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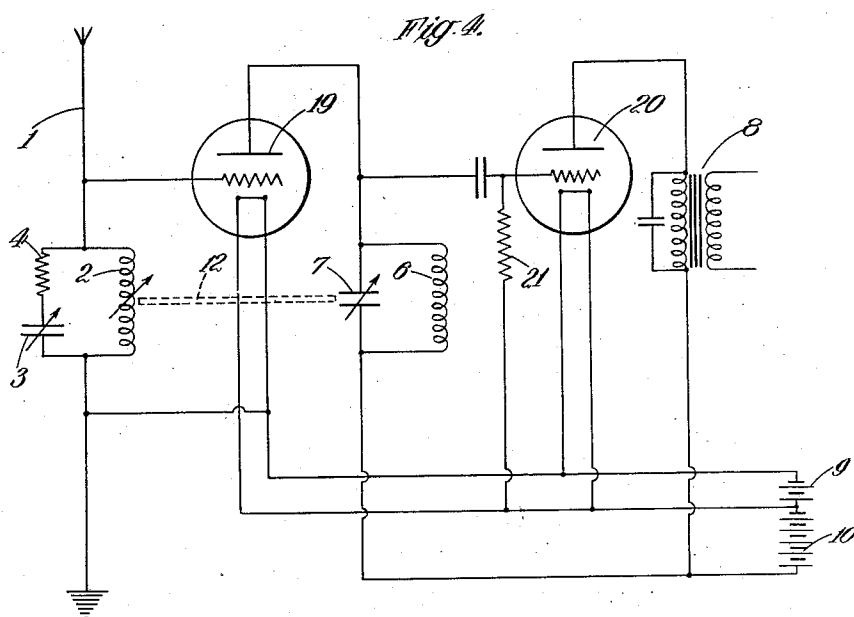
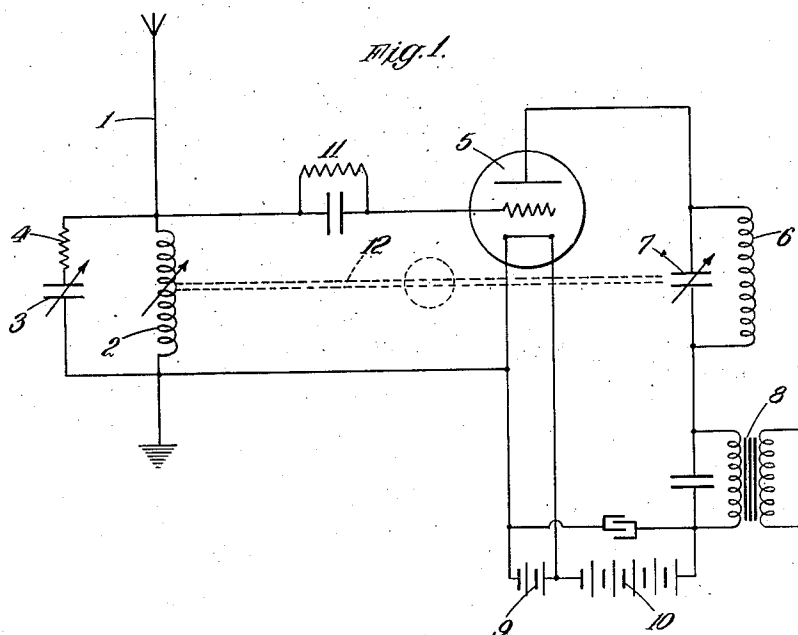
1,518,633

R. E. H. CARPENTER

RADIO SIGNALING SYSTEM AND APPARATUS THEREFOR

Filed May 20, 1924

2 Sheets-Sheet 1



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INVENTOR
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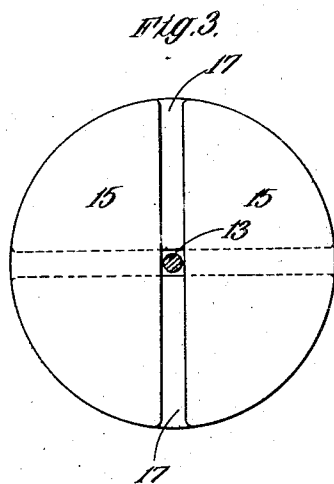
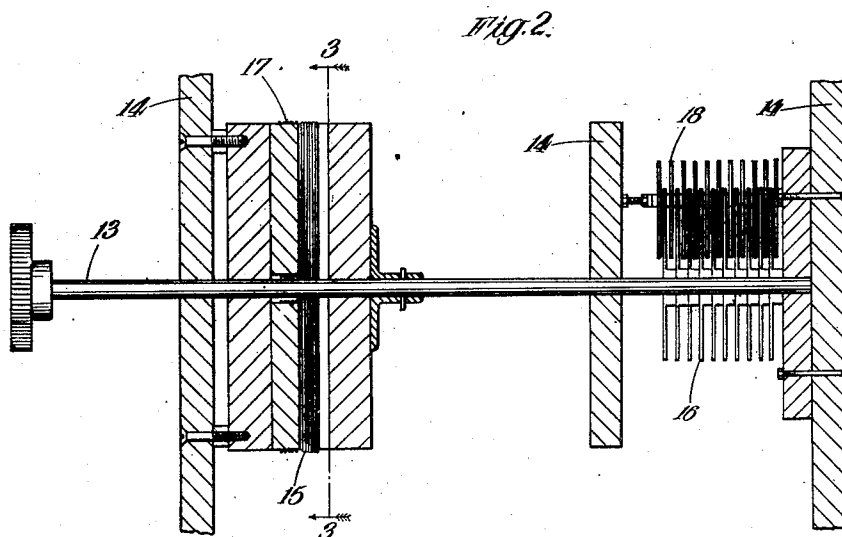
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RADIO SIGNALING SYSTEM AND APPARATUS THEREFOR

