impossible to accomplish this end by means of rotating two or more condensers or variometers on the same shaft since they could not be made to vary their electrical constants in the desired manner due to extreme sharpness of present day transmissions and to slight inequalities in mechanical and electrical features.

One of the objects of my invention is to provide means for varying the electrical constants of any number of circuits in any desired manner by means of one control. By way of example, take the present Armstrong superheterodyne radio receiving set; this set requires two adjustments, one for loop or antenna tuning and the other for adjusting the frequency of the heterodyne oscillator to that necessary to give the desired intermediate frequency. In attaining my object of reducing these two controls to one I mount the variable elements, either capacity or inductance, so as to be rotatable on the same shaft, or gear connected, said shaft or gears being rotated by means of one control. Rotating with said shaft or gears is a cam which in turn operates a vernier compensating condenser or inductance electrically connected to either of the two circuits requiring adjustment. The cam is so shaped that the correct frequency relations are maintained between the two circuits over a continuous range of frequencies.

A further object of my invention is to provide means of tuning by means of one control several independent circuits consisting of inductance and capacity so that each circuit will be continuously resonant to the same frequency over a continuous range of frequencies. By way of example; take the present type of multituned radio frequency amplifier receiving set, there being three tuned stages, this means three independent critical adjustments. By mounting the variable condensers or inductances as stated above and by means of vernier compensating capacities or inductances across each tuned circuit operated by cams, it is possible to so cut the cams as to maintain the three circuits in resonance over a continuous range of frequencies with but one control.

The features of my invention which I believe to be new are pointed out with particularity in the appended claims. The invention itself, however, together with further objects and advantages thereof will be best understood by the following description taken in connection with Figs. 1, 2, 3, 4, 5, 6 and 7. It will be understood that the principles of my invention may be embodied in various forms and that details are not material.

Fig. 1 shows an application in which the electrical constants of two circuits may be made to be variable with respect to each other in a definite manner over a continuous

range of frequencies with but one control. It is understood that this idea is not restricted to two circuits but to any number. By way of example; I will take the two variable circuits of the Armstrong superheterodyne receiver. Reference characters 3 and 4 are two variable air condensers mounted on the same shaft or one to one gear connected and with movable plates in the same relative angular position. The movable plates of 3 and 4 are preferably cut to a shape to give a straight line frequency relation and so proportioned with respect to their associated circuits as to maintain the approximate desired frequency relations. Reference character 1 is a coil antenna or coupling inductance to an aperiodic antenna which with condenser 3 constitutes the circuit tuned to the incoming frequency. Numeral 9 indicates the inductance of the heterodyne oscillator circuit, which with condenser 4 produces the local oscillations whose frequency it is necessary to adjust so that when this frequency is combined with the incoming frequency the desired beat or intermediate frequency is produced. It is evident that the relations between the constants of circuits 1—3 and 4—9 are so critical that it would be very difficult to build condenser 4 or inductance 9 such that the proper frequency relation would exist over the 180 degrees of rotation of condensers 3 and 4. I therefore provide a compensating condenser or inductance which is operated by means of a cam 5 which engages an arm 6 held against the cam by spring 10. The cam rotates with the shaft carrying the two tuning condensers. The proper shape of the cam is determined as follows: Dial 2 is set at zero or so that condensers 3 and 4 are set at minimum capacity, and a frequency of that to which circuit 1—3 is then adjusted is impressed on that circuit. Compensating condenser 7 is then varied by means of adjustment screw 8 until the frequency of oscillator circuit 4—9—7 is such that when combined with the frequency being impressed on circuit 1—3, the desired beat or intermdiate frequency is obtained. The position of arm 6 on disc 5 (5 is at first a semicircular disc) is then marked by a dot on the disc. Dial 2 is then rotated, say two or three degrees, and a frequency of that to which circuit 1—3 is then adjusted is impressed on that circuit and the process repeated. In this way a series of dots are obtained on disc 5, for the various positions of arm 6. The disc is then cut on the dotted line giving the cam 5 as shown by the dotted line. Then, for any setting of dial 2 after cam 5 has been cut, the proper frequency relations of the two circuits must always be maintained. It is of course understood that adjustment 8 is necessary only while determining the shape of cam 5 and is not used thereafter.

Another application is shown in Fig. 2 in which the present three control multituned radio frequency amplifier circuit is shown with but one control. The three variable condensers are shown at 12, 13 and 14. The movable plates of these condensers are attached to the same shaft or arranged to be driven by one to one gears and may be rotated by one dial 30. Rotating with this shaft are the three cams, 15, 16 and 17. Each cam controls a small variable compensating condenser, 21, 22, and 23. These condensers are connected in parallel with the main condensers which are connected to the tuning inductors. The principle of operating of the device is as follows:

