May 13, 1930. P. D. ANDREWS 1,758,816

RADIO TRANSMITTING SYSTEM

Filed June 5, 1929

Fig. 1

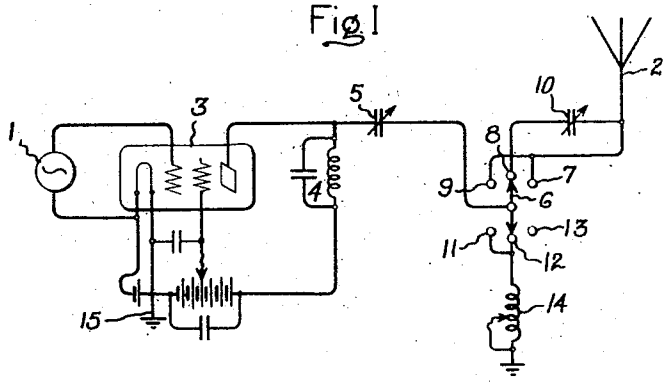
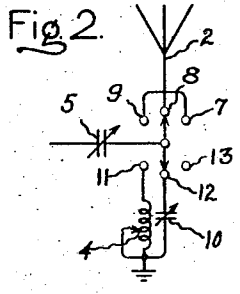


Fig. 2.



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UNITED STATES PATENT OFFICE

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RADIO TRANSMITTING SYSTEM

Application filed June 5, 1929. Serial No. 368,669.

My invention relates to radio transmitting systems, and more particularly to means for exciting radiating antennæ.

It has for one of its objects to provide means whereby an antenna having certain physical characteristics may be efficiently operated over a very broad range of frequencies.

A further object of the invention is to provide a tuning means including a mutual coupling between the antenna circuit and the exciting source of oscillations together with switching means of simple construction whereby the antenna may be caused to operate efficiently over a wide range of frequencies.

On page 758 of the book entitled "Principles of Radio Communication", first edition, by J. H. Morecroft, published by John Wiley and Sons, of New York, is shown a curve representing the general frequency-reactance characteristic of a vertical antenna. It is apparent from this curve that at a certain low fundamental or natural frequency of the antenna the reactance of the antenna is zero and that the reactance is zero at each of the odd harmonics of this frequency. This curve further shows that at the even harmonics of this frequency the reactance is infinite and that as the frequency increases from one of these points of infinite reactance the reactance becomes diminishingly capacitive until a frequency corresponding to an odd harmonic of the fundamental frequency is reached when the reactance is zero. Beyond this point the reactance becomes increasingly inductive until the next higher even harmonic is reached when the antenna again has infinite reactance.

Among the objects of my present invention is to provide an arrangement whereby the antenna may be caused to operate satisfactorily over the broadest possible range of frequencies between those frequencies at which the reactance is infinite. In this way the antenna may be made to operate at practically any frequency higher than the natural period of the antenna with the exception of those frequencies in the immediate neighborhood of the frequencies at which infinite reactance occurs.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself however both as to its organization and method of operation, together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 represents one embodiment of my invention, and Fig. 2 represents a modification thereof.

Referring to Fig. 1 of the drawing I have shown at 1 a source of high frequency oscillations of variable frequency which is associated with a radiating antenna 2. As shown in the drawing oscillations from the source 1 are supplied to the control grid of an electron discharge amplifier 3, where they are amplified and supplied to an output circuit which includes the resonant circuit 4. High frequency oscillations set up in the resonant circuit 4 are supplied to the antenna 2 through a coupling condenser 5 and switch 6 arranged between the coupling condenser and the antenna. The antenna is connected directly to stationary contacts 7 and 9 on the switch and through a variable tuning condenser 10 to an additional stationary contact 8 on the switch. The movable element of the switch 6 is arranged to engage in its different positions each of the contacts 7, 8 and 9, and simultaneously to engage with additional contacts 11, 12 and 13 respectively. Contacts 11 and 12 are connected through a tuning coil 14 to the earth, whereas no connection is made to contact 13.

With the switch in the position shown in the drawing it will be seen that the antenna 2 is connected to earth through the tuning condenser 10, switch 6, in engagement with its contacts 8 and 12 and the variable inductance 14. The reactances of condenser 10 and inductance 14 may be so adjusted that the antenna circuit is in substantial resonance, at any desired frequency within a fairly broad range. The inductance 14 then constitutes a mutual coupling between the resonant cir-

cuit including the antenna and that comprised in the output circuit of the amplifier 3, the cathode of the amplifier being connected to ground at 15. Preferably the condenser 10 is so adjusted that the reactance of the antenna together with the condenser 10 is capacitive over a large portion of the range of frequencies between points of infinite reactance of the antenna. The condenser is then fixed in position and tuning within this range is effected by the inductance 14.