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE.

RUPERT EVAN HOWARD CARPENTER, OF PURLEY, ENGLAND.

RADIO SIGNALING SYSTEM AND APPARATUS THEREFOR.

Application filed May 20, 1924. Serial No. 714,548.

To all whom it may concern:

Be it known that I, RUPERT EVAN HOWARD CARPENTER, a British subject, residing at 21, Smithambottom Lane, Purley, in the county of Surrey, England, have invented new and useful Improvements in and Relating to Radio Signaling Systems and Apparatus Therefor (for which I have filed in Great Britain application 213,309, dated the 27 of November, 1922), of which the following is a specification.

This invention relates to improvements in radio or other high frequency telephonic and telegraphic systems and apparatus of the type in which retroaction or regeneration is employed for the amplification of received signals, or for the production of self-oscillation.

The primary object of the present invention is to provide apparatus in which the retroactive or regenerative amplification is substantially unaffected by the operations of tuning the apparatus for varying frequencies and/or to suit the characteristics of differing aerial systems to which the apparatus may be connected, thus rendering the provision of separate means of control of the closeness of approach to the oscillating condition unnecessary. Amongst the advantages of such apparatus are the simplification of tuning adjustments and the prevention of the setting up of oscillation in the aerial circuit by negligent or inadvertent adjustment, thus rendering the apparatus peculiarly adapted to use by unskilled persons.

The method which I employ to achieve the object set forth consists in the use of mechanical coupling between tuning means in an oscillatory circuit and some other electrical variable or variables in the apparatus.

Although not so limited, I prefer to employ interelectrode capacity retroaction and suitable apparatus for carrying out the invention employing this principle will now be described by way of example with reference to the accompanying drawings in which:—

Figure 1 is a diagrammatic representation of a single valve system,

Figure 2 illustrates one form of mechanical coupling,

Figure 3 is a view partly in section taken on line 3—3 of Figure 2, and

Figure 4 is a diagram of a two valve system.

Referring to the drawings, 1 designates the aerial and 2 a variometer with which is connected in parallel with the variable capacity 3 and resistance 4, as shown. In Figure 1, the valve 5 serves as an amplifier and rectifier, the anode circuit of which contains a fixed inductance 6 and variable capacity 7. A transformer or the like 8 serves for connecting up telephones or another valve while the filament battery is designated 9 and the anode battery 10. A grid leak is indicated at 11. The movable elements of the variometer 2 and the variable capacity 7 are mechanically coupled as indicated in dotted lines at 12 so that both are simultaneously adjusted.

In Figures 2 and 3 which show one form of coupling, the shaft 13 rotatably mounted in supports 14 carries the movable element 15 of the variometer 2 and also the movable element 16 of the capacity 7, the fixed elements of which are indicated at 17 and 18, respectively, and are secured to the supports 14. Rotation of shaft 13 simultaneously varies the inductance in the aerial circuit and the capacity in the anode circuit.

In Figure 4, the valve 19 serves as a high frequency amplifier while valve 20 serves as a rectifier, the transformer or the like 8 being connected in the anode circuit of valve 20. The grid leak is indicated at 21 and the mechanical coupling in dotted lines at 12.

It will be seen that due to the mechanical coupling, as shown for example in Figure 4, existing between the anode or intervalve circuit condenser and the aerial tuning inductance, the value of inductance in the aerial is determined for any wave-length by the setting of the anode circuit condenser and it follows that aerials of differing capacities can only be brought into or near resonance with the anode circuit by variations in the setting of the parallel aerial tuning condenser. Hence, the L/C ratio of the circuit joined between grid and filament of the first valve on which ratio the retroaction partly depends, is determined for any wave-length by the setting of the anode circuit and is substantially independent of the capacity of the aerial system. It will be

seen, however, that when working with aerials of small capacity, the major part of the oscillating current flowing in the aerial tuning inductance will flow in the aerial tuning condenser circuit and this circuit would normally have a much smaller ohmic loss than the aerial earth circuit proper, and a small resistance, shown at 4 in Figure 4, may therefore be connected in series with the aerial tuning condenser to reduce this variation. In practice this will generally be of a few ohms resistance and the value necessary to prevent appreciable change in retroaction as between two aerials of differing capacity is easily found by trial. In some cases I prefer to employ a series variable condenser in the aerial circuit, for bringing aerials of different capacities into resonance in which case the resistance arrangement described above can be omitted.