The three condensers 1, 2 and 3 are as nearly equal in capacity at any setting as it is practical to obtain them on a production basis. The movable plates are connected to the shaft in approximately the same angular position. It will be seen that an exact adjustment of the condensers to give the same resonant frequency to each of the three tuned circuits 12—27, 13—28 and 14—29 over a continuous range of frequencies as the dial 30 is turned thru 180 degrees cannot be obtained due to inequalities of the capacity variation of the three condensers 12, 13 and 14, and to inequalities in the inductances 10, 11 and 12. To attain this end that is, the maintenance of the three tuned circuits in exact resonance as the dial 30 is rotated, the three compensating condensers 27, 28 and 29 are adjusted by means of adjustments 24, 25 and 26. This adjustment of the set over its frequency range is as follows: Dial 30 is set at zero and knobs 24, 25 and 26 adjusted until the three circuits are brought into resonance by the variations in the compensating capacities 21, 22 and 23. The positions of the arms, 18, 19 and 20 against the discs 15, 16 and 17 is then marked by a dot on the disc as described above. The dial 30 is then rotated, say two or three degrees, and the three circuits again brought into resonance by adjusting knobs 24, 25 and 26 and the second location of the arms 18, 19 and 20 marked on the disc. This process is continued until a series of dots have been made on the discs, as shown in Fig. 1. The discs are then cut along the dotted line and the end of the arms adjusted to run on the periphery of the cam thus formed. When the dial 30 is then turned thru 180 degrees the three circuits 12—27, 13—28 and 14—29 will be maintained continuously in resonance by the variations of condensers 21, 22 and 23 which are made to vary in the exact proportions necessary to compensate for inequalities in the constants of the three circuits. Thus with this adjustment once made it becomes possible to operate such a receiving set by means of but one control. As in the former case adjust-

ments of 24—25 and 26 are needed only while determining the shapes of the cams and are not made thereafter.

There are of course several modifications of the arrangements shown in Figs. 1 and 2. Some of these are shown in Figs. 3, 4, 5, 6 and 7. Fig. 3 shows a combination in which a variable condenser 31 and variometer 33 are arranged to be variable thru their range by means of one manual control 78. A compensating variometer 38 connected in circuit with condenser 31 is operated by cam 32 and a compensating condenser 35 connected in circuit with variometer 33 is operated by cam 34.

Fig. 4 shows a combination in which a variable condenser 40 and variometer 42 are arranged to be variable thru their range by means of one manual control 79. A compensating condenser 47 connected in circuit with the condenser 40 is operated by cam 41 and a compensating variometer 45 connected in circuit with variometer 42 is operated by cam 43.

Fig. 5 shows a combination in which a variable condenser 49 and another variable condenser 51 are arranged to be variable thru their range by means of one manual control 80. A compensating variometer 57 connected in circuit with condenser 49 is operated by cam 50, and a compensating variometer 54 connected in circuit with condenser 51 is operated by cam 52.

Fig. 6 shows an arrangement in which a variometer 59 and another variometer 61 are arranged to be variable thru their range by one manual control 81. A compensating variometer 67 connected in circuit with variometer 59 is operated by cam 60 and a compensating variometer 64 connected in circuit with variometer 61 is operated by cam 62.

Fig. 7 shows a combination in which a variometer 69 and another variometer 72 are arranged to be variable thru their range by means of one manual control 82. In this case the two variable circuits are gear connected by means of one to one gears. A compensating condenser connected in circuit with variometer 69 is operated by cam 70 and a compensating condenser 74 connected in circuit with variometer 72 is operated by cam 73. The method of connecting the two variable circuits together by gear 71 Fig. 7 is of course applicable to Figs. 1, 2, 3, 4, 5, 6.

It is not intended to limit the application of this method of unicontrol to two types of receivers, as it may be applied to many forms of circuits in which it may be necessary to vary the electrical constants of two or more circuits in any desired relation with respect to each other over any desired frequency range.

What I claim as new and desire to obtain Letters Patent of the United States is:

1. The combination in a radio receiving device comprising a plurality of adjustable means arranged to be operated by a common means, cams arranged to be operated by the common means, said cams operating continuously variable compensating condensers.

2. The combination in a radio receiving device of cams rotating on the same shaft with continuously variable condensers, each of said condensers being so connected mechanically as to be both varied by one manual control, said condensers having connected in parallel with them continuously variable compensating condensers whose capacities are caused to vary dependent upon the shape of the respective cam to which they are connected.

3. In an apparatus for reception of radio signals the combination of means of tuning a circuit consisting of inductance and continuously variable capacity to any radio frequency by means of one manual control, means for causing by the same manual control the frequency of a radio frequency generating circuit consisting of inductances and continuously variable condensers in parallel to vary in a definite relation to the frequency to which the first named circuit is tuned.

4. In an apparatus for the reception of radio signals the combination of a variable condenser, a second variable condenser so connected mechanically to the first that both condensers may be variable thru a continuous range of capacities by means of one manual control; a cam operated by the same control, said cam operating a compensating condenser electrically connected in parallel with the second variable condenser, said cam being so shaped as to operate the compensating condenser in such a way as to maintain a desired relation between the electrical constants of the radio frequency circuit associated with the first condenser and those associated with the second condenser.

5. In apparatus for the reception of radio signals the combination of two or more variable tuning condensers so connected mechanically to each other as to be continuously variable thru their range of capacities by means of one manual control; a cam associated and rotatable with each condenser by the same control inductances connected across each condenser, a compensating condenser connected in parallel with each variable tuning condenser, said compensating condensers being operated each by one of the said cams in such a way as to maintain each of the circuits consisting of inductance and capacity continuously in resonance with each of the circuits consisting of the inductance and capacity over a range of radio frequen-

cies, said condition being accomplished with but one manual control.

6. A control system for electrical apparatus comprising a plurality of independent electrical circuits whose constants are continuously variable each having inherently different electrical characteristics a single control arranged to simultaneously adjust each of said circuits to a given frequency, cams operated by said single control, said cams operating suitable continuously variable impedances whereby each of said circuits is adjusted to the same frequency.

In testimony whereof, I affix my signature.

FRANCIS W. DUNMORE.