This manner of adjustment simplifies the tuning operation, requiring only one main tuning control. By turning the switch 6 to engage contacts 7 and 11 the condenser 10 is eliminated from the circuit, and the antenna is connected directly to the inductance 14. This position of the switch should be employed in that range of frequencies in which the antenna reactance is capacitive. The inductance 14 may then be made to resonate with the capacity of the antenna.

It will be seen that in both of these positions of the switch the antenna is current fed; that is, the oscillations from the source 1 are supplied to the antenna at a point at which the electrical variations are principally variations in current rather than in voltage, that is at a nodal voltage point, this point being directly between the inductive and capacitive reactance of the reasonant circuit comprising the antenna.

Over a certain range of frequencies approaching those frequencies at which the reactance is infinite, tuning of the antenna by means of inductance and capacity can not readily be effected and accordingly current feeding of the antenna as above indicated is not practical. In order to operate the antenna over these frequencies the switch 6 should be turned to engage its contact 9. In this position the antenna is connected directly through the coupling condenser 5 to the resonant circuit 4 and the mutual coupling or tuning coil 14 is eliminated from the circuit. In this way the entire voltage variation of the resonant circuit 4 is supplied directly to the antenna through the coupling condenser 5. Since, due to the high impedance of the antenna very little current flows in the condenser 5, practically the entire output voltage is impressed upon the antenna. Thus in this position of the switch the antenna is principally voltage fed, or is fed near a nodal current point of the antenna circuit.

The arrangement shown in Fig. 2 differs from that shown in Fig. 1 in that the antenna is connected directly to all of the upper contacts of the switch. Of course the antenna may be connected directly to the armature of the switch if desired. The inductance 4 is connected between the contact 11 and ground, and the condenser 10 is connected between the contact 12 and ground. Thus in that range of frequencies where the antenna reactance is capacitive the switch 6 will be placed in engagement with contact 11 and tuning will be effected by the inductance 4 which also serves as mutual inductance between the resonant inductance 4 and the antenna circuit. In that range of frequencies where the antenna reactance is inductive the switch will be placed in engagement with the contact 12, and the mutual coupling will then be capacitive. In the extreme portions of either of these ranges of frequencies approaching the frequency at which the impedance of the antenna is infinite, the switch will be placed in engagement with contact 9, whereby the antenna may be voltage fed.

It will thus be apparent that I have provided a very simple switching and tuning arrangement whereby the antenna may be adjusted to operate at practically any frequency in the radio range greater than the natural period of the antenna.

While I have shown particular embodiments of my invention, it will of course be apparent that certain modifications will readily suggest themselves to persons skilled in the art, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

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

1. In combination, an antenna, a source of oscillations of frequency variable over a wide range, said source having a ground connection, a connection between said source and said antenna, coupling means connected between said connection and ground, said coupling means being variable substantially to resonate with the impedance of said antenna over a range of frequencies, whereby said antenna is principally current fed from said source over said range of frequencies and switching means arranged to interrupt the connection of said antenna with said coupling means and make another connection whereby said antenna is principally voltage fed from said source at other frequencies.

2. In combination, an antenna, a source of oscillations of frequency variable over a wide range, a plurality of impedances including inductive reactance and capacitive reactance connected in series between said antenna and ground, switching means included in the connection between said impedances having an element movable through a plurality of positions, and a connection between said element and ground including said source, said switching means being arranged in one position thereof to connect said antenna directly through one of said impedances to ground and in another position thereof to connect said antenna to said source and when in said position to interrupt said connection to ground through said last mentioned impedance.

3. In combination, an antenna, a source of oscillations of frequency variable over a broad range, said source having an output resonant circuit connected to ground, an additional resonant circuit including said antenna, and a variable reactive impedance connected between said antenna and ground, a coupling condenser connected between said first mentioned resonant circuit and said reactive impedance and antenna, said reactive impedance constituting a mutual coupling between said resonant circuits, and switching means for interrupting the connection of said antenna to said reactive impedance while maintaining the connection of said antenna to said coupling condenser whereby said antenna is subject to practically the entire voltage variation of said first mentioned resonant circuit.

In witness whereof, I have hereunto set my hand this 4th day of June, 1929.

PAUL D. ANDREWS.