It will further be seen that in the operation of tuning the apparatus for differing frequencies the impedance of the grid circuit will increase as the impedance of the anode circuit is reduced and by making these impedances vary at the correct relative rate, but not necessarily at the same rate, the apparatus can be so designed that the retroaction which is obtained when the two circuits are in correct relative tune is independent of the frequency to which the apparatus as a whole is tuned, within the limits for which it is designed.

In order that the correct relative rates of variation of the impedance of the grid and anode circuits, so as to give constant retroaction, may be obtained, the condenser 7 must be given a special law as regards the relation between its capacity and its angular setting and the method of designing this condenser is as follows:—

The apparatus in, for example, Figure 4, is first set up without there being any mechanical coupling between the variometer 2 and the condenser 7, the variometer being chosen so as to give the desired wave-length range in conjunction with the aerial capacities it is proposed to use, and a trial value for coil 6 being first employed. The variometer 2 is then set to an angular position which is noted and a corresponding arbitrary setting of the condenser 7 is made. The condenser 3 is then varied so as to bring the two circuits into that relation giving maximum retroaction and it is observed whether this maximum is greater or less than the desired value. Usually the desirable value will be that which gives the highest amplification consistent with freedom from distortion in the sound of the received signals. If, for example, the retroaction is found to be insufficient, the condenser 7 is reduced somewhat in capacity and the grid circuit is retuned by means of condenser 3. This process is repeated until

a setting of condenser 7 is arrived at which, in conjunction with the trial coil 6 and appropriate tuning of the grid circuit, will give the desired degree of retroaction. A series of such observations is then made consecutively for various angular settings of the variometer 2, and should the wave-length range covered by the condenser 7 and trial coil 6 be suitable, a condenser for mechanical coupling to the variometer can now be designed in which the capacities vary with angular displacement as the experimentally determined value of 7 varied with the angular displacement of variometer 2. Should, however, the wave-length range be for example too low, a coil having a higher ratio L/R of inductance to resistance should be substituted for the trial coil 6 and the whole experiment repeated anew. Alternatively, should the wave-lengths covered be higher than those desired a coil having more resistance and/or less inductance than the trial coil 6 must be substituted therefor. In order to give the condenser 7 the necessary law, the shape of the plates or the form of mechanical coupling may be calculated from the empirical data.

It will be seen that in the above described apparatus the retroaction is maintained constant for various tunings by arranging that the impedance of the anode circuit decreases as that of the grid circuit increases; but it may be convenient to arrange that the tuning of both circuits is affected in such a way that the impedances of grid and anode circuits, would, in the absence of any further control of retroaction, vary in the same sense with change of tuning, and in such apparatus it is necessary that the mechanical coupling operates a circuit element specially adapted to control the retroaction in some way. Thus where both grid and anode circuits are tuned by means of variometers the spindle of the anode circuit variometer should control for example a small variable condenser connected between the anode and grid of the first valve and so arranged that this extra retroaction condenser increases in capacity as the anode circuit variometer decreases in inductance. Preferably this mechanical coupling should also extend to the grid circuit variometer, in which case the advantages of stabilization of retroaction as regards aerials of differing characteristics will also be obtained as described above.

It will be understood that the extra retroaction condenser described above is only one method of control of the closeness of approach to the oscillating condition and the mechanical coupling may operate a variable self or mutual inductance or a variable damping means to offset the variations which the tuning of the apparatus would otherwise produce in the retroaction.

It may be pointed out that a constant co-

efficient of coupling between grid and anode circuits of a valve will not necessarily give constant feed-back. The co-efficient of coupling between the grid and anode circuits in Figure 4 is given by the expression

$$k = \frac{C_m}{\sqrt{(C_g + C_m)(C_a + C_m)}}$$

10 C_g being the capacity of the grid circuit, C_a the capacity of the anode circuit and C_m the capacity between the anode and grid portions of the valve, valve-holder and associated wiring.

15 Since in the device according to Figures 1 or 4, C_g varies but little and C_a is varied over a considerable range with change of tuning while C_m is of course constant, it will be seen that the co-efficient of coupling
20 decreases as the apparatus is tuned for the lower frequencies.

It will be understood that this invention

may be applied to the production of self oscillation either for use in the reception of signals by the heterodyne method or for other purposes. In this case the electrical variables will be adapted and interconnected with the object of restricting the variations of the maximum amplitude of oscillation which the apparatus will give at various frequencies within its range and/or with various aerials to which it may be connected.

I claim:—

In radio receiving apparatus having a capacity-inductance loop in the antenna ground circuit, the method of accommodating such apparatus to antennæ of different characteristics which consists in inserting resistance in series with said capacity to obtain partial accommodation and then adjusting the capacity until complete accommodation is secured.

RUPERT EVAN HOWARD CARPENTER.